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**Review of the National Program
for Irrigation R&D 1993–1998**

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Review of the National Program for Irrigation R&D 1993–1998

Agtrans Research



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Contents

	Page no
List of Acronyms and Abbreviations	5
Acknowledgments	5
Executive Summary	6
1 Introduction	9
1.1 Background to the Review	9
1.2 Terms of Reference	9
1.3 Structure of Report	9
2 Description of Program	11
2.1 Background to National Program for Irrigation R&D	11
2.2 Aims, Objectives and Priorities	12
2.3 Projects Funded	12
2.4 Financial Resources Invested	12
3 Previous Evaluations of Projects	18
3.1 Introduction	18
3.2 Project Evaluations	18
3.3 Summary and Conclusions from Past Evaluations	21
3.4 A Future Strategy for Evaluation	22
4 Stakeholder Survey	24
4.1 Introduction	24
4.2 Survey Method	24
4.3 Results for Irrigators	24
4.4 Results for Irrigation Service Providers	25
4.5 Results for Principal Investigators	27
4.6 Summary and Conclusions	30
5 Assessment of Program	33
5.1 Introduction	33
5.2 Achievement of Objectives	33
5.3 Summary of Project Outputs	37
5.4 Translation of Outputs into Outcomes	39
5.5 Criteria for Assessing Outcomes and Achievements	40
5.6 Program and Project Management	40
6 Findings and Recommendations	43
References	48
Annex A: Questionnaires Used in Stakeholder Survey	49
Annex B: Comments from Stakeholder Survey	55
Annex C: Summaries of Projects Funded By NPIRD	63

List of Tables

2.1	Irrigation projects funded under phase 1 of NPIRD	13
2.2	Irrigation projects funded under phase 2 of NPIRD	15
2.3	Summary of expenditure by program phase	17
2.4	Sources of Income for NPIRD Program	17
2.5	Leverage of resources from host R&D organisations by NPIRD	17
2.6	Program support costs as percentage of program expenditure	17
3.1	NPIRD projects subjected to economic evaluation	18
3.2	Investment analysis results for CPI4	19
3.3	Investment analysis results for UNE23	19
3.4	Investment analysis results for QPI27	20
3.5	Investment analysis results for UME12	20
3.6	Investment analysis results for UAD14	21
3.7	Summary of investment criteria	21
4.1	Response rate for survey of three groups of stakeholders associated with NPIRD	24
4.2	Rating of specific impacts of NPIRD by irrigators	25
4.3	Rating of communication performance of NPIRD	25
4.4	Ratings by irrigators for priority setting mechanisms	26
4.5	Ratings of specific impacts of NPIRD by irrigation service providers	26
4.6	Rating by irrigation service providers of communication performance of NPIRD	27
4.7	Ratings by irrigation service providers for priority setting mechanisms	27
4.8	Ratings by irrigation service providers for various aspects of NPIRD management	28
4.9	Ratings of specific impacts of NPIRD by research providers	28
4.10	Principal target audiences as nominated by principal investigators	29
4.11	Estimates by principal investigators of adoption characteristics of R&D outputs	29
4.12	Rating of communication performance of NPIRD by principal investigators	29
4.13	Ratings by research providers for priority setting mechanisms	30
4.14	Ratings by principal investigators for various aspects of NPIRD management	30
5.1	How program objectives were addressed in phase 1 of the program	34
5.2	How program sub-objectives for objective 1 were addressed in phase 2	35
5.3	Summary of the principal types of outputs generated from projects funded in phase 1	38
5.4	Summary of the principal types of outputs generated from phase 2	38

List of Acronyms and Abbreviations

B/C	benefit-cost	MDBC	Murray-Darling Basin Commission
BCR	benefit-cost ratio	NIEC	National Irrigation Education Committee
BMP	best management practice	NIRF	National Irrigation Research Fund
COAG	Council of Australian Governments	NLP	National Landcare Program
CRDC	Cotton Research and Development Corporation	NPIRD	National Program for Irrigation Research and Development
CSIRO	Commonwealth Scientific and Industrial Research Organisation	NPV	net present value
DLWC	Department of Land and Water Conservation (NSW)	NSW	New South Wales
DNRE	Department of Natural Resources and Environment (VIC)	PAM	participatory action management
DRDC	Dairy Research and Development Corporation	QLD	Queensland
HRDC	Horticulture Research and Development Corporation	QDNR	Queensland Department of Natural Resources
IAA	Irrigation Association of Australia	QDPI	Queensland Department of Primary Industries
IRR	internal rate of return	R&D	research and development
LBP	local best practice	RDC	research and development corporation
LWRRDC	Land and Water Resources Research and Development Corporation	SRDC	Sugar Research and Development Corporation
		WUE	water-use efficiency

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Executive Summary

This report provides a review and performance assessment of the National Program for Irrigation Research and Development (NPIRD) during 1993–1998. The Program is a partnership between LWRRDC, State water agencies and irrigators. The objective of the review was to assess the performance and impact of the program over that time and to identify where improvements might be made for a third phase of the program that was to be initiated in July 1999.

Performance and Impact of NPIRD

- NPIRD has provided a collaborative industry–government framework for the coordination and investment of joint R&D funds in the national interests for irrigation in Australia.
- The outputs and outcomes of the program have been in line with the declared objectives and strategies.
- The program has stimulated further interest and activities in water-use efficiency, irrigation benchmarking and networking.
- Through its national coordination role, the program has improved the use of existing skills and has positively influenced irrigation research capacity.
- NPIRD has demonstrated great potential for 'participative action management' (PAM) as a new approach to enhancing the adoption of R&D outputs.
- NPIRD has contributed significantly to education initiatives in the irrigation industry.
- Economic evaluations conducted to date indicate a significant, positive rate of return to investment.
- The program has been well managed and the coordination of projects has added significant value to the investment.

Recommendations for Improved Performance

Some of the key recommendations made to improve performance in Phase 3 are:

- NPIRD should consider wider representation on the program's management committee;
- NPIRD should clearly specify its intention on strategic research funding;

- technology audits should be considered for selected areas;
- NPIRD should continue to strive to develop stronger linkages with other R&D funding organisations; and
- performance criteria should be developed at the program level.

Background to NPIRD

Phase 1 of the program invested \$2.45 million during 1993–1996. The expenditure for phase 2 (1996–2000) was some \$5.33 million. Phase 1 initiated some 33 projects and phase 2 some 35 projects. Funding for many of the projects started in phase 1 continued under phase 2.

Approach to Review

The methods used in this review included:

- an analysis of 54 projects funded by NPIRD, in terms of their objectives, outputs, and outcomes;
- an analysis of five projects previously subjected to benefit–cost analysis;
- a stakeholder survey that included irrigators, irrigation service providers and principal investigators of R&D projects; and
- an analysis of the management of the program and its projects.

Meeting Program Objectives and Fulfilling Strategies

Each project funded within each phase of the program was analysed against stated objectives. All objectives appeared to have been addressed by the portfolio of projects funded. Within phase 2, the R&D support objectives of coordination, adoption, communication, and improvement of the R&D base were all addressed. Although significant efforts have been made in all of these areas, the outputs and outcomes in the areas of coordination (in particular integration with extension) and encouragement of adoption have been restricted and further efforts are required. In this regard, however, it should be noted that the NPIRD Program Coordinator position is part time (3 days per week) and there are significant demands in project and program management for this time. Time available for the resource intensive coordination and adoption facilitation is scarce.

Outputs of Projects

Regarding outputs from the funded projects, it was concluded that the intended outputs from the second phase were more orientated towards water authority and regional management and less to irrigators than the suite of projects funded under the first phase. The focus of PAM in phase 2 was on the involvement of users in the identification and development of projects. More time and effort were spent in this activity than on the funding of more projects focusing on the PAM technique itself. Also, there has probably been an associated drop off in the number of projects that included some form of demonstration, even though this form of project was rated highly in the stakeholder survey.

In addition, for both irrigators and water authorities, projects in phase 2 were more likely to be orientated to best management practice, benchmarking and the development of specific technologies using client involvement. This change to funding potentially meaningful and useful R&D, with more specific and potentially useable outputs and aimed at specific decision-makers, is to be commended. Respondents to the stakeholder survey also held the view that a more focused and coherent approach to irrigation issues was now evident within NPIRD.

Strategic versus Applied Research

The decision to take more interest in PAM, best management practice, and benchmarking all may be considered appropriate to lift irrigation management and performance. However, maintaining gains made through these mechanisms will ultimately depend on new knowledge and improved technologies that might only be generated through increased investment in strategic research whose outputs might not be used immediately by industry. It is suggested that a part of the future NPIRD budget (say 20%) be directed towards projects that are clearly strategic and innovative, and from where significant gains in productivity and sustainability might be achieved.

Translation of Outputs into Outcomes

Converting NPIRD project outputs to outcomes and benefits to all potential stakeholders is difficult. Many of the outputs to date are not being widely used by irrigators and water authorities and therefore the potentially large benefits are not always being captured. Approximately half of both irrigator and irrigation service provider respondents in the stakeholder survey said that the NPIRD had had a significant impact on irrigators. The most important impact reported was that associated with water-use efficiency (WUE). The specific impact rated the highest by irrigators was drainage with less nutrients and agrochemicals leaving the farm.

However, truly national level projects like benchmarking and WUE frameworks are likely to have widespread adoption. Issues of extrapolating localised projects to other regions need further investigation.

One of the problems in determining benefits is that little is known about how information is being used or on the adoption characteristics of the knowledge or technology produced by the NPIRD projects once a project is complete. A technology audit in selected irrigation areas, or for selected technologies, is a strategy that could be fruitfully pursued by NPIRD in future to identify constraints to uptake and to plan future R&D.

Impact Assessment

Both phases of the program have made an impact on irrigation practice and sustainability. The second phase was more thematic, and placed greater emphasis on the key supporting factors associated with effective R&D (eg. adoption, communication) as opposed to more traditional science and technology funding, apparent under phase 1. This is an improvement over phase 1 and has been made possible by a higher input of management and coordination resources. Greater effort is required to ensure that benefits are captured and this may require an even higher level of resources allocated in this direction in the future.

Catalytic Role

NPIRD can be credited with stimulating further interest and activities with respect to WUE, benchmarking and networking within other agencies. NPIRD showed leadership in this regard, although it is difficult to directly attribute direct causation. Another spin-off took the form of additional projects funded by others as a result of NPIRD investment.

Research Capacity

The coordination efforts of NPIRD have improved the use of existing skills and this has positively influenced Australian irrigation research capacity. Several valuable travelling fellowships and scholarships were supported.

Assessment Criteria

There does not appear to be a set of criteria against which NPIRD can assess its performance on a continuing basis. Those criteria that have been used tend to be output rather than outcome based. It is suggested that outcome criteria could include economic returns to stakeholders as well as adoption information. A set of 'process orientated' performance criteria should also be developed.

Program and Project Management

Project management was very good overall. Projects within the program have been well integrated with one another, especially since the appointment of a Program Coordinator in late 1995. However, integration outside the NPIRD with other funding organisations, and extension and research providers has been patchy (eg. with the Murray–Darling Basin Commission), although it is identified in the plan for phase 2 as requiring development.

While clients and stakeholders have been consulted extensively concerning the priorities for the program, the involvement in program management per se by industry is perceived as lacking, despite strong representation by industry on the management committee. Ways of improving this situation include the funding of more PAM projects and the move to a stronger regional priority setting process.

Respondents to the survey generally believed that consultations with irrigators and research providers were the key mechanisms to be used in future priority setting for the program. Regional workshops were viewed slightly more favourably than a national workshop and regional priority setting committees were also considered quite important, except by the principal investigator group. Overall, the various components of program management were viewed as being satisfactory by irrigation service providers and principal investigators. The main methods of improving adoption suggested by irrigators were:

- local demonstrations of improved technology where applicable; and
- financial analysis by commodity groups or others to demonstrate profitability.

The investment in program support through the coordinator and other measures to add value to R&D has been rewarding.

Evaluation of Program and Projects

The current review is the first major attempt to evaluate NPIRD. There was an attempt in late calendar 1995, before the 1996 National Workshop, to gain input from stakeholders on priorities, and to some extent this invited comment on phase 1 of the program.

Evaluation of projects has taken place through project reviews, but these have been primarily technical rather than making an overall evaluation of worth or the economic value of the investment. Specialist benefit–cost analyses have been carried out on five projects and the results showed the resulting investment criteria were positive. This suggested, with some qualifications, that the NPIRD R&D investment was providing good returns, with benefits accruing to irrigators, water authorities, and the environment. The qualifications were associated with uncertainty associated with many of the assumptions made, as well as how the projects analysed were selected.

A preferred strategy for evaluation in the future would be to randomly draw a sample from the population of projects, with each project analysed either qualitatively or quantitatively. Such a process may be undertaken regularly within the program, for example, every three or five years.

It is important that NPIRD positions itself to develop into a truly national program. A vision for a funding and organisational structure is needed to drive the NPIRD agenda wider than its current focus on the three eastern States.

1 Introduction

1.1 Background to the Review

This study was initiated as a result of the Land and Water Resources Research and Development Corporation (LWRRDC) and the management committee of the National Program for Irrigation Research and Development (NPIRD) wishing to review and assess the performance of the National Program for Irrigation R&D (NPIRD) over the period 1993–1998. The principal intention of the review was to assess the performance and impact of the program to date and identify where improvements might be made for a third phase of the program that was to start in July 1999.

NPIRD has been a partnership program between LWRRDC, State water agencies and irrigators. The first phase of the program ran for three years from July 1993 to June 1996. The second phase of the program ran for a further three years, from July 1996 to June 1999.

This review was conducted in parallel with another consultancy aimed at developing strategies and priorities for a third phase of the program. Hence, it is more orientated towards the past program, but does, in part, provide some linkages to, and suggestions for, any future program.

1.2 Terms of Reference

1. Review the performance and current management arrangements for the LWRRDC National Program for Irrigation Research and Development (1993–1998) in order to provide a base from which future management strategies can be developed.

This review should focus on:

- 1.1 Outcomes and outputs of the program (70% of task 1), particularly in terms of meeting the needs of the program's full range of clients. In approaching this task, the consultant will need to address how best to analyse outcomes against project objectives, particularly in light of the fact that objectives of the program have changed between the first and second phases.
- 1.2 Effectiveness of program management (20% of task 1), including:
 - setting of priorities
 - selection of projects
 - management of projects
 - management of funds

- involvement of clients/stakeholders in management
- monitoring and reporting
- communication of results
- evaluation
- national coordination

- 1.3 Identification of alternative approaches to achieving a better focus on users R&D needs and improved integration and adoption of results (10% of task 1)
2. Estimate the return on investment from the program (20%)
 - 2.1 Collate B/C analyses already undertaken on projects in current program
 - 2.2 Propose a cost effective strategy for the B/C analyses of other projects to meet overall objectives of the Program Review
 - 2.3 Implement the strategy in 2.2 to the extent that the budget allows.
3. Prepare a draft review paper for circulation to key partners and stakeholders including recommendations on future structure, funding and operation of NPIRD (5%).
4. Collect and collate comments on the draft review paper (2.5%)
5. Prepare a final report on the review of the program (2.5%).

1.3 Structure of Report

Chapter 2 of the report provides a description of NPIRD and its objectives and priorities for both its first and second phases, its constituent projects, the financial resources invested and the management structures and processes adopted. Chapter 3 reports the investment analyses made of projects within the program over the past few years, the results obtained, and their interpretation. Chapter 3 also contains commentary on strategies for future portfolio and project evaluation within the program.

The results of a survey of stakeholders are reported in Chapter 4. The survey focused on assessing the impact of the program and its projects, program and project management and communication, and ideas for where improvements might be made.

A broad review of the program is provided in Chapter 5. This includes a description of program outputs, how the program and its projects have met the objectives for each of phase one and phase two, and how outputs have been translated into outcomes and therefore provided benefits to irrigators and the community in general. Management,

administrative and communication performance are commented upon in Chapter 5. Chapter 6 concludes the report with a summary of findings and recommendations for consideration, particularly in relation to a third phase of the program.

2 Description of NPIRD

2.1 Background to NPIRD

Before NPIRD commenced in 1993, support for national irrigation R&D was administered through the National Irrigation Research Fund (NIRF). In 1992–93 LWRRDC assumed this responsibility and increased substantially the resources available for irrigation R&D.

The earlier funding for NIRF was by way of annual grants from the Water Resources Advisory Council. In 1990–1991, the first year of operation of LWRRDC, NIRF was provided with \$155,000 from the Corporation to fund irrigation R&D. NIRF also attracted \$150,000 from State water agencies to complement the LWRRDC funding and funded 17 projects in that year. NIRF ceased to operate when LWRRDC established NPIRD in 1993.

The first phase of NPIRD was a partnership between LWRRDC and three State agencies, namely the Victorian Rural Water Corporation, the NSW Department of Water Resources and the Queensland Department of Primary Industries. Irrigators were also involved in funding at this stage through the NSW Department of Water Resources, as the NSW water industry was undergoing structural change. The structural change associated with the Rural Water Corporation of Victoria also changed the style of the partnership later in this first phase of the program, with individual irrigation authorities taking over responsibility from the Rural Water Corporation.

The first phase of the program was to provide a national focus for irrigation research, and assemble and coordinate R&D initiatives with a focus on longer term sustainability. The priorities set for the first phase of the NPIRD were based on the NIRF priorities defined in 1988–89 (LWRRDC 1993). The program had, for each of its first three years, attracted approximately \$1.2 M in funds. This included \$0.5 M from LWRRDC for the first year of NPIRD (subsequently increased to \$0.6 M per annum) and \$0.2 M per annum from each of the three partners (or in later years of phase 1, the individual water authorities that had displaced the Rural Water Corporation in Victoria).

The NPIRD was managed by its funding partners through a management committee initially made up by two representatives from each of the four major funding partners (LWRRDC and the three States). Committee members were from the LWRRDC Board, the State water agencies, or irrigators. The chairperson of the

management committee has always been a representative of LWRRDC.

At the end of phase 1 and during phase 2 of the program the funding partners were:

- LWRRDC
- Queensland Department of Primary Industries and Department of Natural Resources
- NSW Department of Land and Water Conservation and irrigators from NSW
- Goulburn Murray Water Authority, Victoria
- Southern Rural Water Authority, Victoria
- Sunraysia Rural Water Authority, Victoria
- Wimmera–Mallee Rural Water Authority, Victoria

To provide strategic directions for phase 2 of the program a consultancy was let in late 1995 to produce a discussion paper that was used as an input to a national workshop held in March 1996. This workshop helped form new irrigation program strategies and priorities for the next five years. These included the following:

- the adoption of a water-use efficiency (WUE) theme for phase 2 of the program — this theme was thought to provide an appropriate context for projects to contribute strongly to natural resource sustainability, profitability for irrigators and the improvement of the environment in which irrigation systems operate;
- NPIRD was to work more closely with the commodity R&D corporations;
- the boundaries of NPIRD and MDBC funding were to be clarified and cooperation encouraged;
- further encouragement of widespread adoption of program outputs at the farm level and further encouragement of irrigators to take ownership of projects and the program;
- R&D that integrated water delivery systems, on-farm applications and off-farm drainage;
- developing adoption techniques that were applicable to irrigated areas to ensure that R&D results were applied;
- improvement of communication with clients;
- development of irrigation research skills; and
- work more closely with MDBC and commodity R&D corporations to eliminate duplication and encourage more investment in R&D on WUE.

These considerations were formalised into objectives and strategies that appear in the program plan.

2.2 Aims, Objectives and Priorities

The aims of the first phase of NPIRD were to:

- enhance productivity and sustainability of irrigation;
- improve water management and water-use efficiency;
- find cost effective solutions to infrastructure refurbishment;
- minimise the impacts of salts, nutrients, and other pollutants; and
- increase the adoption of technology by irrigators throughout Australia.

Four associated priority areas, nominated by the program to be addressed first, were:

- improving productivity and sustainability;
- water-use efficiency and management;
- drainage, pollution and salinity; and
- technology adoption and education.

The program was also aimed at (LWRRDC Annual Report 1992/93, p.35):

- providing a national focus for irrigation research;
- ensuring that adequate funds were available to address the problems; and
- coordinating irrigation activities across the three States involved.

The focus of the program changed to some extent when the second phase commenced in July 1996. This was an outcome of the adoption of WUE as the theme for phase 2.

The mission statement for the program adopted in 1996 for the second phase was:

The mission of the NPIRD is to provide national leadership of irrigation research and development and to improve natural resource sustainability, economic viability and environmental quality by focusing on raising the water-use efficiency of on- and off- farm irrigation systems.

The key objectives of the second phase of the program were to:

- increase water-use efficiency of on- and off-farm irrigation systems to enhance resource sustainability, economic viability and environmental quality;
- improve coordination of irrigation research and development, and reduce duplication of effort;
- improve adoption of irrigation R&D outputs;
- effectively communicate the program and its outputs to its stakeholders and clients; and

- improve the R&D base for irrigation, particularly in the field of agricultural engineering.

The theme of water-use efficiency, reflected in the first of those objectives, addressed the major priorities identified by stakeholders including irrigators and the wider community. These priorities were:

- water supply to farms;
- on-farm irrigation management issues; and
- the off-farm impacts of drainage.

The other four objectives set were more process- than issues-based and reflect the intent of the program management to ensure research was efficient and effective and that research outputs were effectively communicated and were adopted up to their full potential by irrigators and other decision-makers associated with irrigation systems.

A set of strategies to address each of the objectives was reported in the program plan.

The changed emphasis on WUE was cosmetic to some extent, since this theme had been identified as early as 1991 by LWRRDC as a key priority area in water management (LWRRDC R&D Plan 1991–1996 and LWRRDC R&D Plan 1992–1997). Further, phase 1 of NPIRD had an underlying, but not explicit, theme of WUE.

2.3 Projects Funded

Lists of the R&D projects funded by NPIRD since its inception are given in Table 2.1 (phase 1: 21 projects) and Table 2.2 (phase 2: 33 projects). The 54 projects included 14 that had been initially funded by NIRF or LWRRDC and before the formal implementation of NPIRD.

Projects funded from July 1993 onwards were those selected by NPIRD. Projects funded from dates earlier than July 1993 were not initially selected by NPIRD but their funding was continued.

2.4 Financial Resources Invested

Table 2.3 summarises the financial resources committed by NPIRD for each program phase.

Some of the projects funded in the first phase were not completed by the end of phase 1 (June 1996). Hence, there was a carryover of funds from June 1996 to the second phase of the program. This is reflected in Table 2.3 by the gradual increase in expenditure from 1994 to 1998 followed by a gradual decrease from 1998 to 2000.

The income from which this expenditure has been made has been roughly equal in each year. The source of income for each year is shown in Table 2.4.

Table 2.1 Irrigation projects funded under phase 1 of NPIRD

Project code	Title	Start date	Completion date	Host institution	Principal investigator
Water use efficiency (supply and management)					
UOC2	Improving irrigation efficiency through remote sensing	Na	Na	University of Canberra	B. Button
UNE19	Integrating environmental and irrigation water allocation under uncertainty	Na	Na	CWPR, UNE	B. Scott
CWN3	Optimising water management in an irrigation area that grows rice	Na	Na	CSIRO Land and Water	W. Meyer
CWW7	Effect of microbiota, salinity and turbidity on leakage from irrigation channels	Na	Na	CSIRO Land and Water	S. Ragusa
RWC3	Crop Check 500: irrigation schedule component	Jul 1992	June 1995	Rural Water Corp Vic	D. Poulton
UME12	Real time monitoring and control of on-farm surface irrigation systems	Jul 1992	June 1995 — extended to June 1998	University of Melbourne	H. Malano
AIT1	Performance testing of automatic irrigation equipment for flood irrigation	Mar 1993	Dec 1996	Australian Irrigation Technology Centre	J. Cape
DAV11	Control of irrigation salinity through conjunctive use of groundwaters and surface waters	Oct 1993	Sept 1996	Agriculture Victoria	J.B. Prendergast M. Bethune
QP127	Economically and environmentally sustainable use of various water supply sources of irrigation	Dec 1993	Nov 1996 — extended to June 1997	QDPI (now QDNR)	J. Hillier
GMW1	Construction and refurbishment of earthen irrigation channel banks	Mar 1995	Dec 1997 — not yet completed	Goulburn Murray Water	I. Moorhouse
AIT2	Development of a value selection method for choosing between alternative soil moisture sensors	Apr 1995	Feb 1996	Australian Irrigation Technology Centre	J. Cape
UNE23	Viability of irrigation infrastructure refurbishment and implications for private ownership	Aug 1995	Dec 1997 — extended to October 1998	Center for Water Policy Research, University of New England	M. Bryant
SKP1	Review of irrigation flow control and measurement to farms	July 1996	Feb 1997	Sinclair Knight Merz P/L	B. Foley
BSE3	Effective irrigation on suitable soils on uneven surfaces	May 1996	Oct 1998	Bureau of Sugar Experiment Stations	L. Tilley C. Sarich
UAD14	Scheduling flow management of open channel gravity systems	Sept 1996	1997 — extended to June 1999	University of Adelaide	G. Dandy
Drainage, salinity and pollution					
CWN2	Reducing groundwater accessions under rice	Jan 1991	Dec 1993	CSIRO Land and Water	E. Humphreys
DAS1	Salinity management strategies for grapevines	Na	Na	Primary Industries South Australia	R. Stevens
CP14	Development of laboratory and field assays for agrochemical residues arising from Australian plant agriculture	Jan 1992	Dec 1996	CSIRO Plant Industry	J. Skerritt

Table 2.1 (cont'd) Irrigation projects funded under phase 1 of NPIRD

Project code	Title	Start date	Completion date	Host institution	Principal investigator
CWN5	River pollution with agricultural chemicals used in irrigation agriculture	Jan 1992	Dec 1994	CSIRO Land and Water	K. Bowmer
DAV7	Contribution of improved fertilisation techniques in irrigated agriculture	Jul 1992	Jun 1995	Agriculture Victoria	P.H. Jerie
QPI16	A generic hydrological design model for the irrigation management of effluent disposal	Jul 1992	Jul 1995	QDPI	E.A. Gardner
DAN8	Use of saline water in rice based farming systems	Jul 1993	Oct 1996 — extended to Sept 1997	NSW Agriculture	P. Slavich J. Thompson
DAV12	Environmentally sustainable fertiliser use through improved flood irrigation management techniques	Oct 1993	Sep 1996	Agriculture Victoria	J.B. Prendergast N. Austin
QPI26	Nutrient control in irrigation drainage systems using artificial wetlands	Jan 1994	Dec 1996 — extended to June 1999	QDPI	J. Simpson H. Hunter
RWC4	Evaluation of enroute wetland systems for nutrient removal from irrigation drainage	Jan 1994	Dec 1996	Rural Water Corp Vic	L. Lloyd P. Cottingham
Adoption of technology					
IAA1	National accreditation system for irrigation education and training	Jul 1992	Jun 1993	Irrigation Association of Australia	C. Thompson
ISA1	Communication market survey for the irrigation industry	Aug 1994	Feb 1995	Irving, Saulwick and Associates	I. Saulwick
BSE2	Increasing irrigation efficiency in the Australian sugar industry	Nov 1994	Oct 1997	Bureau of Sugar Experiment Stations	S.R. Raine J. Holden
CWN9	Adopting improved use of current water monitoring technology to manage recharge	Feb 1995	Jan 1997 — extended to Aug 1998	CSIRO Land and Water	E. Humphreys
DAV15	Towards excellence in dried vine fruit production	Apr 1995	Oct 1997 — extended to June 1988	Sunraysia Horticulture Center, DNRE	I. Ballantyne R. Hayes
DAV16	Establishing a process to improve irrigation automation	Feb 1995 — delayed to Apr 1995	Dec 1997 — extended to June 1998	Agriculture Victoria	R. Standen G. Roberts
UCQ1	Local best practice (LBP) among cotton producers in Central Queensland	Feb 1995 — delayed to June 1995	Jan 1998 — extended to May 1998	Central Queensland University	G. Lawrence
AIT3	Preparation of a discussion paper for the National Program for Irrigation R&D	Dec 1995	Feb 1996	Australian Technology Irrigation Center	J. Cape

Table 2.2 Irrigation projects funded under phase 2 of NPIRD

Project code	Title	Start date	Completion date	Host institution	Principal Investigator
Water use efficiency (water supply, on farm management, drainage)					
QNR2	Replacement options for concrete-lined channels	Oct 1996	June 1998	Queensland Department of Natural Resources	B. Stevenson
SAS1	Research and Development of Best Practice for horticultural irrigation rehabilitation	Oct 1996	Sept 1997	Stanton Associates Pty Ltd	C. Stanton
DAV19	Prediction of sixty year trends in root zone salinity	1996	1996	Agriculture Victoria	M. Bethune
I 6053 or MDB6	Salinity control with sustainable farm salt balance through integrated management	Jan 1996	Jan 2000	Department of Natural Resources and Environment, Victoria	A. Heuperman
SRW1	Best Practice Identification in irrigation providers through benchmarking	1997	1998	Sunraysia Rural Water Authority and Barracough and Co (Aust)	J. Wood
JCU13	Best practice for new irrigation development in Australia	Aug 1997	Sept 1998	James Cook University	G. Lukacs
QNR1	A generic hydrological model of the irrigation management of effluent disposal	July 1996	June 1998	Queensland Department of Natural Resources	E. Gardner
UQL12	Review of existing participative action management (PAM) projects and socio-economic issues affecting adoption of irrigation technology	1997	1997	University of Queensland	S. Chamala
CDH1	Improving the water-use efficiency of horticultural crops	July 1997	June 1999	CSIRO Horticulture	B. Loveys
DAN11	Improving water-use efficiency by reducing groundwater recharge under irrigated pastures	May 1997	Sept 2000	NSW Agriculture	H. Kingston
CTC10	Guidelines for efficient and sustainable trickle irrigation systems	Dec 1997	Nov 2000	CSIRO Tropical Agriculture	P. Thorburn
DAV23	Alternative irrigation technologies in field cropping to increase water use efficiency	April 1997	June 2000	Agriculture Victoria	S. Lolicato
RMI5	Conservation of water from open storages by minimising evaporation	Apr 1997	June 1999	Royal Melbourne Institute of Technology	A. Akbarzadeh
BAR1	To develop an agreed focus and scope for benchmarking	Mar 1997	Apr 1997	Barracough and Co	J. Wood
CWN13	Determination of optimal irrigation intensity for irrigation areas	July 1997	Dec 2000	CSIRO Land and Water)	W. Meyer J. Madden
AIT5	Development of improved flow measurement in irrigation water supply	Dec 1997	Dec 1998	Australian Irrigation Technology Center	J. Cape
MIL1	Improving hydraulic efficiency of irrigation and drainage systems through benchmarking	Mar 1998	June 2000	Murray Irrigation Ltd	D. Watts
GMW3	Benchmarking the distribution efficiency of an irrigation supply system	May 1998	June 2000	Goulburn Murray Water	K. Preece

Table 2.2 (cont'd) Irrigation projects funded under phase 2 of NPIRD

Project code	Title	Start date	Completion date	Host institution	Principal Investigator
UQL16	Development of participative action management (PAM) for research and development	Jan 1998	June 1999	University of Queensland	S. Chamala
QPI14	Northern Australia irrigation research, development and extension workshop	1998	1998	Queensland Department of Primary Industries	R. Miles
UME58	Improving the efficiency and flexibility of contour irrigation design	Jul 1998	June 2000	University of Melbourne	H. Malano
Coordination					
NDC1	Irrigation program coordinator	Apr 1996	Jun 1998	NRM Consultancy	N. Dawson
EIM3	NPIRD Strategic Plan	Apr 1996	May 1996	Executive Interim Management	J. Doak
AIT4	Position paper on standards and codes for the irrigation industry	Nov 1996	Dec 1997	Australian Irrigation Technology Centre	J. Cape
Adoption					
CSU15	Consultancy brief on irrigation education and skills development	Aug 1997	Sept 1997	Charles Sturt University	W. Meyer
CSU16	Irrigation education modules	Apr 1997	Dec 1997	Charles Sturt University	W. Meyer
GRD3	Irrigated cropping advance 2000: industry development and implementation of best practice	Aug 1997	June 2000	Department of Natural Resources and Environment, Victoria	D. Ugalde
IAA3	Education database of the irrigation industry	Jan 1998	Feb 1998	Irrigation Association of Australia	A. Carmichael
Communication					
EC01	Preparation of a communication strategy for NPIRD	Jul 1996	Nov 1996	Econnect	J. Metcalfe
ANU13	Science Communication Workshop	Mar 1998	Mar 1998	Australian National University	J. Pabian
Irrigation R&D Capacity					
CSU14	An evaluation of subsurface irrigation configurations	Jan 1997	Dec 1999	W Meyer	P. Charlesworth
CSU17	Irrigation travel fellowship	Aug 1997	Jan 1998	Charles Sturt University	W. Meyer
USQ2	Irrigation travel fellowship	Jul 1997	Sept 1997	University of Southern Queensland	R. Smith
UNS26	Water quality sustainability in groundwater abstractions for irrigation	Mar 1998	Aug 2001	University of New South Wales	W. Timms
IAA2	National Irrigation Science Conference	Feb 1998	Jun 2000	Irrigation Association of Australia	G. Connellan

Table 2.3 Summary of expenditure by program phase

Year ended 30 June	Phase of NPIRD	Expenditure (\$)
1994	1	613,888
1995	1	815,063
1996	1	1,022,814
Subtotal Phase		12,451,765
1997	2	1,484,674
1998	2	1,685,533
1999	2	1,565,486
2000	2	594,545
Subtotal Phase 2		5,330,238
TOTAL		7,782,003

Source: LWRRDC

Table 2.4 Sources of Income for NPIRD Program

Year ending 30 June	LWRRDC	Irrigators and States	Other income (a)	Total income
1994	500,000	640,000	30,395	1,170,395
1995	600,000	600,000	110,857	1,310,857
1996	600,000	600,000	127,310	1,327,310
1997	660,000	544,000	141,452	1,345,452
1998	493,000	544,000	155,496	1,192,496
1999	0	544,000	81,803	625,803
2000	544,000	0	78,757	622,757

(a) Includes interest, LWRRDC additional contribution to communication, and other miscellaneous contributions
(Source: LWRRDC)

Table 2.5 Leverage of resources from host R&D organisations by NPIRD

Year ended 30 June	NPIRD expenditure (\$)	Host contributions (\$)	Leverage ratio
1994	613,888	1,006,778	1.64
1995	815,063	1,484,796	1.82
1996	1,022,814	1,300,496	1.27
1997	1,484,674	1,146,972	0.77
1998	1,685,533	1,676,376	0.99
1999	1,565,486	1,559,582	1.00
2000	594,545	870,082	1.46
TOTAL	7,782,003	9,045,082	1.16

Source: LWRRDC

Financial resource commitments (often in kind) made by host R&D organisations to projects funded by NPIRD over each of the two phases are shown in Table 2.5,

alongside the total expenditure by NPIRD in each year. A leverage ratio is also shown.

It should be noted that the figures in Tables 2.3, 2.4 and 2.5 for the years after that ended 30 June 1998 are budget estimates only.

Expenditure is incurred for program support as well as investment in R&D projects. Program support includes the cost of the Program Coordinator, an allocation of the Program Manager's time to the program, travel for the program management committee and executive, and other support costs; communication and administration costs are treated separately. Table 2.6 shows the program support costs as a percentage of the total expenditure for each year.

Table 2.6 Program support costs as percentage of program expenditure

Year ended 30 June	Program support costs (\$)	Total expenditure (\$)	Program support costs as percentage of total expenditure (%)
1994	17,733	613,888	2.89
1995	27,520	815,063	3.38
1996	184,362	1,022,814	18.02
Subtotal phase 1	229,615	2,451,765	9.37
1997	152,739	1,484,674	10.29
1998	116,318	1,685,533	6.90
1999	139,500	1,565,486	8.91
2000	0	594,545	0
Subtotal phase 2	408,557	5,330,238	7.66
TOTAL	638,172	7,782,003	8.20

Source: LWRRDC

The program support costs will average about 8% over the two phases of NPIRD. It is understood from LWRRDC that this is about normal for most programs managed by the Corporation. The program support costs for the 1994 and 1995 years are lower than later years as the Program Coordinator was not appointed until later in 1995. Also, a portion of the Program Manager's costs may not have been included in the first two years of phase 1.

3 Previous Evaluations of Projects

3.1 Introduction

LWRRDC has a program of 'life-of-project evaluations' in which a sample of projects that has just been funded is subjected to benefit-cost analysis, with subsequent updating of each analysis every two to three years. There have been three sets of projects evaluated in this manner with sets of projects initially evaluated in 1993-94, 1995-96 and 1997-98. A fourth set is currently being evaluated. The first set of projects (1993-94) has been updated once already and is currently being subject to a second update. In addition, a set of nine projects all of which were completed by December 1994 was evaluated in 1996.

Some irrigation projects have been selected in the samples taken for these life-of-project evaluations or in the ex-post set of evaluations. One project (CPI4) was selected in the first, 1993-94 set of projects and has been evaluated a second time in 1997. Three projects were subject to economic evaluation at the same time as the 1995-96 random sample was taken from the wider LWRRDC portfolio. Those three projects (UNE23, QP127 and UME12) were selected from the NPIRD by the management committee rather than being selected at random, and were viewed as a special subset of the analyses. Two projects were evaluated in the 1997 ex-post set of projects (CWN2 and CWN5); again these projects were not selected at random but on the basis of achieved outcomes and perceived benefits. A further project (UAD14), was recently evaluated in the third round of life-of-project evaluations. It is understood that there is

also a NPIRD project in the fourth round of life-of-project evaluations currently being undertaken.

NPIRD projects formally evaluated to date are listed in Table 3.1

Summaries of the results of these individual evaluations, as well as an overview of the evaluation strategy used, are reported in the next section. The past evaluations are then summarised in section 3.3 and possible strategies for future evaluation of projects within NPIRD are developed in section 3.4.

3.2 Project Evaluations

The following provides a summary of the results of the economic evaluations carried out to date on each of the NPIRD projects.

Project CPI4 —On-site monitoring of agrochemical residues: a valuable tool for irrigation water management

This project developed enzyme immunoassay kits for detecting a range of pesticides and herbicides in irrigation water systems. The idea was that on-site testing of irrigation water could assist decisions about use of drainage water for further irrigation or for safe return to river systems. In turn this could lead to lowered irrigation costs as well as water conservation and an improved riverine environment.

Table 3.1 NPIRD projects subjected to economic evaluation

Project code	Project title	Reference
CPI4	On-site monitoring of agrochemical residues: a valuable tool for irrigation water management	Temtac (1994); Harrison and Tisdell (1997)
UNE23	Viability of irrigation infrastructure refurbishment and implications for private ownership	ACIL Economics and Policy (1997)
QP127	Economic and environmentally sustainable use of various water supply sources for irrigation	ACIL Economics and Policy (1997)
UME12	Real time monitoring and control of on-farm surface irrigation systems	ACIL Economics and Policy (1997)
CWN2	Reducing groundwater accessions under rice	Sloane Cook and King (1997)
CWN5	River pollution with agricultural chemicals used in irrigated agriculture	Sloane Cook and King (1997)
UAD14	An evaluation of the applicability of genetic algorithm technology to flow management of open-channel gravity systems.	Sloane Cook and King (1998)

The first analysis estimated a break-even value for saved environmental and crop damage of \$50,000 to \$80,000 per annum. Also, it was established that 8,000 kits would need to be sold each year for the research to break even at a 10% discount rate. This was considered a small number in relation to the potential market size, even for use within the irrigation sector alone. The analysis was limited by lack of data for estimating damage functions for agrochemical residues.

The second analysis was undertaken when the project was completed in 1997. A wider framework was used for consideration of project benefits. The following benefits were identified.

- (i) Improved water management for agriculture and the environment. This benefit was valued through the royalties from kit sales, which was considered to provide a conservative estimate. This method of valuation was used because of the difficulty of estimating resource management benefits.
- (ii) Avoidance of unnecessary regulation and compliance costs
- (iii) Reduction in regulatory costs and through savings in testing costs
- (iv) Improved management of own water supplies
- (v) Savings in operating costs of other research projects (This benefit was quantified.)
- (vi) Royalties earned from overseas sales of EIA kits (The assumption was that 10,000 kits would be sold over a three-year period.)

As only the sales of kits are likely to be monitored in the future, the full resource savings and other costs are unlikely to be identified for this project. Further, the impact of changes in the use of drainage water and the saved cost of environmental damage caused by agrochemicals are unknown and difficult to monitor. The benefits estimated are likely to be conservative for this reason.

The results of the second (1997) investment analysis are shown in Table 3.2.

Table 3.2 Investment analysis results for CPI4

NPV (\$ M) (discount rate 7%)	B/C ratio (discount rate 7%)	IRR (%)
1.5	2.7:1	24

Project UNE23 — Viability of irrigation infrastructure refurbishment and implications for private ownership

This project developed a model to assess options for refurbishment of earthen channel infrastructure. Channels were leaking, which not only caused wastage of the water resource but also exacerbated salinity and waterlogging problems across irrigation farms. The

project objective was to allow better integration of economic information with engineering design in order to save water, reduce the severity of environmental problems and reduce the costs of refurbishment. The study was aimed at the ability or otherwise for regional irrigation authorities to finance the refurbishment of existing irrigation infrastructure. Hence, the project was strongly linked to structural adjustment issues in irrigated areas.

The dominant benefit was the likely improvement in refurbishment efficiency. The improvement in the environment through reduced water accessions to groundwater was assumed to result in productivity benefits. This particular benefit, while it could be quite significant, was difficult to quantify as relationships are not known with any certainty.

Project benefits were considered to fall into three areas:

- (i) 5% cost reduction in refurbishment costs due to the modelling effort;
- (ii) the value of water savings valued at its shadow price; and
- (iii) 5% on-farm productivity benefits from reduced waterlogging and quantity of water used (5% cost reduction).

It was assumed that the use of the model would speed up the accrual of the benefits by five years; that is, the benefits would have eventually been captured anyway — the project just brought them forward. While this is realistic, the use of the model was not necessarily proven at the time of the analysis.

The results of the investment analysis are shown in Table 3.3

Table 3.3 Investment analysis results for UNE23

	NPV (\$ M) (discount rate 7%)	B/C ratio (discount rate 7%)	IRR (%)
Total investment	1.7	5.7:1	23
LWRRDC only	0.7	5.7:1	19

Project QPI27 — Economic and environmentally sustainable use of various water supply sources for irrigation

In the Bundaberg region of Queensland, overuse of groundwater has the potential to induce tidal intrusion of saltwater. Thus, the relative use of surface and groundwater is of critical importance. The major objective of Project QPI27 was to formalise models to guide decisions on the relative amounts to use.

The project extended the modelling frontiers in this regard and a knowledge base was developed. In terms of applied outputs, these were restricted to potentially improved decisions in the Bundaberg region concerning sources of irrigation water and consequently security of future land use.

The objective was to link surface and groundwater models with crop water use and water quality, as well as integrate a climate prediction model. It was decided to build linkages between existing models.

Rather than a global, conjunctive use model, QDPI developed a number of utilities that enabled existing models and pre-processing software to be used in an irrigation setting.

The benefits defined for the project were:

- (i) 10% increase in water yield from storages;
- (ii) more effective use of water for irrigation;
- (iii) environmental sustainability of the irrigation area through control of the water table and water quality;
- (iv) economical sustainability of the irrigation area; and
- (v) benefits to managers in other irrigation areas and other modellers.

The benefit included in the quantitative analysis was improved water use. Productivity improvements were available to irrigators, but most of the gain from the R&D appears to be in enabling existing irrigators using groundwater to remain in agriculture when they otherwise may have been forced to cease production. The result is that there is now a greater reliance on surface water than there was before the study.

As with UNE23, this would have been a most difficult project to assess in economic terms. The results of the investment analysis are shown in Table 3.4.

Table 3.4 Investment analysis results for QPI27

NPV (\$ M) (discount rate 7%)	B/C ratio (discount rate 7%)	IRR (%)
2.2	2.1:1	26

Project UME12 —Real time monitoring and control of on-farm surface irrigation systems

This project focused on scheduling of flood irrigation applied to dairy farm pastures and contained elements of real time soil moisture monitoring, decision-making, remote data access, graphical data displays and forecasting of plant water usage.

As the scheduling was aimed at both under-watering and over-watering, there were several potential benefits associated with the project:

- improved productivity through optimal pasture growth;
- saved water; and
- reduced environmental impacts through less groundwater accessions and reduced run-off.

The benefits from the project were assumed to result from bringing forward by three years the benefits that it was assumed would occur anyway. The technology was considered relevant to both the cotton and dairying industries.

The rate and level of ceiling adoption was a critical assumption in the analysis. The ceiling adoption was assumed to be 50%, achieved after five years following annual increases of 10%.

Results of the investment analysis are shown in Table 3.5.

Table 3.5 Investment analysis results for UME12

NPV (\$ M) (discount rate 7%)	B/C ratio (discount rate 7%)	IRR (%)
11.0	2.7:1	22

Project CWN2 —Reducing groundwater accessions under rice

This project produced a system called 'rice puddling' which would reduce excessive water loss through deep percolation on particular soils. However, adoption has been slow. Although this was an ex-post evaluation selected on the basis of perceived positive outcomes and benefits, no investment analysis was carried out for the project.

Project CWN5 —River pollution with agricultural chemicals used in irrigated agriculture

This project produced information on techniques for measuring the impact of agrochemicals escaping from irrigation systems. While the outputs are recognised, their uptake has been limited by a combination of government inertia and lack of resources. Again, although this was an ex-post evaluation selected on the basis of perceived positive outcomes and benefits, there was no investment analysis carried out for the project.

Project UAD14 — An evaluation of the applicability of genetic algorithm technology to flow management of open-channel gravity systems

The principal objective of this project was to evaluate the applicability of genetic algorithm technology to the

improvement of scheduling and delivery of irrigation flows via open channel gravity systems.

The project was essentially strategic in that further product (commercial) development was likely to be required after its completion. The principal beneficiaries were the irrigation authorities responsible for the management of irrigation systems and water delivery, as well as irrigators themselves who should receive more efficient and timely water delivery.

Results of the investment analysis are shown in Table 3.6. As the project is still incomplete, a number of assumptions had to be made.

Further monitoring for measuring benefits should exist. Ongoing collection of farm-level data to assess any efficiency improvements from implementation is required. The results of the investment analysis are shown in Table 3.6.

Table 3.6 Investment analysis results for UAD14

	NPV (\$ M) (discount rate 7%)	B/C ratio (discount rate 7%)	IRR (%)
Total investment	7.9	15:1	61

3.3 Summary and Conclusions from Past Evaluations

Investment criteria were estimated for five of the seven projects evaluated. They are summarised in Table 3.7.

Table 3.7 Summary of investment criteria

	NPV (\$ M) (discount rate 7%)	B/C ratio (discount rate 7%)	IRR (%)
CPI4	1.5	2.7:1	24
UNE23	1.7	5.7:1	23
QPI27	2.2	2.1:1	26
UME12	11.0	2.7:1	22
UAD14	7.9	15:1	61

Overall, these investment criteria are positive and suggest that the NPIRD R&D investment is providing excellent returns, with benefits accruing to irrigators, water authorities, and the environment. However, a closer inspection of the projects selected for analysis, and the assumptions on which the analyses are based, suggests that some qualification should be attached to this conclusion.

First, there is considerable uncertainty associated with many of the assumptions that underpin most of the

analyses. These uncertain assumptions fall into two major categories:

- the relationship between the research outputs and environmental improvement; and
- the adoption assumptions.

The impact of reduced water accessions to groundwater, or saving water for production purposes or for the environment, or improving water quality by reducing outflow of agrochemical nutrients are cases in point. Not only are we uncertain of how the research outputs could link to the degree of improvement in these variables, but also we have difficulty in valuing the improvements in terms of, for example, the impact of different levels of reduction of agrochemical outflows on aquatic ecologies. All we know is that there is probably a linkage. The approach taken in most evaluations is to assume this linkage and place a conservative (usually 5 or 10% improvement) estimate on the degree of improvement. In many cases in the NPIRD evaluations, no attempt has been made to place estimates on the degree of improvement assumed or on valuing the degree of improvement assumed. This is very difficult of course, and conservative estimates have usually been made. However, the variation in approaches between analyses with respect to assumptions and what is valued as a benefit, makes any comparisons between results not particularly meaningful.

The second issue is that of how the projects are selected for evaluation. The NPIRD projects selected for analyses were not randomly chosen. It is not clear what the basis of selection was, as the seven published evaluations included projects drawn from four different exercises carried out in a wider context than NPIRD. Two of the projects (UNE23 and QPI27) have not necessarily produced clear outputs and subsequent benefits are difficult to estimate. Part of the reason for this is that projects were not necessarily completed at the time when the analyses were undertaken. But for projects that were selected on the basis that they were completed (eg. CWN2 and CWN5), no investment analyses were carried out.

The assumptions for adoption are always difficult to make when projects are still in progress or even just completed. However, in assumptions made on adoption in the evaluations reviewed here, only those for CPI4 (second evaluation) have relied on any firm estimates, and then only in relation to sales of the testing kits, rather than particular uses in irrigation. The pursuit of useful adoption information is addressed more directly in the evaluation strategy proposed later.

Other issues in economic evaluations relate to the valuation of improvements and the need for standardisation in valuation processes, and the problem

of attribution of benefits to NPIRD research outputs as opposed to other outputs and forces that might be operating at the same time. These issues are also addressed briefly later.

The program plan specifically addresses NPIRD's strategy for review and evaluation. The strategy for evaluating all projects in relation to benefits and costs, as proposed in the five-year plan, has not been implemented fully. Presumably, this involved prospective benefit–cost analysis of R&D proposals before they were funded, and evaluation of benefits and likely benefits at review points and final reporting stage. Only a few projects appeared to have been subjected to prospective benefit–cost analysis. On the other hand, checking projects against objectives and milestones and continued monitoring of project progress against achievement criteria have been undertaken quite diligently by NPIRD management.

Another evaluation activity envisaged during the period of the NPIRD plan was to subject a random sample of the program portfolio to an independent benefit–cost analysis. This has not yet been done. The benefit–cost analyses undertaken to date have been conducted in a quite complex sampling framework driven by other objectives, by different analysts, and at different times. The need remains for a random sample of projects to be analysed and should be undertaken within the remainder of the five-year plan.

3.4 A Future Strategy for Evaluation

Purpose

This section focuses on a strategy for economic evaluation at program level rather than evaluation in a management context. The latter is addressed more specifically in Chapter 5. Economic evaluation at R&D program level is usually orientated towards accountability for the investment of resources, ie. to address the question of whether the R&D investment is providing a return on funds to investors. In the case of NPIRD, the main investors are irrigators and the Australian public, represented by LWRRDC and the State government agencies.

Another purpose to which economic evaluation may be directed is to gain insight into where large pay-off areas might exist, ie. in influencing the future orientation of priorities in the program. It can be difficult to fulfil both the accountability purposes as well as the orientation purpose at the one time.

Strategies

Two broad strategies can be used to evaluate a program such as NPIRD. The first is with a selected sample of

projects and the second is with a random sample of projects.

Selected sample

A sample of projects can be selected and evaluated in benefit–cost terms. Such projects need to be those most likely to be associated with significant benefits. If NPIRD has so far funded 50 projects, then the most successful 5 or 10 projects might be subjected to benefit–cost analysis. The benefits from the 5 or 10 projects might then be placed against the total costs of the 50 projects to assess whether the most successful projects would have paid for the total program costs. A disadvantage of this method is that it provides no information about the other 40–45 projects that might have been funded. Moreover, such a method relies on being able to choose successful projects with large benefits. NPIRD's experience with choosing successful projects for analysis so far has not been overly positive. The experience of others also suggests that this is not an easy task.

Random stratified sample

A stratified sample can be randomly drawn from the population of projects and each selected project analysed either qualitatively or quantitatively. Let us assume that a stratified sample of 20 projects is chosen. Stratification may be by program area, by size of project or by other specified criteria. Projects should be completed or substantially completed before inclusion in the sample. The projects in the sample that are best suited to quantitative analyses would be analysed quantitatively. Experience suggests that about one third of the 20 projects will be amenable to quantitative analysis with some degree of credibility and meaning. The other two thirds of projects can be assessed in terms of outputs, outcomes and benefits in a qualitative sense. The benefits from the quantified projects can then be compared with the cost of the 20 projects in the sample to produce investment criteria that should be representative for the total portfolio of projects.

The whole sample of 20 projects will provide qualitative information on outputs, outcomes including adoption, and type of benefits and where they fall, and can be useful in obtaining a picture of how the portfolio is performing.

Such a process may be undertaken regularly within the program, for example, every three or every five years. Revised evaluations can be undertaken on previous projects, much as the LWRRDC life-of-project evaluations are undertaken now. The difference would be that the evaluations would be undertaken by program rather than by funding year. Indeed, the LWRRDC life-of-project evaluations might show greater impact if organised on a program basis. Extracting and interpreting

results from the current life-of-project evaluations is difficult as expressed earlier.

Other strategies and options

Another option would be to draw a smaller random sample every year (say five projects) of which one or two may be quantitatively analysed in the first year and then updated every three to five years.

The weakest area in evaluation at present is associated with making credible assumptions about existing and prospective adoption of outputs from NPIRD research. A suggestion for addressing this issue by way of a series of technology audits is made in Chapter 5.

The preferred strategy above focuses on individual projects funded by NPIRD. While this might be considered the appropriate approach since the program is managed on a project basis, consideration might be given

to grouping project outputs and carrying out an analysis of key outputs from the program. Outputs from both phase 1 and 2 are grouped in Chapter 5; while this may not be the most appropriate grouping to pursue, it will provide an idea of the type of evaluation strategy that could be followed.

Another potential and perhaps complementary activity would be to build in benefit-cost analyses to reviews of projects or groups of projects. This would at least provide a framework for analysis for any later evaluations.

The attribution of benefits to other R&D projects in the program, to R&D projects outside the program, or to other factors in the irrigation environment remains an important issue. The attribution difficulty can be eased to some extent through monitoring and one-off surveys or longitudinal monitoring may play a role.

4 Stakeholder Survey

4.1 Introduction

A stakeholder survey was carried out as part of the evaluation, to obtain opinion and input from a range of individuals and groups that have a 'stake' in the NPIRD. The survey covered a range of areas predominantly associated with awareness, outputs and communication of outputs, adoption, impact, and management aspects of the NPIRD.

4.2 Survey Method

Three stakeholder groups were included in the survey. These were:

- Group A: Irrigators;
- Group B: Irrigation service providers including government personnel; and
- Group C: Principal investigators of the projects within the program.

The objective of surveying the irrigator and service provider groups was to gauge awareness of the NPIRD, knowledge of outputs, use of information generated from the program and level of adoption of products or technology emanating from the NPIRD. The aim of surveying the principal investigators was to ascertain opinions of impact of the program as well as assessments of the performance of the management of the program and where improvements might be made in the future.

Each of the three populations was defined with assistance from the NPIRD Program Coordinator. A mail-out survey was undertaken with the objective of obtaining responses from at least 15 stakeholders within each of the three groups. Reminder telephone calls were made to those non-respondents in groups where it was thought that 15 responses might not be obtained. No check was made on non-respondent bias.

The three questionnaires used in the survey are shown in Annex A. Some of the questions used were common to the three surveys.

The response rate achieved is shown in Table 4.1

4.3 Results for Irrigators

Awareness

All but two of the 14 respondents stated that they were aware of NPIRD. Irrigator understanding of what NPIRD was attempting to achieve can be summarised as follows.

- Four respondents considered NPIRD was associated with improving research (funding, coordinating, promoting, acting as a focal agency).
- Three considered that NPIRD was focused on outputs and outcomes (water-use efficiency, reduced cost of supplying water).
- Three indicated NPIRD was associated with both research and its application.
- Two stated that they had no understanding of what NPIRD was attempting to do.

Impact of Research

When asked to nominate the most important outputs from NPIRD, four nominated a combined total of 23 projects from the project list given to them. The only projects that were nominated more than once were projects AIT1, AIT 5 and QNR2. These were each nominated twice. Three respondents nominated water-use efficiency and one nominated training. The other three respondents stated they were not aware of any important specific outputs from NPIRD.

When asked whether NPIRD had had any impact on their own irrigation management, six respondents replied 'no' and five 'yes'. Research results that were reported to have

Table 4.1 Response rate for survey of three groups of stakeholders associated with NPIRD

	Irrigators	Irrigation service providers	Principal investigators	Total
Number of questionnaires sent out	38	42	37	117
Number of responses received by cut-off date	14	22	19	55
Response rate (%)	37	52	51	47

changed irrigation management of the respondents included those associated with laser levelling and fertiliser application, irrigation scheduling, automation of stops, water-use efficiency, and rice soil puddling techniques.

When asked whether NPIRD had had any impact on management of other irrigators, a similar response was obtained (six 'no' and five 'yes'). Most reasons given for change in this case were related to water-use efficiency in a general sense.

The ratings made by irrigators against specific impacts are summarised in Table 4.2. Three respondents stated they did not know enough about the program impacts to reply.

Communication and Adoption

The rating of communication performance by irrigators is shown in Table 4.3.

All respondents felt that there was a need for greater integration. Responses included that:

- commodity R&D involvement would help focus research;
- improved networking would be beneficial; and
- so too would integration through broader projects.

Also, all but one respondent believed that better packaging and integration of research outputs would be desirable.

Table 4.3 Rating of communication performance of NPIRD

Rating	Number	Percentage
Very good	0	0
Good	3	25
Satisfactory	6	50
Poor	2	17
Other	1 (does not know)	8
Total	12	100

Program Priorities

Ratings of various mechanisms for setting priorities for NPIRD are shown in Table 4.4

4.4 Results for Irrigation Service Providers

Awareness

All but one of the 22 respondents were aware of the NPIRD. The understanding of what NPIRD is attempting to achieve included the following.

- (i) Main emphasis was on R&D: nine responses (eg. improved understanding, coordination, funding at national level, national approach, improved irrigation R&D, integrated R&D, coordinated approach, nationally integrated research program).

Table 4.2 Rating of specific impacts of NPIRD by irrigators

Improvement type	Level of improvement		
	Large improvement	Some improvement	Minor or no improvement
Improved water-use efficiency	3	5	2
Lowered off-farm infrastructure and refurbishment costs	0	6	4
Lowered on-farm irrigation costs	1	2	6
Less drainage off-farm	4	3	2
Less accession to groundwater	4	4	2
Less nutrients and chemicals leaving irrigation farms	3	4	2
Increased productivity of irrigated areas	2	3	4
Improved profitability of irrigation farming	1	3	6
Improved sustainability of land and water use	3	5	2
Other			
Greater understanding of mechanics of irrigation	1	0	0
Process improvements			
More effective research through increased coordination	5	3	1
Increased R&D capacity with respect to irrigation	6	2	1
Higher levels of adoption of improved irrigation technology	3	4	2

- (ii) Main emphasis was on outputs and outcomes: eight responses (eg. improved productivity, efficiency, irrigation performance and outcomes, sustainable irrigation practices; improved irrigation efficiency, improved practices; improved irrigation efficiency, improved technology transfer; efficiency, distribution of water, drainage etc.).
- (iii) Emphasis was on both: two responses; (eg. improve knowledge and irrigation practices through research, improve irrigation R&D and related consequences).
- (iv) Don't know: one response

Impact

Two respondents nominated projects containing the most important outputs where impacts had been manifest. These included UME12, AIT5, GMW1, UAD14, GMW3, CWN5, DAV11, DAV16, RWC3, SAS1, SKP1, CWN2, SRW1 (twice), and RWC4. Coincidence with projects also nominated by irrigators included UME12, AIT5, GMW3, SKP1, and CWN2 and CWN5.

Principal themes detected in responses were awareness of water-use efficiency and benchmarking.

Table 4.4 Ratings by irrigators for priority setting mechanisms

Mechanism	Level of importance		
	Essential	Important	Less important
National workshop	4	6	3
Regional workshops	6	4	3
Input from commodity R&D corporations	6	5	2
Consultations with community groups	2	3	6
Consultations with irrigators	9	4	0
Consultations with research providers	6	6	0
Regional R&D priority setting committees	6	3	1
Other			
Those funding projects need representation and input; current situation is minus input	1	0	0

Table 4.5 Ratings of specific impacts of NPIRD by irrigation service providers

Improvement type	Level of improvement		
	Large improvement	Some improvement	Minor or no improvement
Improved water-use efficiency	0	12	5
Lowered off-farm infrastructure and refurbishment costs	1	3	11
Lowered on-farm irrigation costs	0	5	10
Less drainage off-farm	4	4	7
Less accession to groundwater	1	4	10
Less nutrients and chemicals leaving irrigation farms	3	7	6
Increased productivity of irrigated areas	3	6	6
Improved profitability of irrigation farming	1	6	8
Improved sustainability of land and water use	3	6	6
Other			
Greater understanding of mechanics of irrigation	1	0	0
Process improvements			
More effective research through increased coordination	2	12	2
Increased R&D capacity with respect to irrigation	2	9	5
Higher levels of adoption of improved irrigation technology	2	5	8

Ten service providers considered the NPIRD had had an impact on irrigation management while eight thought not and three indicated they were not able to pass comment.

In assessing the impact on water management agencies, eight service providers thought there had been a significant impact whereas ten thought not; two were uncertain.

Ratings for specific impacts are shown in Table 4.5.

Communication and Adoption

The rating of communication performance is shown in Table 4.6.

Table 4.6 Rating by irrigation service providers of communication performance of NPIRD

Rating	Number	Percentage
Very good	0	0
Good	7	32
Satisfactory	5	23
Poor	10	45
Other	0	0
Total	22	100

All but four of the 22 respondents indicated that they favoured better integration with other R&D funders and institutions; three did not, and one was undecided.

The majority of respondents also agreed that better packaging and integration of R&D outputs were desirable, with 16 stating 'yes' and three stating 'no'; two were undecided. One person stressed the need to recognise effective 'extension' as a specialist skill separate from research; another thought that integration

should be promoted only where relevant, as one does not want to burden initiatives such as PMP with the priorities of others.

Program Priorities

Ratings of various mechanisms for setting priorities for NPIRD are shown in Table 4.7

Opinion of Program Management

Ratings for various aspects of program management are provided in Table 4.8.

4.5 Results for Principal Investigators

Impact of Research

When asked to nominate the most important output from NPIRD to date most principal investigators nominated the outputs associated with their own projects. Benefits nominated by principal investigators also related to their own projects. These outputs and benefits are described in Annex C.

Eleven of 20 respondents thought that the program had had a significant impact on irrigators; four thought not, and three were undecided.

In relation to NPIRD's impact on water management agencies, seven of eighteen respondents thought that the program had made a significant impact, seven thought not, and four were undecided.

Ratings for specific impacts are shown in Table 4.9.

Some principal investigators were not sufficiently familiar with the program to rate the specific impacts.

Table 4.7 Ratings by irrigation service providers for priority setting mechanisms

Mechanism	Level of importance		
	Essential	Important	Less important
National workshop	9	9	4
Regional workshops	12	9	0
Input from commodity R&D corporations	7	11	3
Consultations with community groups	6	8	7
Consultations with irrigators	15	6	1
Consultations with research providers	5	11	6
Regional R&D priority setting committees	8	13	1
Other			
Consult with water authorities	2	0	0
Consult with government R&D agencies	1	0	0
Consult with policy people	1	0	0

Table 4.8 Ratings by irrigation service providers for various aspects of NPIRD management

Process	Very good	Good	Satisfactory	Poor
Setting of priorities	1	7	8	0
Selection of R&D projects	0	4	11	0
Transparency in project selection	1	6	6	2
Monitoring and reporting	0	6	7	0
Management of projects	1	6	7	0
Project reviews	0	5	8	2
Involvement of clients/stakeholders in management	0	4	6	6
Management flexibility	3	2	9	1
Communication of results	1	5	7	2
Project evaluation	1	3	10	0
Final reporting	1	6	8	0
Management of funds	0	11	3	0
National coordination	1	6	5	2

Table 4.9 Ratings of specific impacts of NPIRD by research providers

Improvement type	Level of improvement		
	Large improvement	Some improvement	Minor or no improvement
Improved water-use efficiency	5	9	1
Lowered off-farm infrastructure and refurbishment costs	0	9	6
Lowered on-farm irrigation costs	0	8	7
Less drainage off-farm	0	12	3
Less accession to groundwater	0	10	4
Less nutrients and chemicals leaving irrigated farms	1	8	5
Increased productivity of irrigated areas	4	8	3
Improved profitability of irrigated farming	2	6	7
Improved sustainability of land and water use	3	11	2
Other			
Empowerment of growers to help push the cotton industry to realise new technology should be treated seriously	1		
Improved community awareness of problems		1	
Improved financial viability of irrigation authorities	1		
Process improvements			
More effective research through increased coordination	3	8	4
Increased R&D capacity with respect to irrigation	4	5	6
Higher levels of adoption of improved irrigation technology	2	7	7
Other — Improved community consultation standards	0	1	0

Communication and Adoption

Principal investigators were asked to nominate the principal target audience for their research. The following distribution (Table 4.10) was obtained from those who responded.

These results show the preponderance of R&D is targeted at flood irrigation. Closer inspection also reveals that a majority of all R&D supported was in the southern Australian river systems (Murray and Murrumbidgee).

Table 4.10 Principal target audiences as nominated by principal investigators

Response	Specific commodity	All irrigators	Flood irrigators	Other irrigators	Specific scheme	Multiple irrigation areas	Specific water authority	Multiple water authorities
1						X		X
2			X		X			
3			X			X		
4			X		X			
5			X			X		
6	X				X			
7			X			X		X
8	X		X		X			
9	X		X					
10				X		X		
11	X		X			X		
12								X
13			X			X		
14		X						
15		X				X		X
16			X		X			
17			X			X		X
18						X		X
19	X		X		X			

Table 4.11 Estimates by principal investigators of adoption characteristics of R&D outputs

Adoption level	Level of 0–5%	Level of 6–25%	Level of 26–75%	>75%	Don't know
Current	7	3	3	1	4
In 5 years time	2	2	3	1	6
In 10 years time	1	3	4	1	6
Maximum	0	0	5	2	8

Adoption

The results in Table 4.11 were obtained when principal investigators were asked to nominate the adoption levels for their principal outputs through time. Although it was surprising that so many investigators attempted to make estimates, many were unable to estimate the maximum adoption level.

Communication

The ratings for communication performance by research providers is shown in Table 4.12

Integration

Of the 19 respondents to the question about better integration with other programs, 14 replied that better

integration should be pursued, four dissented, and one was uncertain.

In answer to the question on better integration and packaging of outputs 15 of 17 respondents answered 'yes', one 'no', and one was uncertain.

Table 4.12 Rating of communication performance of NPIRD by principal investigators

Rating	Number	Percentage
Very good	2	12
Good	9	55
Satisfactory	3	14
Poor	2	12
Other	1	6
Total	17	100

One suggestion was that the NPIRD outputs need to be integrated with crop management packages rather than with other programs. Two people mentioned there could be a problem of information overload if too much of it is provided at the one time; the view was that, in general, research results should be provided to the wider audience in short, easily understood packages.

Program Priorities

Ratings of various mechanisms for setting priorities for NPIRD are shown in Table 4.13.

Program Management

The ratings by principal investigators for various aspects of program management are provided in Table 4.14.

4.6 Summary and Conclusions

Awareness

All irrigators were aware of NPIRD but this was not surprising since they were selected on that basis. However, there were three interpretations of NPIRD objectives: the first was associated with improved research; the second with NPIRD delivering outputs and outcomes; and the third viewed NPIRD as associated with both. The responses from irrigation service providers could be divided into the same three groups.

Impact

Approximately half of both irrigator and irrigation service provider respondents thought that the NPIRD had had a significant impact on irrigators and about half

Table 4.13 Ratings by research providers for priority setting mechanisms

Mechanism	Level of importance		
	Essential	Important	Less important
National workshop	6	7	4
Regional workshops	10	6	1
Input from commodity R&D corporations	5	10	2
Consultations with community groups	8	8	1
Consultations with irrigators	12	4	1
Consultations with research providers	12	3	2
Regional R&D Priority Setting Committees	5	8	3
Other			
Consult with water authorities	1		
Consult with other potential beneficiaries	1		

Table 4.14 Ratings by principal investigators for various aspects of NPIRD management

Process	Very good	Good	Satisfactory	Poor
Setting of priorities	1	12	2	1
Selection of R&D projects	0	8	7	1
Transparency in project selection	0	5	8	4
Monitoring and reporting	1	11	5	1
Management of projects	1	11	6	0
Project reviews	2	8	5	2
Involvement of clients/stakeholders in management	0	8	9	0
Management flexibility	0	11	6	0
Communication of results	0	10	7	1
Project evaluation	1	3	7	1
Final reporting	1	6	8	1
Management of funds	0	14	5	0
National coordination	3	4	9	0

thought that this was not the case. Most reasons for believing there had been impacts were associated with water-use efficiency in a general sense. In particular, service provider respondents from non-eastern States were dismissive in the impact of NPIRD. Eleven of the 20 principal investigator respondents thought that their project had had a significant impact on irrigators, four thought not and three were undecided.

When asked to comment on the impact on water authorities, a larger number of service providers felt there had been little impact. Again there appeared to be a State difference in response; some service providers in the eastern States thought that the impact was minimal, but areas of improvement due to NPIRD included improved communication between water agencies in sharing information.

Irrigation service providers saw significant impacts being derived from the general areas of increased awareness of water-use efficiency among irrigators and water authorities, and a more focused and coherent approach to issues that was now evident with NPIRD. Benchmarking activities of NPIRD were also seen as contributing significantly to impacts.

Ratings for specific impacts by irrigators showed that the impacts associated with water leaving the farm (less drainage, nutrient export and groundwater accession) were thought to be more evident than other types of impacts. Impacts in the areas of infrastructure and irrigation costs were rated very poorly by irrigators in terms of program impact, as were those associated with productivity and profitability.

The ratings for specific impacts from irrigation service providers were less clear than those for irrigators. More than half of the respondents thought that there had been at least some improvement in water-use efficiency, less nutrients leaving the farm, improved productivity and improved sustainability. The process impact rated most highly was the more effective research through improved coordination.

The impact types rated highest by principal investigators were improved water-use efficiency and improved sustainability of land and water use. These were followed by less drainage from farms, and increased productivity of irrigation areas.

Impacts and benefits described by principal investigators mainly related to the projects with which they had been associated. A summary of these statements is given in Annex C.

Communication and Adoption

NPIRD communication was considered mainly satisfactory by irrigators. However, a total of 50% of service provider respondents rated the communication performance of the program as poor, with approximately 25% rating it as satisfactory or good, respectively. A major feature of service provider response was that the communication may have been satisfactory for the water authorities but not for the irrigators. In other words, water authorities saw the program communication weakness mainly in its communication with irrigators.

On the other hand, principal investigators rated the communication performance of NPIRD much higher than the other two groups. About two-thirds rated the communication as very good or good and only about 12% rated it as poor.

A range of communication methods was mentioned for improvement by irrigators and service providers. Frequently suggested methods included more use of electronic media and more regular summaries and precis of projects.

Integration of the research effort with other programs, mainly to reduce duplications and make best use of funds was supported by irrigators, service providers, and principal investigators. Better packaging and integration of R&D outputs and information were also considered desirable by all three groups.

Two principal methods of improving adoption were suggested by irrigators. These were:

- local demonstrations of improved technology; and
- financial analysis by commodity groups or others to demonstrate profitability.

Methods suggested by service providers to improve adoption were:

- continuing with education support;
- closer contact with irrigators;
- specific technology transfer workshops; and
- closer linkages with commodity based groups, State agencies and water management agencies

Target audiences as nominated by principal investigators showed that flood irrigators were the major target audience, but that much of the research was or could be associated with more than one irrigation area. Target audiences were more likely to be irrigators than water authorities. Some projects targeted both.

Fourteen principal investigators made estimates of the current adoption rate of their main technology. The average was 22% adoption. This average was expected to

rise to 34% in five years time, 38% in ten years time and would eventually reach a maximum 61%. These results appear extremely optimistic given that much of the research was incomplete, but it is encouraging for such estimates to be made.

Program Priority Setting:

Irrigators rated consultations with irrigators and research providers as the most essential mechanisms for priority setting for the program, followed closely by input from commodity R&D corporations and regional workshops. Regional workshops were rated slightly higher than national workshops. There was also some support for regional R&D priority setting committees from irrigators.

Regional workshops, consultations with irrigators and regional R&D priority setting committees were seen as the most important mechanisms for priority setting by irrigation service providers. These were closely followed by national workshops and input from commodity groups.

The three most important mechanisms nominated by principal investigators for priority setting were consultations with irrigators and research providers, and regional workshops.

Overall, a consensus existed that consultations with irrigators and research providers were essential in priority setting. However, regional workshops were slightly ahead of a national workshop, and regional priority setting committees were also considered quite important, except for the principal investigator group.

Comments on priorities from irrigators suggested that there were two schools of thought: that there should be more local orientation or that the program should concentrate only on national priorities.

Program Management

The only process that a majority of irrigator service respondents considered was being performed very well was management of funds, where the number of good or very good ratings exceeded the poor and satisfactory ratings.

Other processes where the good and very good rating was considered by service providers to be nearly as high as the combined poor/satisfactory group were:

- setting of priorities;
- transparency in project selection;
- monitoring and reporting;
- management of projects;
- final reporting; and
- national coordination.

The poorest rating by service providers was given to involvement of clients and stakeholders in management.

Other processes where ratings of satisfactory/poor exceeded good/very good by a significant margin were:

- selection of R&D projects;
- project reviews;
- management flexibility;
- communication of results; and
- project evaluation.

Principal investigators rated most processes used in program management higher than service providers. The processes where the number of ratings of very good or good exceeded those for poor/satisfactory ratings included:

- setting of priorities;
- monitoring and reporting;
- management of project reviews;
- management flexibility;
- communication of results; and
- management of funds.

The processes where the number of poor/satisfactory ratings exceeded the good very good ratings included:

- project evaluation;
- transparency in project selection;
- final reporting; and
- national coordination.

Ratings were fairly neutral in terms of those defined above for:

- selection of R&D projects; and
- involvement of clients/stakeholders in management.

Overview

One important message provided by the survey respondents was that the impact of the program had not been overly significant or had at least been patchy. Water-use efficiency awareness was highlighted and the most specific impact rated the highest by irrigators was the improvement in drainage which led to reduced amounts of nutrients and agrochemicals leaving the farm.

The view of the communication performance, particularly from irrigators, was quite negative. This view contrasted with that of principal investigators who were involved to some extent in communication themselves and who rated the communication performance far higher.

Regional workshops were seen as more important than a national workshop for priority setting in future, and regional priority setting committees were also supported strongly by irrigator and service provider groups.

5 Assessment of Current Program

5.1 Introduction

This chapter provides an overall assessment of the performance and impact of NPIRD over the first two phases. This assessment initially addresses the following areas:

- achievement of objectives;
- outputs produced;
- translation of outputs into outcomes;
- performance criteria; and
- project and program management.

The assessment has drawn information from a range of sources including project and program files, an analysis of project outputs and outcomes, the independent project evaluations that have been undertaken up to the end of 1998, discussions with the Program Manager, Program Coordinator, a past Program Coordinator, and the survey of stakeholders. While the assessment has focused on the achievements and performance in each of these areas, some ideas and suggestions for future improvements in the scope, direction and management of any future program are presented.

5.2 Achievement of Objectives

Table 5.1 presents an assessment of which of the five program objectives are addressed by each project funded initially in phase 1 of NPIRD. A reminder that the objectives of phase 1 were to:

- enhance productivity and sustainability of irrigation;
- improve water management and water use efficiency;
- find cost effective solutions to infrastructure refurbishment;
- minimise the impacts of salts, nutrients, and other pollutants; and
- to increase the adoption of technology by irrigators throughout Australia.

All 23 projects funded appeared to address objective 1 (enhancing productivity and sustainability). Fifteen projects addressed objective 2, thirteen projects addressed objective 4 and eight projects addressed objective 5. Six projects addressed objective 3 (infrastructure refurbishment).

The mission statement for phase 2 of NPIRD was 'to provide national leadership of irrigation research and development and to improve natural resource sustainability, economic viability and environmental quality by focusing on raising the water-use efficiency of on- and off-farm irrigation systems'.

The key objectives of phase 2 of the program were:

- (i) for water-use efficiency — to increase water use efficiency of on- and off-farm irrigation systems to enhance resource sustainability, economic viability and environmental quality;
- (ii) for coordination — to improve coordination of irrigation research and development and reduce duplication of effort;
- (iii) for adoption — to improve adoption of irrigation R&D outputs;
- (iv) for communication — to effectively communicate the program and its outputs to its stakeholders and clients; and
- (v) for the R&D base — to improve the R&D base for irrigation, particularly in the field of agricultural engineering.

Key objective 1 — Water-use efficiency

Within objective (i) there were three key sub-objectives:

- (a) to improve the efficiency of water delivery;
- (b) to optimise water use on farm, while minimising downstream impacts; and
- (c) to minimise off-farm drainage and maximise the use of drainage water on-farm to reduce downstream effects of disposal to acceptable levels.

Some assessment of how the sub-objectives of the first key objective were addressed through project funding is provided in Table 5.2.

All of the sub-objectives set for the key objective of increasing water-use efficiency appeared to have been addressed under the program portfolio funded in phase 2 of the NPIRD.

Key objective 2 — Coordination

Some attempts have been made to improve NPIRD's coordination with other funding agencies during both phases. In particular, MDBC was approached in 1996 for a joint call and representation of both NPIRD and MDBC at management committee meetings of the other body. MDBC meetings on irrigation were either attended by the

NPIRD Coordinator or comments on selected issues were provided. Joint projects were not developed, mainly because of the review and restructuring of the Commission and its Investigation and Education Program. Problems in the timing of joint calls also constituted a barrier to this form of coordination. Early in the program it was agreed that the MDBC would concentrate on the NPIRD strategies covering benchmarking and best management practice development on-farm and on drainage R&D, and NPIRD would concentrate on benchmarking off-farm. No formal working arrangements were developed, but there was good cooperation and linkages. NPIRD and MDBC worked together to develop jointly funded projects and workshops where they met the objectives of both organisations. However, no formal boundaries have been defined regarding the funding roles of MDBC, RDCs and NPIRD. A letter inviting MDBC attendance at future NPIRD Committee meetings has now been dispatched.

Coordination with the RDCs included involving them in priority setting for the program and in project selection, and negotiating with them on funding. RDCs also

referred projects to NPIRD where they thought there was some match with NPIRD objectives. NPIRD generally sought industry funding or RDC involvement where projects had a productivity improvement component but often this was difficult because industry calls occurred at different times and their emphasis was on local rather than strategic or generic R&D. RDC advice on participants for reviews of projects was also sought in projects with an industry focus.

As mentioned, coordination with commodity RDCs has occurred at the project level, with a number of projects being jointly funded. NPIRD has played an important role in brokering and developing projects. Most progress in this regard has been made with SRDC, DRDC, HRDC and CRDC with respect to joining with NPIRD in forging a more coordinated approach to irrigation R&D. It has been suggested also that most commodity RDCs are now planning an increased involvement in irrigation R&D in general, with particular regard to water-use efficiency and sustainability issues.

Table 5.1 How program objectives were addressed in phase 1 of the program

Project	Objective i	Objective ii	Objective iii	Objective iv	Objective v
RWC3	X	X			
UME12	X	X			X
AIT1	X	X			
DAV11	X	X		X	
QPI27	X	X		X	
GMW1	X	X	X	X	
AIT2	X	X			X
UNE23	X		X		
SKP1	X	X	X		
BSE3	X	X			X
UAD14	X	X	X		
CPI4	X			X	
CWN5	X			X	
DAV7	X			X	
DAN8	X			X	
DAV12	X			X	
QPI26	X		X	X	
RWC4	X		X	X	
BSE2	X	X		X	X
CWN9	X	X			X
DAV15	X	X		X	X
DAV16	X	X		X	X
UCQ1	X	X			X
TOTAL	23	15	6	13	8

Likewise, there was some representation made to the National Landcare Program (NLP) in 1997 to explore the possibility of forming closer linkages and cooperative arrangements. However, this has not resulted in any formal or informal working arrangements between NPIRD and NLP. Rather, the development of linkages with NLP and other group and farm-orientated funding programs was seen to be the responsibility of individual project proponents. Generally, project selection teams checked that these linkages were considered in the applications.

The differences between NPIRD and other initiatives in timing of funding and/or activities makes coordination between programs difficult. Nevertheless, efforts should be continued by NPIRD in this direction, particularly in relation to on-farm demonstrations and training programs (to be discussed later). It may well be worthwhile NPIRD investigating how the MDBC is handling the interface between its R&D program and the community and State-driven approach to Landcare, even though the MDBC program is based on supporting implementation of group/catchment plans, a slightly different focus to NPIRD.

Table 5.2 How program sub-objectives for objective 1 were addressed in phase 2

Project	Sub-objective (a)	Sub-objective (b)	Sub-objective (c)
QNR2	X		
SAS1	X		
DAV19		X	X
MDB6		X	X
SRW1	X		
JCU13	X	X	X
QNR1	X	X	X
UQL12		Key objective 3	
CDH1		X	
DAN11	X	X	X
CTC10		X	X
DAV23		X	X
RMI5		X	
CWN13	X	X	X
AIT5	X		
MIL1	X		X
GMW3	X		X
UQL16		Key objective 3	
UME58		X	X
GRD3		Key objectives 2 and 3	

Note: UQL12, UQL16 and GRD3 did not address any sub-objectives within key objective 1, but did address other key objectives, as indicated in the above table.

Linkages and integration of effort between NPIRD and both research and extension efforts in State agencies usually takes place at the project level. While NPIRD is only a small player in research funding overall, the focus on how results might be delivered could be improved by developing and promoting for its researchers a stronger understanding of existing and planned participatory extension philosophies, structures and operations in the various regions. This might be a first step in ensuring that integration with extension is taken more seriously by researchers rather than researchers viewing extension as just a part to include in a proposal to increase its chances of being funded. This step would necessitate a closer relationship with industry strategies, the RDCs and State agencies. To some extent there is an interaction with meeting the broad coordination objective, and the communication and adoption objectives which are addressed later.

An intended strategy included in the phase 2 plan for NPIRD was to produce an annual R&D compendium; this has been achieved in terms of the description of projects and project outputs included regularly in the NPIRD newsletter, *WaterWheel*. The objective of NPIRD coordinating and integrating what other funders and groups are contributing in irrigation R&D is achieved to some extent already through the *Streamline* bibliographic database supported by LWRRDC and the Water Services Association of Australia. While this is a very easily accessible source of this information it is not generally used by non-R&D people. Even LWRRDC groups have not used this database as effectively as it could be used. However, improvements in this activity should be picked up even more comprehensively through the National Irrigation Science Network. While there is probably still some duplication occurring in irrigation R&D, the advent of the Network should eliminate any remaining duplication. The Network should also assist with literature that is not in the usual publication domain and be able to document projects in the developmental stages, something that *Streamline* does not cover.

The first part-time external NPIRD Program Coordinator was appointed at the end of phase 1 of the program (late calendar 1995). There have been three coordinators over the past three years.

The coordination objective has been approached through NPIRD support for various workshops and conferences that involved irrigation science, policy, communication and education. NPIRD has encouraged the development of regional forums as a means of obtaining input for priority setting, but these are only at an early stage of development.

Incomplete coordination within LWRRDC's water-related programs has impacted on NPIRD. This is a function of the LWRRDC issue-orientated program. It is

understood that an attempt to more strongly integrate the various LWRDC and other water-related programs is under way. An attempt was made in 1997 to integrate the irrigation and river health programs to some extent through a joint foresighting exercise, but the demise of the river health program has meant that any synergy generated from that exercise will probably be lost.

Key objective 3 — Adoption

Adoption of outputs remains a critical aspect of NPIRD investment. All new projects in phase 2 were to encourage adoption by:

- including a plan in the proposal to ensure that results were available to users for earlier adoption;
- ensuring users were involved in the planning and implementation of projects; and
- including an economic evaluation of results in project planning.

While it appears that the first two of these strategies have been applied, the requirement for an economic evaluation does not appear to have always been met in project proposals. This is a common problem in R&D and, in the future, R&D providers will need to be able to provide quality benefit–cost estimates at both the beginning and final stages of projects.

To address the possibility of user involvement in the R&D at all stages, five participatory action management (PAM) projects were funded by NPIRD in phase 1 of the program and there was significant involvement of irrigators in these at all stages of the research. During phase 2, these projects were reviewed in workshop, and the outputs and prospective outcomes were regarded as being generally useful. However, even at that stage several researchers did not understand the PAM approach. As a result of the review and analysis, a further project is now being implemented for education and training of R&D personnel in the PAM approach, but there were no PAM projects in phase 2. The reason for the latter was that all projects involved in phase 2 were to incorporate the PAM approach. Most of the new projects funded during phase 2 did involve potential users in the development of the projects and in monitoring and review. The results of these projects are not yet available so it remains difficult to assess the effectiveness of this strategy. That aside, it is surprising that there are still no new, PAM-specific projects, given the inherent user orientation and the recognised weakness of output adoption within the program.

A second strategy to address the adoption issue was to improve linkages with agribusiness and extension agencies. This has been achieved to a large extent through individual projects. Further, desirable wider linkages have been mentioned under the coordination objective above. Such linkages have not been pursued particularly

strongly by NPIRD. It is a matter of resources and priorities for NPIRD, and differing philosophies and priorities held by agribusiness and extension agencies. Again, this is a difficult area.

Another strategy to foster adoption would be to work with NLP and other organisations to conduct on–farm demonstrations of results and technologies derived from NPIRD projects. As mentioned earlier under coordination, this is an area that could be developed further by NPIRD as it appears to be of critical importance. Linkages with the PAM approach are obvious. Furthermore, one of the more common suggestions made by irrigators in the survey responses was for NPIRD to focus more on demonstrations. It is interesting to note that phase 2 saw some additional funding for projects to ensure successful technology transfer, but it is not clear how this additional funding was deployed.

Another means of increasing adoption would be to ensure either that training packages are developed as part of a project or that results are incorporated into existing training packages. While it is not the role of NPIRD to fund extension per se, it may have to contribute to specific demonstration projects or training packages in one way or another. The PAM approach appears the most promising as it has the added spin-off of ownership at the beginning of the project.

Ensuring adoption requires that data and information are translated into best management practices and other actions and decisions that might be taken by decision makers. Until the effects of change on profitability is included in extension material, many irrigators will not act on NPIRD outputs. There is a need to identify benefits within the irrigators own decision-making framework. The packaging and delivery of such information is addressed through the communication objective discussed later.

Finally, education is another strategy for improving adoption over time. This has been given considerable support through NPIRD through project funding of an irrigation education audit. NPIRD has also catalysed action by the irrigation industry through funding at least two forums on irrigation education and training. The education initiative is being driven by the Irrigation Association of Australia (IAA), and a National Irrigation Education Committee (NIEC) to oversee education and training needs for the irrigation sector has recently been established.

Key objective 4 — Communication

NPIRD communication activities take a number of forms. NPIRD has ensured that most project proposals have built into them a clear process for communication of results to users. Communication of R&D outputs at the project level has been encouraged by the program

management during milestone reviews and face-to-face reviews. Various communication mechanisms have been used via workshops and media at the project level.

Specific resources have also been tagged by NPIRD to enhance adoption and communication of outputs from specific research areas. As mentioned under coordination, a series of conferences and workshops has been sponsored by NPIRD. Many of these have assisted communication, including two communication workshops and a 'best practice' workshop.

A communication study, including a survey of stakeholders, was conducted in 1995 and resulted in a newsletter (WaterWheel) being developed for communication about NPIRD. The newsletter initiative spanned both phase 1 and phase 2 of the program and is the centrepiece of NPIRD's communication. The newsletter has been expanded and improved in format over time. Demand for the newsletter has increased from about 400 to perhaps over 3000 during the period 1996 to 1998. A survey in 1998 showed that readers were appreciative of the current newsletter.

A communication strategy was prepared in phase 2 of the program (1997) by ECONNECT. Twenty tactical strategies were recommended, with each having a specific budget and timeline. As a result of the overall strategy, a Communication Coordinator was appointed (initially 2 days per week, later increased to 3 days). Tactical measures included the application of a media strategy, the use of a web site for communication, and improvements to the content of the WaterWheel newsletter and an update of its circulation list.

The communication strategy was comprehensive but was not resourced adequately. The action plan was well targeted but was resource hungry in relation to the size of the program. There appears a strong argument for an integrated communication strategy among a number of research funders.

The development of the web site should be given a high priority. The site will allow electronic media to be used more than hitherto. Linkages with the National Irrigation Science Network should ensure that this happens and guarantees linkages with other irrigation web sites.

Another strategy implemented by the program was to distribute research results through other newsletters, including that of the IAA.

Key objective 5 — Improvement of R&D base

The strategies to be pursued for improving the R&D base were to audit the skills base, develop a postgraduate and fellowship program, and commission

specifically targeted, skilled individuals into integrated projects.

The audit of the skills base has been effected but follow-up is now required on the recommendations emanating from the audit. The postgraduate scholarship scheme has been implemented and two scholarships have so far been awarded. It may be useful in future to give prominence to broad discipline areas where students might best contribute in terms of future skills required for irrigation science. A travel fellowship program has also been instituted. by NPIRD

Alongside the skills base, NPIRD has helped improve use of existing skills. This has enhanced research capacity. Inadequate research effectiveness in engineering has largely been addressed through team building and coordination through NPIRD coordination and project funding. A further contribution to research capacity has been, and is being made, through the support of the PAM approach.

Economics and policy specifically associated with irrigation are still areas where enhanced skills and effective organisation that can deliver would be beneficial to the program. A new program that is to be supported by LWRRDC in the policy and socioeconomics area may address this issue and NPIRD should take a strong interest in its development.

Overall, the five key objectives of phase 2 have been addressed by NPIRD in the past three years. Some of the phase 2 objectives were actually addressed during phase 1 also (adoption, communication, and coordination). However, in some cases (coordination and adoption in particular), the outputs from the pursuit of these objectives have not universally been regarded as successful. Also, there is still some time for all program plan objectives to be addressed, as the planning period was to 2001 although phase 2 was to end in June 1999. Further, it should be noted that the NPIRD Program Coordinator position is part-time (3 days per week) and there are significant demands in terms of regular project management (reviews etc.). Time available for the resource intensive coordination and adoption facilitation is scarce.

5.3 Summary of Project Outputs

Tables 5.3 and 5.4 summarise project outputs from both phases of the program. These outputs are those from science, technology, and adoption projects, rather than projects supporting more general initiatives such as communication or education.

Of the projects analysed for phase 1:

- eight projects produced general information that was relevant to the farm level;

Table 5.3 Summary of the principal types of outputs generated from projects funded in phase 1

Type of output	Frequency of output
RELEVANT TO IRRIGATORS	
General information for irrigators	8
For example:	
– agronomic and financial,	
– sensors,	
– scheduling,	
– automatic irrigation equipment,	
– fertiliser,	
– use of saline water,	
– N and P in drainage waters.	
Development of a specific technology for irrigators	1
Development and demonstration of best management practice	3
– scheduling,	
– water monitoring,	
– conjunctive use.	
Benchmarking	1
Other participatory projects	2
RELEVANT TO WATER AND REGIONAL AUTHORITIES	
General information for water authorities and regional water management	5
For example:	
– infrastructure refurbishment and management,	
– measuring systems for agrochemicals,	
– information on artificial and natural wetlands for drainage systems.	
Information for irrigators and water authorities integrated into best management practice	2

- five projects provided general information for regional managers and water authorities
- three projects produced information that was associated with best management practice at farm level;
- three projects were associated with development and demonstration;
- two other projects were classified as participatory;
- two projects provided information for best management practice for water authorities; and
- one project delivered a specific piece of technology.

Of the projects analysed for phase 2:

- eight projects provided best management practice or benchmarking results for water authorities or regional management;

Table 5.4 Summary of the principal types of outputs generated from phase 2

Type of output	Frequency of output
RELEVANT TO IRRIGATORS	
General information for irrigators	6
For example:	
– groundwater recharge	
– trickle irrigation	
– subsurface irrigation	
– WUE	
– contour layouts for rice.	
Specific information regarding new technology for irrigators	3
– subsurface irrigation,	
– evaporation reduction.	
Increased adoption	3
RELEVANT TO WATER AUTHORITIES AND REGIONAL MANAGEMENT	
General information on infrastructure and regional management including some strategic research	4
Information on best practice and benchmarking water management	8
For example:	
– rehabilitation of horticulture irrigation infrastructure,	
– evaporation basins,	
– flow measurements,	
– hydraulic performance,	
– WUE,	
– benchmarking.	

- six projects provided general information for irrigators;
- four projects provided information for water authority management or regional management;
- three projects provided specific information about new technologies for irrigators; and
- three projects were targeted at improved process for irrigator adoption

This brief analysis indicates the intended outputs from the second phase were more orientated towards water authority and regional management and less to irrigators than were the suite of projects funded under the first phase. The focus on PAM in phase 2 was on the involvement of users in the identification and development of projects. More time and effort was spent in this activity rather than the funding of more projects focusing on the PAM technique. Also, there has probably been an associated drop off in the number of projects that included some form of demonstration, even though this form of project was rated highly in the stakeholder survey.

It would also appear that in the second phase, for both irrigators and water authorities, that projects were more likely to be orientated to best management practice, benchmarking and the development of specific technologies using client involvement. This change to funding potentially meaningful and useful R&D and with more specific and potentially useable outputs and aimed at specific decision-makers, is to be commended.

While the more general and less focused applied research may be lessening in prominence within NPIRD, there is still a significant void of strategic research funded within the program. Generally, there has been a tendency for strategic research to be funded under the guise of applied research so that proposals are more palatable to funding bodies. In the case of NPIRD, the combination of some research providers used for generally 'applied research' and the strong drive on the Management Committee for immediately applicable results, may not be conducive for funding either important strategic research or good applied research. Vertical integration of strategic and applied research is important for maximum effectiveness, but clear definition of each project in this regard is also most important; blurring at the edges is often unhelpful.

The recent change to taking more interest in PAM, best management practice, and benchmarking, all may be considered appropriate to lift irrigation management and performance. However, continuing gains made through these mechanisms in the future will ultimately depend on new knowledge and improved technologies that may be generated only through investment in strategic research where outputs may not be immediately used by industry. It is suggested that a part of the NPIRD budget (say 20%) be directed towards projects that are clearly strategic and innovative, and from which significant gains in productivity and sustainability may be achieved.

5.4 Translation of Outputs into Outcomes

The R&D projects funded under both phases of NPIRD have produced, and are producing, outputs that are directly relevant to the original objectives set for both phases 1 and 2. However, there appears to be some confusion among principal investigators about what is an output and what is an outcomes. While an output is a piece of information, or perhaps some form of technology, that can be used by all or part of industry, the term outcome is usually defined as being the result of an output. The outcome needs to be associated with an actual improvement. Hence, if a technology (an output) is developed but not used, the outcome is non-existent. For example, the production of a manual is not an outcome (unless it has significant process benefits through involvement of users as in some benchmarking and BMP initiatives). The manual has to be used, with consequent

change in production or sustainability, for an outcome to be achieved. The outcome is then an improved production system, a higher level of use of industry best practice or other improvement (eg. see page 11 of November 96 newsletter reference to recommendations and a manual as being outcomes). Ensuring that principal investigators understand what the program is attempting to achieve in this regard cannot be emphasised strongly enough; otherwise lip service to outcomes will continue.

The translation of NPIRD project outputs into outcomes is a difficult process and existing methods are far from perfect. Many of the outputs to date from the NPIRD projects are not necessarily being used by irrigators and water authorities and therefore the desired outcomes are not always being achieved.

One of the problems of assessing outcomes, and therefore impact, is that there is little information available for each project on how information from projects is being used or the adoption rate of the technology emanating from the research.

The critical issues are:

- Is the right research being funded?
- Is the research providing information that is relevant to irrigators and water managers?
- Is the information being properly communicated to irrigators and water managers?

NPIRD has addressed all of these questions but it is still likely that improvements in all three areas can be made. Two areas are explored further here; the first is the integration of outputs and their delivery; the second is the need to measure and understand barriers to low adoption rates by irrigators and develop strategies to remove these barriers.

Integrating outputs

NPIRD has used focus workshops to bring outputs together and also targeted further information packaging in 1998–99. The idea is to target key topics that irrigators want to know about and provide information packages relevant to different irrigation areas. It is intended that the web site should be used in this regard. This approach is to be applauded and should be monitored as to its success.

Technology audits

There is inadequate information about which outputs are being adopted and which are not. A technology audit in selected irrigation areas or for selected technologies is therefore a strategy that could be pursued by NPIRD in future. Associated information that might be assembled in such an audit would include the reasons why certain technologies, project outputs, or best management

practices are being adopted and others are not. Information on the rate of adoption would also be useful. The identification of reasons for non-adoption in order to develop more appropriate messages was included as a recommendation in the Communication Strategy. Such information may be useful in assessing how outputs can be better packaged. Economic evaluation of projects would also be enhanced with improved information about adoption.

The joint funding of technology audits could be explored with other organisations such as industry (through RDCs) and MDBC.

The final difficult question is whether the two phases of program funding have provided good value for money. Some outputs have been translated into outcomes, especially in regard to improved water-use efficiency. This was the opinion of irrigators and service providers, elicited from the survey. Further, the economic evaluation of NPIRD projects suggests that the rate of return to investment has been quite significant for some projects. But, as expressed in Chapter 3, there are difficulties with some of the assumptions about the reality of the outputs envisaged and some of the adoption rates assumed. In addition, there are likely to have been significant benefits in improved effectiveness from future research from the coordination provided by NPIRD resulting in people from different organisations and different States working together. Also, the program has had a catalytic effect through stimulating further WUE interest in NSW and Queensland. NPIRD was one of the first R&D groups promoting and emphasising the theme of water-use efficiency in R&D. NPIRD showed leadership in this regard although it is likely that the growing emphasis on WUE from other organisations would have emerged at some stage. Other spin-offs from NPIRD projects have been evident (eg. COAG funding of further benchmarking projects following on from SRW1).

Both phases of the program have had an impact. The second phase was more thematic, and placed greater emphasis on the key supporting factors associated with effective R&D (eg. adoption, communication) as opposed to more traditional science and technology funding.

5.5 Criteria for Assessing Outcomes and Achievements

There does not appear to be a set of criteria against which NPIRD can assess its performance. The criteria that have been applied to the performance of the Coordinators and the program tend to be output- rather than outcome-based. This is a deficiency in the program planning.

It is understood that a set of performance criteria for five priority areas is being developed under the plan for a third phase of NPIRD. There appears a mix of specific

targets and ongoing criteria; most appear qualitative and to require documentation or evidence for assessment.

It is suggested that targets be separated from ongoing performance criteria, that the number of criteria be reduced for each priority area, and that performance criteria at the program level be developed.

Program performance criteria for consideration are listed below. They fall into two groups — outcome criteria and process criteria:

Outcome criteria:

1. Economic returns measured through benefit–cost analysis of a random sample of completed projects
2. A most important performance indicator for NPIRD is a demonstration that the irrigation industry and community are benefiting from R&D resources invested. Therefore, evidence should be provided that adoption of outputs and technologies is occurring and that profitability improvements are being experienced by irrigators, and sustainability benefits are being experienced by irrigators and the rest of the community. The technology audit could provide input to this, and the development of the benchmarking systems will enable some assessment of performance to be made.

Process criteria:

3. Priority setting system — is best practice being adopted?
4. Accountability of research providers eg. number of final reports outstanding.
5. Administration costs and management support costs for R&D funding (various ratios).
6. Some measure of coordination and integration.

5.6 Program and Project Management

The following provides a brief description of, and comments on the major features of the NPIRD management processes used in the two phases of the program.

Management Committee

The composition of the NPIRD Management Committee has already been given. The individuals on the committee provided a balance between representation of funding groups, some technical and economic expertise, broad R&D management experience, and irrigation experience. Independent technical expertise was introduced whenever deemed appropriate through invitations to selected meetings or through consultancies or the use of independent specialist reviewers or panels. The question remains as to the desirability of the committee being restricted to those States who are contributing financially

to NPIRD. An alternative model that might be considered is for a wider representation with two pools of resources; one pool of LWRRDC money matched by the member States as is done currently; a second pool available to non-contributing States and irrigation groups on a matching funds basis. This would help to move NPIRD towards a truly National Program.

The appointment of a part-time Program Coordinator has been a success in terms of coordination between projects and providing a focus for the program. The Management Committee needs to evaluate the time needed by the Program Coordinator to undertake the changes recommended in this review.

Funding

The existing three-year funding cycle limits the efficiency of the program. There is a need to be able to quarantine unallocated funds. During phase 1, some LWRRDC money was lost to the Commonwealth Government as it was carried over into a period of budget cuts. While the Commonwealth policy can be criticised as contributing to inefficiency in long-term investment program such as NPIRD, there is a need to face reality and therefore plan the program well ahead, with approval of each new phase well in advance of (say one to two years) and before the end of the existing program. A three-year 'rolling' program could be established with the NPIRD management always able to see at least one to two years ahead in terms of secure funding.

It is understood that NPIRD is already considering 'contingency' projects and consultancies that can be funded when project budgets change, other projects do not proceed or unexpended funds are returned. This preparation is logical and should enhance and secure efficient use of funds.

While a levy on water use would provide greater security of funding, it is apparent that structural constraints remain to such a development.

Strategic Planning and Priority Setting

The priority setting exercise for phase 2 of the program by NPIRD has involved considerable consultation followed by a national workshop. A 5-year program plan was established at the beginning of the second phase. Both these processes assisted the formulation of targeted priorities.

In 1997, NPIRD began preparation of the plan for the third phase of the program. It included program evaluation, foresighting and stakeholder involvement in the priority setting exercise. The stakeholder involvement was to have included regional input through meetings and a national workshop, but this did not eventuate. A key new feature was the development of the foresighting

exercise in 1997, in conjunction with the River Health Program. The key strategies emanating from this workshop were to:

- develop a stronger national leadership role in coordination of R&D and networking and search for improved mechanisms to achieve these needs;
- maintain program flexibility with a focus on long-term outcomes;
- pursue more secure funding for irrigation and river health, particularly through the continued advocacy to industry of a water-related levy on water users, and convince industry and commodity R&D corporations to allocate more monies to irrigation and river health R&D;
- continue to advocate participative (involving users) research, encourage greater emphasis on integration of findings from all R&D efforts and ensure that education and management aspects regarding the use of knowledge are not neglected;
- develop and facilitate a stronger capacity in policy and socio-economic R&D;
- develop and promote necessary availability of skills.

These strategies were an endorsement of the existing direction of the irrigation program and should be taken by NPIRD as indicating strong support for its priorities and planning, and endorsement of future coordination and leadership. Broad themes emanating from the foresighting exercise which had implications for R&D priorities included smart irrigation and water-use efficiency, zero pollution and water quality, and environmental flows and understanding of riverine ecology.

A workshop to determine priorities for a third phase of the program was held in September 1998. Priority areas included:

- water use efficiency ;
- irrigation knowledge and use;
- environmental impacts on and effects of irrigation;
- water availability and capability;
- benchmarking, monitoring and feedback; and
- institutional structures and change.

While the existing priority-setting mechanisms (largely consultation) may be acceptable, improvements may be gained particularly by introducing more formal regional input through workshops and possibly by developing regional priority-setting committees. Such workshops and committees could also use the regional forums and nodes which have been encouraged by funding grants from NPIRD and the emerging National Irrigation Science Network. Such a change would be compatible

with further commitment to a PAM approach for part of the program. Agendas from the regions could build into the more national priorities addressed by NPIRD and would also have implications for the programs of other industries and State agencies.

The Southern Murray Darling Basin Irrigated Cropping Forum, the Northern Australian Network for Irrigation, other established forums and the National Irrigation Science Network could be used in any regionally based development of priority setting.

Project Identification and Selection

Calls for project proposals within the priority areas specified within each phase were invited and proposals considered in a two-step process, as with other LWRDC programs. In some cases, direct commissioning of projects and consultancies was undertaken. Workshops were used in some areas to involve the potential users and other stakeholders, and help develop projects within a broad R&D area defined as a priority (eg. infrastructure refurbishment).

The two-phase selection processes (preliminary proposals followed by consideration of invited full proposals) of the Management Committee involved a scoring system whereby each member of the committee would score projects against a set of criteria and then the scores were discussed, averaged etc. Before this, the proposals were referred for comment to relevant industry groups or specialists in the field.

Projects with industry participation were encouraged, and the committee preferred projects that were industry-rather than research-driven. However, this was possible only to the extent that industry groups were involved with, or could be encouraged to be involved with research proposals.

Project selection appeared sound, and projects funded addressed objectives of the respective program phases.

Where expertise is not available on the Management Committee, special expertise has been sought. This is far more cost-effective than establishing a standing technical committee as the size of the program would not justify such a development.

Management Systems

Monitoring and reporting systems focusing on milestone reporting were established. Here, principal investigators of projects were responsible for reporting to NPIRD, progress against milestones initially agreed by the committee and the Principal Investigator and included in the contract with LWRDC. Payment of funds was linked to milestone achievements. Final reports were necessary and were seen as the final milestone for each project.

Final financial payments were linked to the provision of the final report.

There has been only one direct project termination (RWC4) over the two phases of NPIRD, although some other projects had to be restructured and redirected.

Each project was supposed to be reviewed at least once during its lifetime, but information on what proportion of projects was actually reviewed cannot be gleaned from the LWRDC program management system.

Overall, project management was very good, though in one instance management could have acted more quickly on administrative and legal matters.

Projects within the program have been well integrated with one another, especially since the appointment of a Program Coordinator in late 1995. However, links between NPIRD and other funding organisations and extension and research providers have been few, although referred to in the plan for phase 2 as requiring development.

While clients and stakeholders have been consulted extensively about the priorities for the program, the involvement in program management per se by industry is perceived as lacking. One way of improving this would be to fund more PAM projects and to move to a more regional priority setting process.

The investment in program support through the coordinator and other measures to add value to R&D has brought returns.

Evaluation of program and projects

The program has been little evaluated until the current review. There was an attempt in late 1995/early 1996, before the 1996 national workshop, to gain input from stakeholders on priorities, and to some extent this invited comment on phase 1 of the program.

Evaluation of projects has taken place to some extent through project reviews, but these have been more of technical than economic. Specialist benefit-cost analyses have been carried out on a number of projects as reported in chapter 3. A potential evaluation strategy has also been proposed in chapter 3.

6 Findings and Recommendations

The principal findings from the review of NPIRD are reported in this chapter and some recommendations emanating from the review are made.

1. NPIRD has funded over 40 technical and scientific projects over the past five and a half years. Further projects have been supported in the important research enhancement functions of coordination, communication, and adoption of R&D outputs. A total investment of \$7.8 million has been committed by NPIRD over the 6 years of the two phases of the program. This investment has been made approximately equally by LWRDC and the other NPIRD partners (irrigators and State agencies).

Scope

2. It is important that NPIRD positions itself to develop into a truly national program. This may mean that it will need to address the issue of widening the future funding base through more flexible mechanisms of partnership funding. If this matter is not progressed, NPIRD risks losing credibility in national leadership. Tiered member contributions, a pool of secondary funds from LWRDC or other avenues should be pursued. It may not be possible to include all irrigators without building a national program from a regional and/or industry focus. Therefore, any funding scope changes interact with such aspects as priority setting processes, the advent of new organisational structures for coordination of research in northern Australia and in Western Australia, and the proposed National Irrigation Science Network. A vision for a funding and organisational structure is required which should drive the NPIRD agenda wider than its current focus on the three eastern States.
3. Wider representation on the management committee should be considered, with two pools of resources to administer: one pool with LWRDC resources matched by the member States as is done currently; and a second pool available to non-member States and irrigation groups on a matching funds basis. It is recommended that such a structure be considered by LWRDC and the management committee of NPIRD.

Meeting objectives and producing outputs

4. Objectives and priority areas were set for each of the two phases of the program and have been addressed directly through the projects funded in each phase. The outputs from the program have generally been

in line with the objectives of the projects and the program phase.

5. For phase 1, at least some projects addressed each of the five priority areas, with the infrastructure refurbishment priority area being addressed by the smallest number of projects.
6. For phase 2, outputs relevant to WUE, the main theme of the program, have been produced. Outputs directed to the other objectives of improving coordination, communication and adoption, and improving the R&D base, have also been pursued and there is significant evidence of relevant outputs in these areas.
7. The intended outputs from the second phase were more orientated towards users such as water authorities and regional natural resource managers and planners and less to irrigators than the suite of projects funded under the first phase. However, the second phase included projects that were more likely to be orientated to best management practice, benchmarking and development of specific technologies than those funded in the first phase.
8. While it would appear, by comparing phases 1 and 2, that directly relevant applied research may be increasing, strategic research is poorly funded within the program. While it is important that vertical integration of strategic and applied research be achieved, clear definition of each project with respect to its major research role is essential. It is **recommended** that NPIRD clearly specify its intention regarding funding strategic research projects (where the research is usually riskier, where outputs are usually inputs to other R&D, and where no applied outputs are expected from the project itself). NPIRD could tag part of the budget for such strategic research. Strategic research funding should be able to demonstrate the potential to provide significant gains in productivity and sustainability.
9. With some recent exceptions, the program outputs have favoured surface (flood) irrigation at the expense of other irrigation technologies. The potential lateral transferability of prospective research results between irrigation areas appeared quite acceptable, although the actual transfer and its effectiveness could be investigated further.
10. Outputs in the areas of communication and adoption, research capacity and to some extent coordination have perhaps fallen short of what was intended in the program plan for phase 2. This is

probably a function of the plan being too exhaustive for the resources available to NPIRD over the period. Nevertheless, there is still time for all program plan objectives in these areas to be addressed during the life of the plan. If a revised five-year plan is developed, it will be important for the original intentions of the first plan to be retained — they remain relevant.

Outcomes and impact

11. A less positive view is offered with respect to outcomes (as opposed to outputs) achieved to date from the program. For example, approximately half of the irrigators and water authorities surveyed thought there had been no significant impact of NPIRD on management by irrigators or water authorities. The other half thought there had been a significant impact. Water-use efficiency awareness was highlighted and the most specific impact rated the highest by irrigators was drainage, with a reduction in nutrients and agrochemicals leaving the farm.
12. NPIRD has used a variety of approaches to assist the translation of outputs into outcomes and hence increase adoption. Nevertheless, this is issue is so critical for NPIRD that it must continue to seek ways in which this translation can be achieved.
13. The translation of project outputs from the NPIRD to outcomes is a difficult process, and existing methods and knowledge for this process are far from perfect. Many of the outputs from the NPIRD projects are not necessarily being used widely by irrigators and water authorities and therefore the desired national outcomes and benefits are not always being achieved. One of the problems of assessing outcomes, and therefore impact, is that there is little information and few measures available on adoption characteristics of each technology. Benchmarking may assist in this area.
14. There is a need to better communicate differences between outputs and outcomes to principal investigators in order to enhance clarity both in proposals and aspects of adoption and communication. It is **recommended** that clear definitions in these areas be developed and conveyed to those research organisations which are intending to submit proposals and which are communicating actual and prospective project results.
15. It is perhaps too early to assess whether the two phases of investment in the program have provided good value for money. Some outputs have been translated into outcomes, especially in regard to improved water-use efficiency. Further, the summary of results from past economic evaluations, despite the imperfections, suggests that the rate of return to investment is likely to have been quite positive for some projects.

16. In addition, the program has had a catalytic effect through stimulating further interest and activities with respect to WUE in NSW and Queensland. NPIRD was one of the first R&D groups promoting and emphasising the theme of water-use efficiency and how it might be influenced through R&D. NPIRD showed leadership in this regard although it is difficult to attribute direct causation. Other spin-offs in the form of additional projects being funded by others as a result of NPIRD investment are available.
17. Both phases of the program have made an impact. Phase 1 focused more on project funding per se, whereas phase 2 was more thematic, and placed greater emphasis on the key supporting factors associated with effective R&D (eg. adoption and communication).

Coordination

18. Coordination of projects internally has been excellent but not so coordination with external organisations. Some attempts have been made to improve coordination with other funding agencies during both phases but more effort is required. Coordination might be made easier if NPIRD were pursuing a truly national program.
19. Coordination with the RDCs is improving while coordination with the MDBC program has been somewhat more difficult. More formal arrangements need to be developed. It is **recommended** that NPIRD continue to strive to develop stronger linkages with other R&D funding organisations. Further, it is **recommended** that NPIRD investigate how the MDBC is handling the interface between its R&D program and the community and State-driven approach to Landcare.
20. Coordination in terms of NPIRD integrating what other funders and groups are contributing in irrigation R&D has not been possible, because of a lack of resources. This activity could be developed through the Irrigation Science Network and it is **recommended** that NPIRD enter discussions with that network in ascertaining their respective roles for information integration.
21. Coordination between NPIRD and other LWRRDC water-related programs could be improved. It is understood that attempts to more strongly integrate the various LWRRDC programs are in train.
22. NPIRD has found it difficult to forge strong relationships with the extension efforts of NLP and some State agencies. This may be partly the result of the differing philosophies and priorities among agribusiness and extension agencies towards R&D and extension of irrigation knowledge. It is **recommended** that NPIRD continue to recognise the value of PAM approaches, incorporate

participation and demonstrations into projects and embed such in contracts, or link in more closely with extension agencies including NLP and RDC programs to ensure that demonstrations take on greater prominence.

Research capacity

23. The program, through coordination, has improved the utilisation of skills that are already available and this has positively influenced irrigation research capacity. Examples include the funding of PAM projects, the PAM review and current training and education initiatives in this area, as well as improvement in research capacity in irrigation design criteria.
24. The intended audit of the skills base has been effected but follow-up on the recommendations is now required. Also, a postgraduate scholarship scheme and a travel fellowship scheme have both been implemented. With regard to the postgraduate scholarship scheme, it is **recommended** that some thought be given by NPIRD in future to include in selection criteria disciplinary areas where the skill base is lacking and where contributions are likely to be of future strategic significance to irrigation. NPIRD could be more active in seeking postgraduate students to study in these areas.
25. Socioeconomic R&D relevant to irrigation is still not well serviced by existing institutions, and building capacity in this area should be an important objective in the third phase. It is **recommended** that NPIRD pursue this objective and take a strong interest in the new LWRRDC program on policy and socioeconomics.

Adoption and education

26. Two principal methods of improving adoption were suggested by irrigators: local demonstrations of improved technology; and financial analysis by commodity groups or others to demonstrate profitability. It is **recommended** that NPIRD take note of these views in the further development of the program and attempt to introduce more demonstrations and financial analyses. More emphasis should be given to translation of research outputs into decision-making frameworks of irrigators and this will usually have financial implications.
27. The NPIRD approach to PAM has been interesting and useful. However, along side a training program it may also be desirable to fund more PAM projects as a learning exercise in itself. It is **recommended** that NPIRD continue to actively fund projects that utilise the PAM approach.
28. There is inadequate information on the levels and reasons for adoption or non-adoption of outputs and

best management practices. It is **recommended** that a 'technology audit' be carried out in selected irrigation areas on selected R&D outputs or technologies. This may be effected in conjunction with other industry organisations, State agencies and MDBC. Information that could be assembled in such an audit would include the reasons why certain technologies, project outputs, or best management practices are being adopted and others are not

29. The focus on how outputs might be better packaged and delivered could be improved by NPIRD developing and promoting for its researchers a stronger understanding of extension philosophies, structures and operations currently existing and those being planned in the various regions. This might be another step in ensuring that integration with extension is taken more seriously by researchers and would necessitate a closer relationship with industry strategies, the RDCs and State agencies. It is **recommended** that NPIRD prepare by State an account of the current and envisaged extension activities being supported that are relevant to NPIRD.
30. NPIRD has contributed to education initiatives for the irrigation industry through its funding of education projects (eg. education audit) and workshops. In future, education and training needs for the irrigation sector will be overseen by the National Irrigation Education Committee.

Communication

31. A total of 45% of irrigation service providers thought NPIRD communicated poorly. Water authorities saw this weakness as being mainly in communication with irrigators. Only 17% of irrigators thought the performance in this regard was poor and most (50%) thought it was satisfactory rather than good or very good.
32. NPIRD has achieved a significant amount in terms of communication improvements during the two phases of the program. The communication strategy was comprehensive but was not resourced adequately. The action plan was well targeted but was resource hungry in relation to the size of the program. There appears a strong argument for an integrated communication strategy among a number of research funders and it is **recommended** that the feasibility of such a strategy be investigated further by NPIRD.
33. The newsletter *WaterWheel* has been expanded and improved over time, and is valued by many users. However, while the demand for the newsletter has increased, further improvements could be made by including a more regular and continuous summary of new and existing projects.
34. The degree of progress on developing the NPIRD web site since the communication strategy was

adopted has been disappointing. It is **recommended** that this initiative be given high priority.

Management

35. The program appears to have been well-managed, given the national perspective required and the joint partners coming from only three States. Management difficulties regarding continuity of funding and resource carryover from year to year, have been particularly difficult, given the long-term nature of sustainability and natural resource R&D.
36. Only one project was terminated during the two phases, although several projects were reorientated and restructured after progress had been inadequate. For one project, management could have acted more quickly on administrative and legal matters in order to ensure rapid publication of information.
37. The two phases have been well planned, and processes for identifying priority areas have included consultations with industry and research providers. In general, priorities have been well founded in terms of industry needs. However, national priorities, with which NPIRD should be concerned, should emerge from sets of regional priorities. It is **recommended** that regional workshops and/or regional priority setting committees should be used by NPIRD for future priority planning.
38. The appointment of a part-time Program Coordinator has been a success in terms of coordination between projects and providing a focus for day-to day-management of the program. The investment in program support in general has been rewarding. However, coordination is resource hungry. It is **recommended** that NPIRD recognise support activities suggested in this review will require additional resources or prioritisation of existing resources available.
39. The strategies that emerged from the joint foresighting exercise for irrigation and river health were an endorsement of the existing direction of the irrigation program and should be interpreted by NPIRD as giving strong support to their priorities and planning and endorsement of future coordination and leadership.
40. A review was to be carried out for each project at least once during its lifetime. The LWRRDC program management system does not easily allow analysis of what proportion of projects have been reviewed. It is understood that this weakness in the system is to be addressed by the Corporation. It is **recommended** that the project management system also allow output categories to be specified for each project in the program (eg. categories to match program objectives) as well as defined categories of target end-users and/or beneficiaries.
41. Projects within the program have been well integrated with one another, especially since the appointment of a Program Coordinator in late 1995. However, it is **recommended** that some consideration be given to the holding of an annual principal investigator forum where the individual project outputs can be integrated at least in the minds of the principal investigators. This has worked well in the MDBC I&E program as well as in other LWRRDC programs.
42. While clients and stakeholders have been consulted extensively concerning the priorities for the program, the involvement in program management per se by industry is perceived as lacking as demonstrated in the survey responses. This perceived need may be accommodated through the funding of more PAM projects and the move to a more regional priority setting process.

Evaluation

43. Performance criteria were not established for either phase of the program.
44. The extent of evaluation of the program has been minimal until the current review. There was an attempt in late 1995/early 1996, before the 1996 national workshop, to gain input from stakeholders on priorities and to some extent this invited comment on phase 1 of the program.
45. Benefit–cost analyses have been carried out on a number of projects funded under NPIRD. Results available for five projects indicate NPVs ranging from \$1.5 M to \$11.0 M per project and benefit–cost ratios ranging from 2 to 1 to 15 to 1. These results are not dissimilar to what has been found in analysis of projects in other programs. However, the analyses were undertaken largely by different analysts, in different years, and using different selection methods for projects.
46. It is **recommended** that the best option for a future economic evaluation strategy be based on a regular random sample of projects, some of which may be analysed in quantitative terms and others in qualitative terms. This strategy should accommodate accountability requirements.
47. It is understood that a set of performance criteria for five priority areas is being developed under the plan for a third phase of NPIRD. These appear a mix of specific targets and ongoing criteria. It is **recommended** that targets be separated from ongoing performance criteria, that the number of criteria be reduced for each priority area, and that performance criteria at the program level be developed.
48. Program performance criteria that might be used could be classified into two groups — outcome criteria and process criteria. Potential outcome

criteria could include economic returns measured through benefit–cost analysis of a random sample of completed projects, evidence that adoption of outputs and technologies is occurring, that profitability improvements are being experienced by irrigators, and that sustainability benefits are being experienced by irrigators and the rest of the community.

49. Potential process performance criteria could include best practice in priority setting, accountability of research providers, administration costs and management support costs for R&D funding (various ratios), and some measure of coordination and integration

Summary of Recommendations

It is recommended that:

Scope

- (a) LWRRDC and the management committee of NPIRD consider wider representation on the management committee and a two pool structure for funding (para. 3)
- (b) NPIRD clearly specify its intention regarding funding strategic research projects and consider tagging part of the NPIRD budget for such strategic research. (para. 8)

Translation of outputs into outcomes, adoption and communication

- (c) Clear definitions for outputs and outcomes be developed and conveyed to those research organisations who are intending to submit proposals and who are communicating about actual and prospective project results. (para. 14)
- (d) NPIRD take note of the views of irrigators regarding demonstrations and financial analyses. (para. 26)
- (e) NPIRD actively fund projects that utilise the PAM approach. (para. 27)
- (f) NPIRD continue to recognise the value of PAM approaches, incorporate demonstrations into the scope of projects and embed such in contracts, or link in more closely with extension agencies including NLP and RDC programs to ensure that demonstrations take on greater prominence. (para. 22)
- (g) NPIRD prepare by State an account of the current and envisaged extension activities being supported. (para. 29)
- (h) A 'technology audit' be carried out in selected irrigation areas on selected R&D outputs or technologies. (para. 28)

- (i) An integrated communication strategy among a number of research funders should be investigated further by NPIRD. (para. 32)
- (j) The NPIRD web site initiative be given high priority. (para. 34)

Coordination

- (k) NPIRD continues to strive to develop stronger linkages with other R&D funding organisations (para. 19)
- (l) NPIRD investigate how the MDBC is handling the interface between its R&D program and the community and State-driven approach to Landcare. (para. 19)
- (m) NPIRD enter discussions with the National Irrigation Science Network to ascertain their respective roles for information integration. (para. 20)

Research capacity

- (n) The postgraduate scholarship scheme widen its selection criteria to include areas of strategic importance and disciplinary areas where skills are lacking. (para. 24)
- (o) NPIRD take a strong interest in the new LWRRDC program on policy and socioeconomics. (para. 25)

Management

- (p) Regional workshops and/or regional priority setting committees should be used NPIRD for future priority planning. (para. 37)
- (q) The LWRRDC project management system allow output categories to be specified for each project in the program as well as defined categories of target end-users and/or beneficiaries. (para. 40)
- (r) Consideration be given to the holding of an annual principal investigator forum where the individual project outputs can be integrated at least in the minds of the principal investigators. (para. 41)
- (s) NPIRD recognise support activities suggested in this review will require additional resources or prioritisation of existing resources available. (para. 38)

Evaluation

- (t) The best option for a future economic evaluation strategy be based on a regular random sample of projects, some of which may be analysed in quantitative terms and others in qualitative terms. (para. 46)
- (u) Targets be separated from ongoing performance criteria in phase 3, that the number of criteria be reduced for each priority area, and that performance criteria at the program level be developed. (para. 47)

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Annex A

Questionnaires Used in Stakeholder Survey

NATIONAL PROGRAM FOR IRRIGATION RESEARCH AND DEVELOPMENT (NPIRD) SURVEY

(Confidentiality: This return will be seen only by the members of the Program Evaluation Team and the information will be used only to develop aggregate responses. Thus your response will remain strictly confidential.)

A: QUESTIONS FOR IRRIGATORS

NAME: _____

1. AWARENESS OF PROGRAM

- a. Are you aware that there has been a national irrigation R&D program operating for the past six years?
☐ Yes ☐ No (If no, please move straight to Question 4)
- b. What is your understanding of what the program is attempting to achieve? (a few words only)

.....

2. IMPACT OF THE RESEARCH

- a. What do you think have been the important results of the research to date?
-
- b. Have the results of the research had any impact on how you manage your irrigation enterprise?
☐ Yes ☐ No
- c. If yes, in what way has your management changed?
-
- d. Do you think that the program has had any significant impact on others in the region with respect to irrigation?
☐ Yes ☐ No
- e. If you think there has been little or no impact on others, please give reasons why this is so
-

3. COMMUNICATION

- a. Can you recall any communications about the program and its projects?
☐ Yes ☐ No
- If yes, what has been the principal communication method used? (e.g. newspaper, journal, field days, radio, etc.)
-
- b. How would you rate the communications performance of the program and its projects?
☐ Excellent ☐ Poor
☐ Good ☐ Other (please specify)
- ☐ Satisfactory
- c. How could R&D results be better communicated to you?

INTEGRATION

- a. Do you consider the more strategic or basic research projects need to be better integrated with more applied projects so that results are interpreted and made available to irrigators more readily?
☐ Yes ☐ No
- b. Do you consider that R&D funded within the NPIRD could be better integrated with non-NPIRD projects and other R&D initiatives in the field of irrigation?
☐ Yes ☐ No
- c. Do you consider that the delivery of research results could be better packaged and integrated with the delivery of other information to irrigators (e.g. property management planning)?
☐ Yes ☐ No

FUTURE R&D PRIORITIES

What do you see as the principal R&D priorities in the field of irrigation for the future? (List in order of importance)

- (i)
- (ii)
- (iii)

GENERAL COMMENTS (optional)

Please make any further comments on the performance of the current R&D program and how any future program might be orientated.

.....

.....

.....

NATIONAL PROGRAM FOR IRRIGATION RESEARCH AND DEVELOPMENT (NPIRD) SURVEY

(Confidentiality: This return will be seen only by the members of the Program Evaluation Team and the information will be used only to develop aggregate responses. Thus your response will remain strictly confidential.)

B: QUESTIONS FOR COMMUNITY REPRESENTATIVES

NAME: _____

1. AWARENESS OF PROGRAM

A. Are you aware that there has been a national irrigation R&D program operating for the past six years?

☐ Yes ☐ No (If no, please move straight to Question 5.)

B. What is your understanding of what the program is attempting to achieve? (a few words only)

2. IMPACT OF THE RESEARCH

a. What do you think have been the important results of the research to date?

b. Do you think that the program has had any significant impact on irrigators and irrigation management authorities in the region with respect to irrigation management?

☐ Yes ☐ No

c. If you think there has been an impact, please describe how the impact is linked to the NPIRD

d. If you think there has been little or no impact, please give reasons why this is so

3. COMMUNICATION

a. Can you recall any communications about the program and its projects?

☐ Yes ☐ No

If yes, what has been the principal communication method used? (e.g. newspaper, journal, field days, radio, etc.)

b. How would you rate the communications performance of the program and its projects?

☐ Excellent

☐ Good

☐ Satisfactory

☐ Poor

☐ Other (Please specify)

c. How could R&D results be better communicated to you?

4. INTEGRATION

a. Do you consider the more strategic or basic research projects need to be better integrated with more applied projects so that results are interpreted and made available to irrigators more readily?

☐ Yes ☐ No

b. Do you consider that R&D funded within the NPIRD could be better integrated with non-NPIRD projects and other R&D initiatives in the field of irrigation?

☐ Yes ☐ No

- c. Do you consider that the delivery of research results could be better packaged and integrated with the delivery of other information to irrigators (e.g. property management planning)

☐ Yes ☐ No

5. FUTURE R&D PRIORITIES

- a. What do you see as the principal R&D priorities in the field of irrigation for the future? (List in order of importance)

- (i)
(ii)
(iii)

6. GENERAL COMMENTS (optional)

Please make any further comments on the performance of the current R&D program and how any future program might be orientated.

.....
.....
.....

NATIONAL PROGRAM FOR IRRIGATION RESEARCH AND DEVELOPMENT (NPIRD) SURVEY

(Confidentiality: This return will be seen only by the members of the Program Evaluation Team and the information will be used only to develop aggregate responses. Thus your response will remain strictly confidential.)

C: SURVEY OF PRINCIPAL INVESTIGATORS

NAME: _____

1. IMPACT OF THE RESEARCH

- a. Please specify the *most important impact* of your research project (to date or expected in the future) with respect to improved conservation and management of remnant native vegetation.
-
- b. Do you think that the *program as a whole* has had any significant impact with respect to irrigation management?
- ☐ Yes ☐ No Please give reasons for your answer.
- c. Please nominate what you consider to be the most important criterion for assessment of the impact of the program.
-

2. COMMUNICATION

- a. What has been the most significant message communicated from your project?
-
- b. What methods were used to ensure this message reached its target?
-
- c. Do you think these methods have been effective?
- ☐ Yes ☐ No
- d. How would you rate the communications performance for your project?
- ☐ Excellent
- ☐ Good
- ☐ Satisfactory
- ☐ Poor
- Other (Please specify)
- e. How would you rate the communications performance of the program as a whole?
- ☐ Excellent
- ☐ Good
- ☐ Satisfactory
- ☐ Poor
- Other (Please specify)
- f. How could the communication performance of the program be improved?
-

3. INTEGRATION

- a. Do you consider the more strategic or basic research projects need to be better integrated with more applied projects so that results are interpreted and made available to irrigators more readily?
- ☐ Yes ☐ No

- b. Do you consider that R&D funded within the NPIRD could be better integrated with non-NPIRD projects and other R&D initiatives in the field of irrigation?

☐ Yes ☐ No

- c. Do you consider that the delivery of research results could be better packaged and integrated with the delivery of other information to irrigators (e.g. property management planning)

☐ Yes ☐ No

4. FUTURE R&D PRIORITIES

What do you see as the principal R&D priorities in the field of irrigation for the future? (List in order of importance)

- (i)
 (ii)
 (iii)

5. GENERAL COMMENTS (optional)

Please make any further comments on the performance of the current R&D program and how any future program might be orientated.

.....

6. OPINION OF PROGRAM MANAGEMENT

Please rate the following processes undertaken by LWRRDC for managing and administering the Program

- | | | | | |
|--|------------------------------------|-------------------------------|---------------------------------------|-------------------------------|
| i) Setting of priorities | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| ii) Selection of projects | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| iii) Transparency in project selection | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| iv) Monitoring and reporting | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| v) Management of projects | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| vi) Project reviews | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| vii) Involvement of clients/stakeholders in management | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| viii) Management flexibility | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| ix) Communication of results | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| x) Project evaluation | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| xi) Final reporting | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| xii) Management of funds | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |
| xiii) National coordination | ☐ Excellent | ☐ Good | ☐ Satisfactory | ☐ Poor |

- b. Please provide comments on where major improvements can be made in the future.

.....

Annex B

Comments from Stakeholder Survey

Methods for Better Communication

When asked how R&D results could be better communicated to them, respondents included:

Irrigators

- Use of farmers' newsletters
- On farm (commercial) demonstrations
- Maintain Waterwheel newsletter but its distribution should be broader and it does not get through to grass roots irrigators
- More emphasis on development and implementation
- More concise summaries of R&D projects
- Direct mailing to irrigators
- More coordination and relevance across states
- Work with irrigation authorities more to get results out

Service providers

- Easier access to publications and background material. eg. web site with reference material and an index search tool
- One or two page descriptions of each project; regular updates giving succinct outcomes of completed projects, and activity in ongoing projects
- There is insufficient communication of R&D outputs to practicing irrigators. NPIRD should consider facilitating a series of regional field days on theme of say 'improving w.u.e.' to transfer new technology from NPIRD program to irrigators.
- Through national coordinator actively using range of communication technologies to me individually and to industry.
- Use newsletters more with testimonials
- Briefings to existing industry forums eg. ARWA (Association of Rural Water Authorities) in Victoria
- More relevant topics - a lot focused on channel irrigation
- The plain English summaries of the R&D results are good but better results are needed for uptake by farmers

- Advice on completed or near completed projects with a precis of results
- Transfer of data electronically is required with input from irrigators
- Each year a booklet of projects and outcomes should be published as a reference guide. This may also assist duplication with other research programs; such a guide should be sent to all interested parties (that is, the recipients of this survey)
- Communication OK for us but not for irrigators
- Use local publications more eg. newsletters
- Communication OK for water authorities and commodity groups; but needs improving for irrigators though regular newsletters in simple format containing summaries and highlighting where more information available; local newspapers (weekly times) in agriculture feature; internet; publicity
- More involvement with states not currently contributing to NPIRD program
- More demonstration sites and field days would improve the awareness of producers

Methods to Encourage Adoption

Ways of encouraging adoption of NPIRD project outputs would include:

Irrigators

- Local demonstration coordinated by advisory officer or consultants on commercial farms (3)
- Local focus in each valley
- Financial analysis by commodity groups or others to support adoption (3)
- Integrate R&D outputs into training programs
- Results reported via workshops and regional meetings
- Direct mailing to irrigators
- Increased range of extension products and greater advertising of them
- Ensure research results are relevant to specific areas

Irrigation service providers

- Put more emphasis on education and technology transfer
- Regional field days with themes
- Closer integration and ownership with state authorities, water management agencies etc
- Establish linkages with commodity based groups
- It all comes down to business needs. If research will benefit farm businesses or agencies they are likely to pick it up - if it does not they will not
- You first have to work closely with irrigators to both learn from them and teach them what their major limitations are; if irrigator sees it as important he will pay attention to results
- Continued education program
- Identify irrigation bodies/groups and pass on information; ensure each R&D project has a budget for delivery of results to end users (either to be used by researcher or by NPIRD)
- Have the adoption of the research outcomes included as a condition of commercial funding
- Closer contact with irrigators required
- Support for formation of irrigation industry forum/network
- Good communication with regional water distribution agencies and irrigated commodity groups
- More direct contact with irrigators at their meetings
- Lower level regular newsletter
- Specific technology transfer workshops
- More effective jointly developed policy with the States to raise the focus on water use efficiency

Principal Investigators

- Information brochure could be sent out with Water Authority accounts; displays at agricultural field days around the country; cooperative efforts with extension staff from industry groups and state primary industry departments
- Fund projects with substantial genuine stakeholder involvement in all phases of the research
- NPIRD should give more emphasis to extension and advisory programs
- The employment of extension officers to specifically extend these results
- NPIRD might provide evidence to the industry representative bodies that grower-focussed approaches, such as the LBP method, will inevitably lead to growers requesting more locally-relevant

information. They could be told of the frustration which growers felt in being 'marginalised' by the industry bodies when their requests for assistance were either ignored or viewed as frivolous or wrong-minded.

- Encourage policy research projects through collaboration with ABARE and Government Departments; promote a few innovative projects to raise awareness of future possibilities
- Give emphasis to the relations between improved water management, sustainability and productivity. Support model extension programs. Recognise that adoption rarely reaches a significant level during the life of an R&D project. Joint R&D/Demonstration with industry that links irrigation/nutrition with fruit quality and yield
- Link projects to extension/advisory services to increase adoption of outcomes
- Industry based newsletters are likely to be more effective than general "environmentally" based pamphlets. Links between NPIRD and the industries could possibly be improved and more formalised
- The NPIRD should evaluate project results with a view to providing funding for extending results into particular markets. This should be a post-research activity that would not be considered at the research funding stage, as it is unrealistic to assume all research will lead to production of useable results
- Some form of accountability of NPIRD for the release and dissemination of outputs
- Appointment of a technology transfer coordinator
- There is no one best method; published reports, magazine articles, newsletters and workshops, field days, seminar presentations, TV and radio are all useful and should continue
- Integration with industry codes of practice
- Market research is vital

General Comments

Irrigators

- Sufficient funding to allow (time and travel) national coordinator to develop understanding and feel for professional assessment; too much part-time input, while always valuable, must limit the potential for a better program
- Without a local focus you will find it very difficult if not impossible to convince us to contribute funds to *your* R&D program
- Please send information on the R&D program

- All mechanisms are essentially equally important; it is getting outcomes back to users in acceptable format - this is of most importance
- There is a need to focus on the more wide interest and general R&D topics and less focus on more narrow fields of limited interest and publication
- Current program is too focused on existing problems within MDBC and does not look broadly enough to identify new opportunities for development. There seems to be a focus on what has gone before rather than what could be. The program needs to be more nationally focused on creating opportunities in irrigation and for developing nationally appropriate solutions. I think there are opportunities for improved facilitation with industry and other R&D corporations to establish irrigation R&D as part of larger industry programs
- Work with VFF water resources committee, GM water and VDV
- Some of the projects look interesting, but the information is not reaching the farm gate

Irrigation service providers

- Research is essential for irrigation industries long-term future. Commodity R&D corporations will essentially turn to property right type R&D which will omit access to certain information and methods. NPIRD should focus on developing a role within this process to make the R&D process more effective
- Project selection often seems ad hoc and influenced by bias of management committee. Fewer well funded projects may be more likely to produce results and easier to manage. Education and extension of existing knowledge may have a greater impact on irrigation management and irrigation efficiency than new knowledge through research
- The key issue is to establish a truly national effort
- The challenge of NPIRD is profound - how to engage organisations focused on business performance on projects with a long gestation period
- I think that because the NPIRD R&D funding is limited, the focus should be on programs of national significance rather than local influence
- The focus should be on projects of national interest
- Clear need for supportive and encouraging programs for farmers to grasp need for improved WUE; presume there is a need for increased R&D on high WUE species for crop and pasture; critical need for R&D and action learning on managing people to manage change. What works and what does not work; critical need to create informed community

involvement in water reform including understanding of system top down and bottom up

- More emphasis on D part of R&D
- Need overall research coordination to produce quantifiable benefits to include other research providers research outputs
- Until all states are included in NPIRD, it will lack credibility outside eastern states
- This is an excellent program and one that has the potential to make a huge difference. The integrated approach requires the collaborative approach by a number of agencies (DOE, DNR, DPI Commodity groups). In Qld this has not occurred in the past due to lack of recognition by the agencies of this as a priority. Extensive consultation with state government and CEO/Policy makers is urgently needed across northern Australian centres of R,D and E excellence with distribution networks are needed to increase and coordinate R,D and E efforts.

Principal investigators

- Main problem for NPIRD is insufficient funds – somehow need to get more funds directed towards irrigation research
- The failure of our current system to produce quality graduates and post graduates with a desire to pursue a career in irrigation science continues. More effort needs to be put into attracting young bright people into irrigation science careers. Some ways of helping to promote this are:
 - make (more) funds available for undergraduate summer scholarships and honours projects
 - post graduate studentships
 - -award funds to proposed projects regarded as being of high priority and suitable for students, but without an identified student – to enable research groups to compete for the best students around. The current system of identifying the student first and then applying for the scholarship is incestuous, and in practice excludes the major providers of irrigation research – CSIRO and state agencies – because they do not have ready access to students
- As a part of the Crop Check 500 program it was recognised a low cost soil moisture measurement technique was required. A low cost tensiometer was developed in conjunction with a Melbourne electronics company. The tensiometer is now sold in all states of Australia and overseas, and has been used in many research programs by GMW, NRE and other government agencies. This outcome is clearly a spin-off, not envisaged in the original program, but arguably has had more impact than the original objectives

- Regular yearly meetings of those in all the funded projects might have helped to give us a better picture of where we stood in relation to others, and how some of their insights might have assisted our practices.
- It would be great to think that NPIRD could take a more national approach. The links with States and now maybe regions, is a symptom of a grossly inadequate funding base (together with the immaturity of the irrigation sector per se!). Anything which promotes a more national and generic approach will be advantageous. Local and regional issues need to be dealt with through Land and Water Management Plans, TCMs, Landcare and so on. NPIRD should provide them with information and contracts which empower, not do it for each regional interest group.
- The program should also try to redress the balance between short-term and strategic research. Thus far, the emphasis has been heavily on short-term
- Develop strategies for basic research, applied research and model extension or extension research on water/nutrient matters
- More emphasis should be placed on the involvement of potential beneficiaries of research outcomes (ie. irrigators, and others who have been identified as such) in the prioritisation and selection of research project areas and proposals, and less on researchers and agencies which stand to benefit from allocations of NPIRD funds
- Experience with NPIRD has been bad and something has to be done to help LWRRDC/NPIRD lift its game. I have not been able to acquire any useful advance information on what NPIRD's research priorities are, further than a long list of wooly generalisations. Consequently, much time has been wasted in putting forward proposals that have subsequently been rejected for no stated reasons. Delays in publication of results by NPIRD has reduced the impact of the results. Further, obtaining other publications from LWRRDC is difficult
- The Waterwheel newsletter is good however it is the only feedback of results from other projects that I have seen. You need to raise the profile of NPIRD nationally by using other media more effectively
- Dissemination of research activity and results through Water wheel could be more frequent. For example, SKP1 was a short-term project and was nearing completion when first publicised through this medium
- Further irrigation R&D is urgently required to support and help implement COAG water reform agenda? – what is ecological impact of water trading within a catchment? What guidelines are required?

Major Impact of Program

Irrigation service providers

- Other areas nominated as to impacts included:
- On farm methods and application research
- Networking and exchange of information through national workshops
- Improved efficiency in water distribution by system operators and improved measurement of water use efficiency parameters
- Focused thinking on irrigation efficiency (attempts to improve) and irrigation performance through benchmarking
- NPIRD is a contributing factor on the changed behavior of irrigators and will rarely be able to be identified as having a 'significant impact' in isolation. As such we should be assessing its performance in terms of coordination/integration and contribution to changed behaviours
- Increase in awareness of need for efficiency
- A more generic and coherent approach to Australian irrigation issues
- Improved communication between agencies
- Specific outputs can not be identified. And this is a criticism of the program
- Benchmarking and best management practice as an awareness tool and gauge for improvement
- Bringing together issues for small irrigation districts and passing on strategies and solutions
- Focus on efficient use of water resources in irrigation
- Most impact in eastern states only
- Awareness, collaborative approach, enhanced effort and focus on sustainability and water use efficiency

Reasons for Impact on Irrigators

Irrigation service providers

- Reasons given or the impact being or not being significant for irrigators were
- Major inputs into land and water management plans
- Many of the research projects are not adequately communicated and /or have other constraints that inhibit adoption
- Irrigators are now more committed to improving WUE
- NPIRD has low profile in SA and very little impact at ground level. However, the same may be true for other states

- There is no apparent mechanism for the uptake of R&D
- I see little direct reference to NPIRD among local irrigators
- Most of our customers would not know of it
- Provision that technology transfer needs to be greatly improved
- Not significant from evidence of impact in SA
- Crop check and BMP projects have and are having an impact on farm management practice, not necessarily irrigation practices
- In some areas more information on use of new technology is required
- Awareness of need for efficient water use practices
- Not much of any of the program gets to irrigators
- Road testing sensing equipment
- NPIRD not well known outside irrigation authority and commodity groups
- No impact within SA WA Tas and NT
- Limited impact in Queensland

Principal investigators

- The reasons for the positions taken regarding impact were:
- I have seen no evidence of NPIRD activities effecting irrigation practices
- Don't know – there are so many political, economic and social factors that influence what irrigators do, plus numerous activities seeking to influence irrigation management (including land and water management plans). It would be very difficult to single out what impact a single program has; I expect that NPIRD has its incremental impact along with the rest of them
- There are significant constraints to adoption of improved irrigation management practices. Many research outcomes fail to be adopted by farmers
- We have not had a joint final meeting at which all the projects could be discussed and evaluated. This question could really only be answered via a comparative analysis. We are looking forward to attending any meeting which compares results of the work done under the auspices of the NPIRD.
- There have been positive changes in irrigation management over the last ten years. NPIRD has had a part to play in these changes as have many other agencies. NPIRD has had a positive influence
- NPIRD has increased irrigator's awareness of the importance of water management and long-term

sustainability significantly, relative to the size of the program

- I find it hard to comment on the whole of NPIRD. In my area the R&D it partially funded has, through ongoing nutrition and irrigation extension programs, provided specific information on fertigation, root depth, acidification, run times etc that has given those programs a lot more impact. However, without such ongoing extension programs funded by others the impact would be much reduced
- Especially those that have involved farmers at planning, implementation and delivery stages. However, many NPIRD projects appear to do lot of research and do very little action and are not action research orientated
- NPIRD has provided focus and direction on sustainability issues within irrigated agriculture in Australia and raised levels of awareness of the issues
- Our decision support tool will make farmers more aware of the management issues involved in groundwater reuse
- Manual has not yet been published so no impact has been gained
- Wide diversity of well focused projects has had an impact
- Personal experience of NPIRD is via our project which is aimed mainly at water authorities and equipment providers. The main impact on irrigators is likely in the medium term as water authorities implement improved irrigation supply procedures
- Although significant lag periods remain between R&D and uptake by irrigators, some R&D (eg. scheduling) appears to have had a real impact on irrigators
- Our project has demonstrated an impact on attitude, management, and installation of structures

Irrigation service providers

- Reasons given for the impact being or not being significant for water authorities were:
- Research outcomes are readily adopted sometimes before the research project is completed. Information sharing between water authorities has been significantly enhanced through activities of NPIRD
- Water distribution/management agencies have implemented improved measurement, improved operational practices, improved asset management and improved asset rehabilitation (eg. channel sealing) partly due to NPIRD R&D
- Water management agencies in SA little or not interaction with NPIRD; unlikely to be aware of useful outputs and products

- Other factors such as COAG have overwhelmed the impact
- Focus to date (for our group) has been on organisational restructuring and performance (customer service, commercial viability etc) rather than R&D
- Issues of water authorities are more appropriately addressed by ANCID
- More communication between agencies has resulted from NPIRD
- Projects are focused on farm and as such do not seem to relate to agency arrangements
- I think other bodies such as ANCID address these issues much better
- Research is usually read and used by authorities and agencies
- Profile of NPIRD in WA is very low. This is currently being addressed by the formation of the WA irrigators forum with a \$ contribution to the NPIRD program
- Research focus has only improved recently
- Little impact within SA WA Tas and NT
- Keeps them honest

Principal investigators

- Reasons given for the opinions regarding impacts on water authorities were:
- I have seen in recent times, cooperation and communication between separate Australian Water Authorities that simply did not happen a few years ago
- A major strength of the NPIRD program has been the exchange of ideas through workshops and joint research projects. There are significant external pressures on water authorities to reduce costs and improve water efficiency, so adoption of research is not constrained
- Speaking in relation to one irrigation area, there is certainly a view emerging amongst growers that a) water must be better managed at the on-farm level b) the costing of water and the introduction of the WAMP means that new ways to enhance water use-efficiency must be identified and implemented and c) downstream effects are being seriously considered by government and communities. Whether these points culminate in better (eventual) management by water authorities is something we cannot, at this stage, determine
- In these early years of new water authorities, they have not been receptive to the need for irrigation management change. This situation is evolving and water authorities are maturing. They are and will

become more receptive. They will also hopefully become less parochial and locally focused and more embracing and open to learn from others

- The response from the irrigation authorities is varied, although this is more a reflection of the irrigation authority itself than of NPIRD
- Not in my area. Water supply conditions for horticultural irrigators, micro irrigation users, have not improved and there are complaints that BMPs can not be adopted due to supply
- NPIRD has provided focus and direction on sustainability issues within irrigated agriculture in Australia and through its R,D&E program it is contributing to the development of more sustainable irrigation management practices. However I am uncertain whether this has yet led to changes in how water authorities manage irrigation schemes
- Manual has not yet been published so no impact has been gained
- Most projects seem to be at irrigator level; it is also much harder to change policy than for an irrigator
- Improved knowledge and understanding of irrigation flow conditions and requirements for proper operation in future and interchange of information between scheme manager and technical staff. In case of project SKP1 this has been facilitated by wide distribution of project reports etc.
- In many ways (water use efficiencies, pricing) R&D has impacted upon authorities; however, insufficient R&D and uptake exists for ecological issues
- Can only assess for local project, and has improved awareness of what is possible from a good project

Better Integration with Other Programs

When asked how better integration might be achieved, responses were:

Irrigation service providers

- Yes, if integration focused on improving irrigator economic performance; otherwise no
- Closer integration of MDBC/NPIRD programs; combine annual review meetings at MDBC I and E program and NPIRD projects
- Brokering more jointly funded irrigation R&D projects
- One option is to use the new Aust Irrig Network (ATTC/NITC framework)
- Less duplication and more chance of uptake of R&D if integrated more

- Integrate extension of results
- They are inextricably linked anyhow and what is important is to focus on the key limits to production under irrigation
- Being able to pool funding and resources
- Attempt to reduce duplication of projects and improve cross pollination of ideas and resources
- More collaborative funding to ensure best use of funds is made and research overlap is minimised
- Would reduce duplication; increase outcome, uptake and strategic management
- Better value for \$, less duplication, strategic approach
- Less duplication and cost of research benefits
- Better integration into farming systems
- The limited impact in northern Australia is due to the low priority placed on water use efficiency by the states

Principal investigators

- One loud voice can be heard further afield than several smaller voices
- Maybe all projects with irrigation issues as the major focus could come under the LWRDC umbrella to enable better national coordination - but at the risk of creating a worse bureaucracy
- Avoid overlap between essentially similar programs; communication and extension of results from several research programs, synthesised into an integrated extension program
- Have one large forum with all funding bodies to discuss projects
- Knowledge of other projects - and findings - would enhance the ability of researchers to judge what processes might be occurring in the irrigation industry throughout Australia. The comparative dimension would be strengthened. Having said this, however, our literature review showed that little sociological investigation had been undertaken in the irrigation industries
- Joint funding would benefit both end users and researchers provided the funding agencies do their jobs by having a single administration
- Only if integration means overall control on funding to drive the research agenda
- There is a lot of benefit to be gained from better coordination in negotiating R&D with HRDC or the farmer groups that actually determine HRDC funding decisions. A better mechanism for grant application is required eg. that gives authority to negotiate with some industry group with a very high likelihood of

NPIRD funding subject to industry agreeing with set parameters. Dual applications on the chance that all parties pick it up are a waste of time. NRMS runs a strong set of priorities. Close coordination with them would reduce diversity and MDB issues would dominate irrigation R&D

- Establish an irrigation information centre or have a web page on the internet for everybody to access
- A consortium of R&D funders (eg. to integrate production issues with sustainability issues) would provide a more holistic approach to addressing management issues, potentially resulting in greater levels of 'ownership' and adoption by growers
- Coordination and networking reasonable at present. However, integration might reduce the bureaucratic process (funding/reporting). There seems to be a trend for commodity R&D corporations to be involved in this area; traditionally they were more involved in pure production issues but environmental issues are now becoming more prevalent in their programs
- More collaboration might make NPIRD more accountable for its output
- From an overall perspective of the irrigation industry also would reduce overlap and funds could be targeted better
- Need to focus on irrigation not on other priorities

Better Packaging and Integration

Irrigation service providers

- Respondents also agreed that better packaging and integration was desirable with 16 stating yes and three stating no (two don't know). One person stressed the need to recognise effective 'extension' as a specialist skill separate from research; another thought only to do so where relevant as one does not want to burden other initiatives like PMP with priorities of others

Principal investigators

- One suggestion for better integration and packaging was that the NPIRD outputs need to be integrated with crop management packages. Another also thought that NPIRD outputs needed to be integrated with crop management packages. Two people mentioned there could be a problem of information overload if too much information is provided at the one time; the view was that generally research results should be provided to the wider audience in short, easily understood form.

Regional Orientation

Some comment was passed about national versus regional orientation. One comment was that as NPIRD is

a national program then need to be careful about paying a lot of attention to regions. There is not very much money to spread around and it is easy for it to get hijacked. Another comment was that NPIRD should be national with all regions represented.

Areas for Improvement

Irrigation Service Providers

Major improvements listed for NPIRD by this group included:

- Improve communication of final reports and access to background information
- It is important that Water Services Committees are fully informed and have ownership of the research program; this is best achieved through regular communication and involvement in setting priorities and review processes
- NPIRD is seen as an eastern states program, despite good attempts to involve SA. End users are not interested in funding research when already making commodity contributions. SA does not have the same scale of irrigation or the same volume of water used – but is expected to make the same financial contributions. SA had operated AITC for 10 years without financial assistance (apart from some project funding)
- Spend more time talking to regional people through workshops or one on one
- Few NPIRD funds hit the ground in WA as yet so it is hard to make meaningful comments- however, a national focus is required
- Having people who undertake R&D come to your area rather than just request for information is more effective
- All funds seem to be expended in one or two areas and the rest are advised. Spread the projects around more
- Support to establish state/regional networks of irrigators to improve communication with program
- Use funds for implementation. No good doing research if users do not know about it
- Make concerted effort to make program fully national
- The greatest problem is the perceived priority of this (WUE) by the states in northern Australia (QLD, NSW, WA and NT)

Principal investigators

- It is obvious that NPIRD is trying very hard to improve the distribution of information generated from research projects. In these days of information

overload, it is becoming more and more difficult to have your message heard over everybody else. This is not an easy task, but there is still room for further improvement in the distribution of research findings

- Given that this is a national program, a major benefit could be achieved by research and advisory staff sharing information and experiences in different areas. While this happens informally and through conferences, there are major potential benefits in this area and a clear role for NPIRD in leading the National program in irrigation R&D
- It was very difficult to discover what other projects were doing, what findings they had come up with, and the 'success' or otherwise of the PAM approach
- NPIRD should not try to be all things to all people. It has a vital role but is not the only essential player necessary to get quantum improvements in irrigation practice and R&D. If NPIRD does a good job of garnering R&D funds (let's aim to get 10 x more!) and then brokers good R, D&E projects it will have done its job
- Given the limited amount of funding available, the program will need to promote the joint participation of research providers with specific comparative advantages eg. scientific capacity and transfer of results often reside in different agencies
- Program management (consulting, negotiating concepts for projects, evaluating, etc) works very well in defining issues and this activity could be increased. It is at that level that coordination with other funds for a particular issue should be negotiated. These positions should also take a central role with researchers in broadening collaboration
- The system of project evaluation during the second year works well
- LWRRDC and NPIRD specifically have to realise that their objectives are only half addressed with the satisfactory completion of an R&D project – the dissemination of this output to the potential users has to be managed as well, and even more sensitively. If results delivery is not made part of the R&D commission, then either the capability to deliver the R&D results has to be acquired in-house, or it needs to be outsourced
- Irrigation and water use needs to be better placed in an ecological context – particularly with other LWRRDC or R&D programs. Linkages between irrigation R&D and catchment management and environmental flows R&D should be more explicit
- Project reviews have 'culture' of needing to find fault no matter how well project is progressing.

Annex C

Summaries of Projects Funded by NPIRD

Project code	Title	Page no
Phase 1 projects		
RWC3	Crop Check 500: irrigation schedule component	65
UME12	Real time monitoring and control of on-farm surface irrigation systems	65
AIT1	Performance testing of automatic irrigation equipment for flood irrigation	65
DAV11	Control of irrigation salinity through conjunctive use of groundwaters and surface waters	66
QP127	Economically and environmentally sustainable use of various water supply sources of irrigation	66
GMW1	Construction and refurbishment of earthen irrigation channel banks	67
AIT2	Development of a value selection method for choosing between alternative soil moisture sensors	67
UNE23	Viability of irrigation infrastructure refurbishment and implications for private ownership	68
SKP1	Review of irrigation flow control and measurement to farms	68
BSE3	Effective irrigation on suitable soils on uneven surfaces	69
UAD14	Scheduling flow management of open channel gravity systems	69
CP14	Development of laboratory and field assays for agrochemical residues arising from Australian plant agriculture	70
CWN5	River pollution with agricultural chemicals used in irrigation agriculture	70
DAV7	Contribution of improved fertilisation techniques in irrigated agriculture	70
DAN8	Use of saline water in rice based farming systems	71
DAV12	Environmentally sustainable fertiliser use through improved flood irrigation management techniques	71
QPI26	Nutrient control in irrigation drainage systems using artificial wetlands	71
RWC4	Evaluation of enroute wetland systems for nutrient removal from irrigation drainage	72
BSE2	Increasing irrigation efficiency in the Australian sugar industry	72
CWN9	Adopting improved use of current water monitoring technology to manage recharge	72
DAV15	Towards excellence in dried vine fruit production	73
DAV16	Establishing a process to improve irrigation automation	73
UCQ1	Local best practice (LBP) among cotton producers in Central Queensland	74
Phase 2 projects		
QNR2	Replacement options for concrete-lined channels	74
SAS1	Research and Development of Best Practice for horticultural irrigation rehabilitation	75
DAV19	Prediction of sixty year trends in root zone salinity	75
I 6053 or MDB6	Salinity control with sustainable farm salt balance through integrated management	75
SRW1	Best Practice Identification in irrigation providers through benchmarking	76
JCU13	Best practice for new irrigation development in Australia	76
QNR1	A generic hydrological model of the irrigation management of effluent disposal	76

Project code	Title	Page no
UQL12	Review of existing participative action management (PAM) projects and socio-economic issues affecting adoption of irrigation technology	76
CDH1	Improving the water-use efficiency of horticultural crops	78
DAN11	Improving water-use efficiency by reducing groundwater recharge under irrigated pastures	78
CTC10	Guidelines for efficient and sustainable trickle irrigation systems	78
DAV23	Alternative irrigation technologies in field cropping to increase water use efficiency	79
RMI5	Conservation of water from open storages by minimising evaporation	79
CWN13	Determination of optimal irrigation intensity for irrigation areas	80
AIT5	Development of improved flow measurement in irrigation water supply	80
MIL1	Improving hydraulic efficiency of irrigation and drainage systems through benchmarking	80
GMW3	Benchmarking the distribution efficiency of an irrigation supply system	81
UQL16	Development of participative action management (PAM) for research and development	81
UME58	Improving the efficiency and flexibility of contour irrigation design	82
GRD3	Irrigated cropping advance 2000: industry development and implementation of best practice	82

PROJECT CODE: RWC3

PROJECT TITLE: Crop check 500: irrigation scheduling component

HOST ORGANISATION: Rural Water Corporation

PRINCIPAL INVESTIGATOR: Derek Poulton

STATUS: Completed

OBJECTIVES:

- (i) Increase the area and yield of a range of irrigated crops, through the adoption of established crop management and irrigation scheduling methods
- (ii) Establish the relationship between crop yield and crop water use for a range of irrigated crops grown under differing soil type and management constraints
- (iii) Develop an improved understanding of the soil physical constraints limiting crop yields in northern Victoria
- (iv) Improve the irrigation scheduling skills of farmers

PRINCIPAL TARGET AUDIENCE: Northern Victorian irrigation cropping farmers

OUTPUTS: Assembly of relevant agronomic, soil water and financial information for comparative analysis; identification and demonstration of proper irrigation practices and relationships between crop water use and crop yield established.

BENEFITS: Potentially farmers will change irrigation practices with resulting improvements in water use efficiency, but little information on the extent of the change is available.

PROJECT CODE: UME12

PROJECT TITLE: Real-time monitoring and control of on-farm surface irrigation systems

HOST ORGANISATION: University of Melbourne

PRINCIPAL INVESTIGATOR: Hector Malano

STATUS: Completed

OBJECTIVES:

- (i) To develop a PC based approach to improve irrigation scheduling and application of water on dairy farms

PRINCIPAL TARGET AUDIENCE: Dairy farm irrigators in northern Victoria

OUTPUTS: Identification and testing of sensors and methods for forecasting crop water use. The use of sensors and scheduling processes could save two irrigations per annum.

BENEFITS: Potential benefits from the techniques and equipment described in the project are significant but low adoption has restricted benefits to date. This has been due to low priority given to water management by irrigators and the perception that how changing management on an individual farm will make any difference overall.

PROJECT CODE: AIT1

PROJECT TITLE: Performance testing of automatic irrigation equipment for surface irrigation

HOST ORGANISATION: Australian Irrigation Technology Centre

PRINCIPAL INVESTIGATOR: Jeremy Cape

STATUS: Completed

OBJECTIVES:

- (i) To develop performance criteria and standards for automatic irrigation equipment. The standards to become a preliminary national standard for current and future equipment manufacturers
- (ii) To provide an independent assessment of automatic irrigation equipment currently being sold in Australia. The assessment to form the basis of recommendations to farmers
- (iii) To publish the results and extend to the farming community. To ensure that farmers are fully informed of failure rate and likely longevity of automatic irrigation equipment
- (iv) To develop improved standards for radio control equipment used in automatic irrigation. To develop improved standards for remote monitoring and control of equipment more suited to the needs of farmers.

PRINCIPAL TARGET AUDIENCE: Manufacturers and users of automatic flood irrigation equipment in the Goulburn-Murray Region of Victoria and major flood irrigation districts in NSW.

OUTPUTS: An assessment of automatic flood irrigation equipment currently on the Australian market and production of draft national standards for such equipment.

BENEFITS: The outputs from the projects could enhance the adoption of reliable automatic equipment resulting in more efficient irrigation and reduced drainage flows. However, there is no evidence of any linkage between the use of the assessment information / standards and increased adoption of automatic equipment in general or the more reliable equipment in particular.

PROJECT CODE: DAV11

PROJECT TITLE: Control of irrigation salinity through conjunctive use of groundwaters and surface waters

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: Mathew Bethune

STATUS: Completed

OBJECTIVES:

- (i) To delineate broad categories of conjunctive water use systems, based on soil and hydrogeological characteristics and irrigation intensity. Each category will have different optimal management practices
- (ii) To establish parameter values for use in simple lumped parameter models and extend management guidelines for the categories represented by the monitored projects
- (iii) To establish 'best management practice' to minimise root-zone salinity and maintain system sustainability for three selected project areas which fall into three categories representing the most widespread conjunctive use system types in the Shepparton Irrigation Region
- (iv) To undertake a benefit-cost analysis on conjunctive water use, incorporating good management practices as determined in the project
- (v) To extend good management practices to the community Landcare groups running the project area
- (vi) To establish management guidelines for community groups wishing to adopt conjunctive water use to control salinity problems on irrigated land

PRINCIPAL TARGET AUDIENCE: Irrigators and community groups in the Shepparton Irrigation Region.

OUTPUTS: Best management practices have been developed for conjunctive water use at various sites in the Shepparton Irrigation Region.

BENEFITS: As the best management practices will slow the rate of aquifer salinisation, the need for construction of evaporation basins will be delayed as will losses in farm water resources, both delays resulting in significant savings.

PROJECT CODE: QPI27

PROJECT TITLE: Economic and environmentally sustainable use of various water supply sources for irrigation

HOST ORGANISATION: Queensland Department of Primary Industries

PRINCIPAL INVESTIGATOR: John Hillier

STATUS: Completed

OBJECTIVES:

- (i) To develop an extensive set of software utilities to enable experienced modellers to construct, with much less difficulty than at present, a model suitable for the management of a particular conjunctive use irrigation area so that all aspects of the economic and environmental suitability of an irrigation area be considered in its management.
- (ii) To use the modelling system:
 - to make better decisions on the optimal mix of water sources to be used at any time (from surface storages, groundwater or other sources) to maximise water availability,
 - to consider the use to which water should be put — urban, irrigation, artificial recharge etc to enable maximum benefit to be obtained from the available resources
 - to ensure that minimum environmental degradation occurs both within and outside the irrigation area
- (iii) To incorporate a climate prediction model into the linked models to allow decisions on allocations and water storage use to be made considering probable future weather conditions
- (iv) To calibrate and trial the system in two large integrated source irrigation areas in the Bundaberg area and the Lockyer Valley
- (v) To hold a workshop and produce manuals to show managers the benefits in adopting more sophisticated management techniques in irrigation areas

PRINCIPAL TARGET AUDIENCE: Queensland government departments; groundwater irrigators in Bundaberg region.

OUTPUTS: Groundwater modules/utilities that enable existing modelling and model pre-processing to be used in an irrigation setting for use in conjunctive water use modelling.

BENEFITS: The use of models in the Bundaberg irrigation area with associated recommendations for conjunctive use has will result in improved management of the water resource in the region. In addition, strategic knowledge in the form of enhanced model capability is now available for modelling efforts in other regions.

PROJECT CODE: GMW1

PROJECT TITLE: Construction and refurbishment of earthen irrigation channel banks

HOST ORGANISATION: Goulburn Murray Water

PRINCIPAL INVESTIGATOR: Ian Moorhouse

STATUS: Ongoing

OBJECTIVES:

- (i) To identify means to reduce the lifecycle costs of earthen channel banks
- (ii) To develop means to reduce the rate of deterioration of earthen channel banks
- (iii) To develop design parameters and construction control criteria for use with materials exhibiting high plasticity, erodability, or other undesirable characteristics
- (iv) To publish for industry use a comprehensive manual of best practice approaches to channel bank construction and refurbishment, incorporating the latest technology and techniques, and covering:
 - causes of channel bank deterioration
 - material selection
 - bank design
 - construction and re-modelling techniques and equipment selection
 - better erosion control measures
 - lining materials
 - yabby and carp control techniques
 - standardised documentation for channel bank construction and remodelling

PRINCIPAL TARGET AUDIENCE: Irrigation authorities in Victoria, New South Wales and Queensland

OUTPUTS: A set of 'best practice' procedures for construction and refurbishment of earthen irrigation channel banks using modern technology and techniques. The procedures will be published as a manual.

BENEFITS: Reduction of life cycle costs of existing earthen channel banks including reduction of water loss and reduced percolation into groundwater. For new constructions benefits may be greater due to the possibility of choosing construction materials that are optimal.

PROJECT CODE: AIT2

PROJECT TITLE: Development of a value selection method for choosing between alternative soil moisture sensors

HOST ORGANISATION: Australian Irrigation Technology Centre

PRINCIPAL INVESTIGATOR: Jeremy Cape

STATUS: Completed

OBJECTIVES:

- (i) To analyse how a value selection method could be used by irrigators to select soil moisture sensors to assist irrigation scheduling decisions
- (ii) To establish key attributes which impact on the selection of soil moisture sensors
- (iii) To determine the relative importance of these attributes in different environments to establish a weighting for each attribute
- (iv) To develop a methodology that can be used in a range of situations for the selection of appropriate soil moisture sensors, using the attributes and weightings developed
- (v) To implement a strategy to communicate the methodology and its use to key clients

PRINCIPAL TARGET AUDIENCE: Irrigators and irrigation equipment consultants.

OUTPUTS: Formulation of a value selection model using sensor attributes and relative weightings.

BENEFITS: Potentially increased adoption of sensors and automatic irrigation equipment due to removal of confusion regarding accuracy of sensors as well as overall performance ratings. This potentially increased adoption would confer benefits to irrigators and the wider community through increased water scheduling and the associated implications for water use efficiency.

PROJECT CODE: UNE23

PROJECT TITLE: Viability of irrigation infrastructure refurbishment and implications for private ownership

HOST ORGANISATION: Centre for Water Policy Research, University of New England

PRINCIPAL INVESTIGATOR: Michael Bryant

STATUS: Completed

OBJECTIVE:

- (i) To develop a modelling framework to investigate, using a case study in the Murrumbidgee Region, the viability of alternative infrastructure refurbishment options, and implications for private ownership

PRINCIPAL TARGET AUDIENCE: Irrigation supply system owners, managers, and developers.

OUTPUTS: A computer package with the ability to identify the most cost effective (profitable) option for irrigation infrastructure refurbishment or development. This includes integrated assessments of on-farm irrigation technology options and enterprises, scheme viability, and water charges needed to cover system operation and capital costs.

Guidelines on the financial capacity of different farm types within the Murrumbidgee Region to support irrigation infrastructure renewal and identification of farm types facing the greatest adjustment pressures and in need of structural adjustment strategies.

BENEFITS: Can recommend specifications for building or refurbishing irrigation schemes to maximise their profit potential, by selecting optimal combinations of water supply methods and capacities, irrigation technologies and enterprises for each farm.

The use of the model should result in lowered infrastructural refurbishment costs due to strategies for refurbishment of irrigation infrastructure being able to take into account the ability of irrigators to pay and likely structural adjustment futures.

PROJECT CODE: SKP1

PROJECT TITLE: Review of irrigation flow control and measurement to farms

HOST ORGANISATION: Sinclair Knight Merz

PRINCIPAL INVESTIGATOR: Brian Foley

STATUS: Completed

OBJECTIVES:

- (i) Review existing measurement methods and metering devices for farm irrigation supplies, analyse their appropriateness, accuracy, availability and compatibility with crop needs and farm water management practices
- (ii) Examine systems of irrigation water control and delivery to farms, including use of automated devices and SCADA technology
- (iii) Critically review performance of existing methods and devices highlighting advantages and disadvantages of all types
- (iv) Determine significant deficiencies in existing infrastructure which might constrain optimum irrigation performance on farm
- (v) Suggest possible new procedures or devices that should be trialed and outline further research work needed
- (vi) Develop best practice guidelines for application of technology to the irrigation supply process having regard to crop needs, economic, social and local circumstances

PRINCIPAL TARGET AUDIENCE: Irrigators and irrigation water supply agencies; irrigation flow control and measurement manufacturers and suppliers.

OUTPUTS: Review of existing and potential flow control systems and measuring devices. Detailed report setting out historical perspective, current practices and desirable future directions.

BENEFITS: Potentially improved water use efficiency through minimising water loss and wastage as well as improved farm productivity through increased efficiency of water delivery in meeting crop water requirements. Improved ability for water authorities to properly manage water resources with particular reference to restrictions on total water volumes available under the Murray-Darling Basin 'cap'.

PROJECT CODE: BSE3

PROJECT TITLE: Effective irrigation of suitable soils on uneven surfaces

HOST ORGANISATION: Bureau of Sugar Experiment Stations

PRINCIPAL INVESTIGATOR: Christopher Sarich

STATUS: Complete

OBJECTIVES:

- (i) To improve the efficiency of irrigation practices on uneven surfaces having regard for furrow and trickle irrigation, including furrow shape/length, trickle emitter spacing, tape placement, application rate, soil type and land slope
- (ii) To analyse the most cost effective means of irrigating uneven surfaces through life cycle cost analysis
- (iii) Establish guidelines for best practice in selection, layout and management of irrigation systems to encourage greater irrigation effectiveness and efficiency
- (iv) To print and distribute guidelines
- (v) To disseminate findings to growers as part of the ongoing Property Management Planning initiative through workshops and shed meetings
- (vi) To determine the geographical regions of Australia to which the best practice guidelines will apply and ensure distribution of the guidelines to all relevant irrigator groups

PRINCIPAL TARGET AUDIENCE: Sugarcane farmers using furrow irrigation on lighter soils in the Mackay region.

OUTPUTS: Development of a new furrow design for lighter soils that has increased water use efficiency by 50%, decreased power costs by 50% and increased cane yield by 10%. 25% adoption of tensionmeters by irrigators. Better understanding of the effectiveness of furrow irrigation under a green cane trash blanket for a range of soil types. Guidelines for best practice for selection and operation of irrigation systems to increase water use efficiency. Low-pressure overhead systems were the most profitable irrigation methods, with centre pivot identified as the most cost effective. Irrigation investment returns was sensitive to water use efficiency, water allocation and cane sugar price.

BENEFITS: Increased productivity and profitability of cane farmers using furrow irrigation on lighter soils in the Mackay region.

PROJECT CODE: UAD14

PROJECT TITLE: An evaluation of the applicability of genetic algorithm technology to flow management of open-channel gravity systems

HOST ORGANISATION: University of Adelaide

PRINCIPAL INVESTIGATOR: Graeme Dandy

STATUS: Ongoing

OBJECTIVES:

- (i) To evaluate the applicability of genetic algorithm optimisation to improving scheduling and delivery of irrigation flows via open channel gravity systems
- (ii) To determine what objectives are important in delivering irrigation water by interviewing personnel in irrigation authorities
- (iii) To apply the methodology to a case study open channel flow delivery system for the Tatura irrigation area of Goulburn-Murray Water in Victoria
- (iv) To determine the cost savings arising from implementation of optimisation within computerised irrigation ordering techniques

PRINCIPAL TARGET AUDIENCE: Irrigation authorities controlling open channel delivery systems

OUTPUTS: A methodology that can be incorporated as a module in a computer ordering program and assist water planners in determining how to re-allocate irrigation deliveries during peak demand days.

BENEFITS: Operational logistics will be improved so that time of water planners will be reduced significantly. In addition, more efficient scheduling will be possible with smoother delivery and minimisation of spillage losses. Also, more timely delivery of required water will ensue as will increased equity between irrigators in obtaining supply.

PROJECT CODE: CPI4

PROJECT TITLE: On site monitoring of agrochemical residues – a valuable tool for irrigation water management

HOST ORGANISATION: CSIRO Division of Plant Industry

PRINCIPAL INVESTIGATOR: John Skerritt

STATUS: Completed

OBJECTIVE:

- (i) to develop, trial and facilitate the use of enzyme-immunoassay (EIA) kits for detection in the field of pesticides in groundwater, irrigation surface run-off, stock and domestic water supplies.

PRINCIPAL TARGET AUDIENCE: Water and irrigation management agencies and individual irrigators.

OUTPUTS: Immunoassay kits were developed for a range of pesticides.

BENEFITS: Reduced costs for monitoring for agrochemicals, the magnitude of which will depend on the rate of uptake and use of the kits. In addition, there is potential through use of the kits to achieve improvements in water quality over time.

PROJECT CODE: CWN5

PROJECT TITLE: River pollution with agricultural chemicals used in irrigation agriculture

HOST ORGANISATION: CSIRO Land and Water

PRINCIPAL INVESTIGATOR: Kathleen Bowmer

STATUS: Completed

OBJECTIVES:

- (i) Develop rapid methods for collection and analysis/assay of key pesticides used in irrigated crops
- (ii) Describe the release of selected pesticides from at least two systems of irrigated land uses into surface waters/streams, and assess the biological impact of these pesticides using key aquatic organisms
- (iii) Use this information to develop improved management practices which will reduce pollution by, and the effects of, these pesticides
- (iv) Identify any production systems which use agricultural chemicals but represent a low risk to the environment, as a guide to avoiding unnecessary regulation

- (v) Make this information available to, and promote adoption by, state water management agencies and departments of agriculture, and irrigation industry groups

PRINCIPAL TARGET AUDIENCE: Water management agencies and agricultural producer organisations.

OUTPUTS: ELISA kits for key pesticides used in rice, maize and horticulture were developed, a description of contamination of surface waters downstream of the above industries made and an assessment made of the biological impact of the monitored pesticides

BENEFITS: Increased awareness of linkages between pesticide use and downstream contamination leading to development of best practice management solutions.

PROJECT CODE: DAV7

PROJECT TITLE: Development of improved fertilisation techniques for irrigated horticulture

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: Peter Jerie

STATUS: Completed

OBJECTIVES:

- (i) To monitor nitrate and phosphate contamination of surface and sub-surface drainage from orchards for one whole season, including rain-fed drainage in winter
- (ii) To study fertiliser movement and ammonium and nitrate profiles under orchards or vineyards to identify the zone of acidification and to determine nitrogen losses
- (iii) To develop fertiliser application techniques and soil management strategies that minimise soil acidification and limit nutrient leaching in horticulture

PRINCIPAL TARGET AUDIENCE: Tree crop producers.

OUTPUTS: Findings regarding fertiliser application rates and timing of applications have been produced. Some best management practice guidelines were developed.

BENEFITS: Potential for reduced nutrient export from horticultural farms, but little information regarding actual change in practices due to this project is available.

PROJECT CODE: DAN8

PROJECT TITLE: Use of saline water in rice based farming systems

HOST ORGANISATION: NSW Agriculture

PRINCIPAL INVESTIGATOR: John Thompson

STATUS: Completed

OBJECTIVES:

- (i) To determine across a range of soil types and watertable conditions, the effect of increasing the irrigation water salinity on the infiltration properties of rice soils
- (ii) To determine the potential use of groundwater, pumped for watertable control, within a rice rotation
- (iii) To develop and publish practical strategies for the management of groundwater, channel water and salinity in rice-based cropping systems

PRINCIPAL TARGET AUDIENCE: Water supply managers and ricegrowers.

OUTPUTS: Confirmation of concerns regarding use of high salinity water in relation to increased sodicity of soils.

BENEFITS: Potential benefits from guidelines to be developed in continuing projects for use of saline water for irrigation.

PROJECT CODE: DAV12

PROJECT TITLE: Environmentally sustainable fertiliser use through improved flood irrigation management techniques

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: Nicholas Austin

STATUS: Completed

OBJECTIVES:

- (i) To quantify levels of nutrient (nitrogen and phosphorus) run-off from irrigated perennial pasture bays, after fertiliser application
- (ii) To determine and demonstrate irrigation management methods that minimise or eliminate nutrient run-off after fertiliser application, and minimise deep percolation losses of fertiliser
- (iii) To establish penetration uniformity of fertiliser into soil on irrigation bays
- (iv) To publish a booklet that provides guidelines for water management practices that promote efficient use of fertiliser

PRINCIPAL TARGET AUDIENCE: Flood irrigators of pasture in northern Victoria and southern NSW.

OUTPUTS: Confirmation that irrigated dairy farms in the Shepparton Irrigation Region contribute significant loads of nitrogen and phosphorus to drainage waters. Several farm-level management strategies arising from the research were developed.

BENEFITS: The farm level strategies have the potential to reduce nutrient exports and hence contribute to higher quality water in drainage systems which may in turn contribute to a reduction in the incidence of algal blooms in downstream waterways if widespread adoption of practices occurs.

PROJECT CODE: QPI26

PROJECT TITLE: Nutrient control in irrigation drainage systems using artificial wetlands

HOST ORGANISATION: Queensland Department of Natural Resources

PRINCIPAL INVESTIGATOR: Heather Hunter

STATUS: Ongoing

OBJECTIVES:

- (i) To assess the effectiveness of constructed wetlands for removing selected contaminants (nutrients, solids and pesticides from irrigation drainage water in tropical and subtropical areas
- (ii) To develop guidelines for the planning, design and management of constructed wetlands
- (iii) To inform the farming community and client groups (such as regulators, consultants, and agricultural industries) of the progress and findings of the study and to promote awareness of the benefits and technology of artificial wetlands
- (iv) To facilitate the adoption of this technology through farm and irrigation scheme planning

PRINCIPAL TARGET AUDIENCE: Irrigators of sugar cane in the Burdekin Irrigation Area and to a lesser extent regulators of water quality in the Burdekin.

OUTPUTS: Guidelines for the planning, design and management of constructed wetlands for improving the quality of drainage water from tropical irrigation systems

BENEFITS: Improved quality of drainage water (eg. less pesticides and nutrients) exported from the Burdekin Irrigation Area with potential benefits to ecosystems including those of the Great Barrier Reef

Note: Variations to this project are being negotiated.

PROJECT CODE: RWC4

PROJECT TITLE: An evaluation of the effectiveness of en route wetlands for the removal of nutrients from irrigation drainage

HOST ORGANISATION: Rural Water Corporation

PRINCIPAL INVESTIGATOR: Peter Cottingham

STATUS: Completed

OBJECTIVES:

- (i) To describe the quality and variability of irrigation drainage water arising from agricultural enterprises in northern Victoria
- (ii) To determine the effectiveness of natural wetlands in reducing nutrient levels in irrigation drainage water
- (iii) To make a preliminary assessment of the response of wetland vegetation to irrigation drainage discharge

PRINCIPAL TARGET AUDIENCE: Water managers in northern Victoria.

OUTPUTS: Natural wetlands should not be used for irrigation drainage disposal for conservation reasons, as well as them not offering long term nutrient retention.

BENEFITS: Avoidance of environmental and possibly engineering costs of using natural wetlands for disposing of drainage irrigation water.

PROJECT CODE: BSE2

PROJECT TITLE: Increasing irrigation efficiencies in the Australian sugar industry

HOST ORGANISATION: Bureau of Sugar Experiment Stations

PRINCIPAL INVESTIGATOR: James Holden

STATUS: Completed

OBJECTIVES:

- (i) To encourage irrigation scheduling and water use monitoring by all growers
- (ii) To increase water use efficiency by 1 t cane/ML/ha on 25% of furrow irrigated canefields
- (iii) To develop benchmarks and set standards for efficient water use by canegrowers
- (iv) To develop a framework for improving grower adoption of irrigation technology that can be applied to technology transfer in other irrigated crops and areas

PRINCIPAL TARGET AUDIENCE: Burdekin River Irrigation Area and Burdekin Delta sugarcane producers

OUTPUTS: Demonstration of the value of scheduling and increased monitoring by irrigators and the development of best practice guidelines and benchmarking

BENEFITS: Water savings and increased productivity for irrigators from increased technology adoption.

PROJECT CODE: CWN9

PROJECT TITLE: Adopting improved use of current water monitoring technology to manage recharge

HOST ORGANISATION: CSIRO Land and Water

PRINCIPAL INVESTIGATOR: Liz Humphreys

STATUS: Completed

OBJECTIVES:

The overall goal was to determine a process for successful technology transfer and adoption at a pilot scale which could be used as a model for other crops and locations in the irrigation industry

Specific objectives were:

- (i) To determine irrigator, community and agency perceptions of the advantages and disadvantages of water use monitoring (both self monitoring and external monitoring, for supply and drainage water)
- (ii) To determine perceptions of desirable scales and methods of water use monitoring
- (iii) To assess community acceptance of proposed scales and methods of water use monitoring and policy, both before and after demonstration and evaluation of selected farms
- (iv) To demonstrate and evaluate methods of water use monitoring on selected farms
- (v) To determine irrigation efficiency and recharge for a range of soil by crop by irrigation management practices
- (vi) To determine the amount and type of assistance and equipment needed/desired by irrigators to help them monitor water use, and to help them use this information to improve irrigation efficiency
- (vii) To define water monitoring policy and procedures desired by/acceptable to the Coleambally community
- (viii) To evaluate the effectiveness of the project by a telephone survey of irrigators

PRINCIPAL TARGET AUDIENCE: Irrigators and Coleambally Irrigation Management Board

OUTPUTS: Demonstration of a process for involving irrigators in research. The project paved the way for Coleambally Irrigation to successfully introduce a comprehensive water use monitoring system. Also, the project mobilised interest in the importance of reliable paddock scale determination of crop water use and recharge.

BENEFITS: Potentially increased water use efficiency and water management skills by irrigators resulting in reduced accessions to watertables and improved water quality downstream.

PROJECT CODE: DAV15

PROJECT TITLE: Towards excellence in dried vine fruit production

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: Robert Hayes

STATUS: Ongoing

OBJECTIVES:

- (i) To implement an industry developed model of technology transfer for the irrigated horticultural industries based on the development and facilitation of localised, task focused 'Landcare' style groups supported by a mobile information resource centre
- (ii) To assess the relevance and effectiveness of the model for the Dried Vine Fruit (DVF) industry and other horticultural industries in closer settled irrigation areas
- (iii) To enhance the sustainability of the DVF industry by the adoption of whole property management of the soil, nutrient and chemical applications, water quality and water use efficiency

PRINCIPAL TARGET AUDIENCE: Dried vine fruit producers in the Sunraysia and Riverland regions.

OUTPUTS: Improved technology transfer mechanisms in the DVF industry through a focus on integrating known technology particularly that associated with trellis drying. Increased development of business plans and increased involvement in benchmarking projects by growers.

BENEFITS: Higher productivity and improved financial management in the DVF industry through increased adoption of trellis drying, business planning and use of benchmarking results.

PROJECT CODE: DAV16

PROJECT TITLE: Establishing a process to improve irrigation automation

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: Greg Roberts

STATUS: Completed

OBJECTIVES:

Higher order objectives are

- (i) To develop and demonstrate a successful process of farmer adoption of technology
- (ii) To document and make the process available to others needing adoption of irrigation management and/or technology

In achieving the above higher order objectives the project will also focus on adoption of automatic flood irrigation as a component of improved irrigation management. As such, these will be the objectives:

- (iii) To have 4% of dairy farms in the Murray Valley Irrigation Area adopt automatic irrigation on part of their farm for each of the next five years
- (iv) To achieve a more even demand for irrigation water through a rise in night and weekend deliveries of irrigation water
- (v) To achieve the environmental benefits of better waste management and reduced drain flows

PRINCIPAL TARGET AUDIENCE: Irrigators in the Goulburn Murray Water region and future Principal Investigators of R,D&E projects.

OUTPUTS: Description and testing of a program logic model process for achieving change. In addition, facilitation of increase in adoption of automatic irrigation equipment by irrigation farmers.

BENEFITS: Improved water use efficiency due to an increase in use of automatic irrigation equipment; also, potential for enhanced adoption of other irrigation technologies through the program logic process.

PROJECT CODE: UCQ1

PROJECT TITLE: Local best practices among cotton producers in central Queensland

HOST ORGANISATION: Central Queensland University

PRINCIPAL INVESTIGATOR: Geoffrey Lawrence

STATUS: Completed

OBJECTIVES:

- (i) Determine through group discussions and interviews with stakeholders and experts
 - existing uses of land and water on cotton properties
 - local best practice in the district
 - opportunities which exist for improved practices among producers
 - opportunities for research and extension which arise out of the process above
- (ii) Evaluate the Local Best Practice (LBP) model of Participatory Problem Solving (PPS), indicating the extent to which it has facilitated change in attitudes and behaviour

PRINCIPAL TARGET AUDIENCE: Cotton producers in the Emerald Irrigation Area.

OUTPUTS: Formation and regular meetings of the Weemah Local Best Practice Group of eight cotton producers who identified key problems, best practices in a number of areas, and potential solutions to key problems.

BENEFITS: Adoption of potentially key improvement identified (drip irrigation) has been constrained by time, financial resources, lack of suitable technologies and lack of support for trials from industry and state agencies. Increased ownership of problems and

changed attitudes may provide benefits to individuals in the group in future.

PROJECT CODE: QNR2

PROJECT TITLE: Replacement options for concrete lined channels

HOST ORGANISATION: Queensland Department of Natural Resources

PRINCIPAL INVESTIGATOR: Brett Stevenson

STATUS: Ongoing

OBJECTIVES:

- (i) To reduce the amount of water lost through leakage from Concrete Lined Irrigation Channels. This is to be achieved by the development of a CDROM based electronic textbook on the repair and or replacement of concrete lined irrigation channels. The publication will be made available to all Australian water authorities to help them better manage the maintenance of concrete lined irrigation channels.
- (ii) Finalisation of guidelines, specifications or current practice notes for a range of options including:
 - joint repairs
 - crack repairs
 - concrete replacement and patching
 - foundation stabilisation
 - flexible membrane liners
 - prefabricated replacement lining
 - post joint installation in existing non jointed concrete
 - shotcrete over geotextiles
 - pipe replacement options

PRINCIPAL TARGET AUDIENCE: Water authorities in Queensland, New South Wales and Victoria.

OUTPUTS: An Electronic reference book published on CDROM and possibly the internet, describing best practice methods for the maintenance of concrete lined irrigation channels.

BENEFITS: Lowered costs of maintaining performance of concrete lined channels; more effective maintenance processes; additional potential benefits through reduced water seepage and wastage. Also reduced ground water salinity problems through a reduction in losses of irrigation water to ground water systems.

PROJECT CODE: SAS1

PROJECT TITLE: Research and development of best practice for horticulture irrigation rehabilitation

HOST ORGANISATION: Stanton Associates Pty Ltd

PRINCIPAL INVESTIGATOR: Chris Stanton

STATUS: Completed

OBJECTIVES:

- (i) To conduct a domestic and international literature search in horticultural irrigation technologies and asset management
- (ii) To carry out a scoping study to determine the best approach for subsequent investigation and identify sites for further study
- (iii) To investigate sites in different States where horticultural irrigation infrastructure is in need of rehabilitation
- (iv) To conduct a technical investigation of the most promising forms of infrastructure rehabilitation
- (v) To evaluate the agronomic effects of rehabilitation options
- (vi) To conduct an economic evaluation of the rehabilitation options including funding options and ability to pay issues
- (vii) To conduct a socio-institutional evaluation of the rehabilitation options, including urban development, structural adjustment and implementational issues
- (viii) To consult with community and institutional representatives and State agency representatives on the preliminary findings with a view to refining and aiding implementation
- (ix) To develop a recommended best practice for horticultural irrigation rehabilitation nationally including an implementation plan

PRINCIPAL TARGET AUDIENCE: Water agencies and authorities involved in refurbishment of irrigation systems serving horticultural industries.

OUTPUTS: A best practice manual for rehabilitation of horticulture irrigation infrastructure.

BENEFITS: Improvements in water use efficiency in horticultural irrigation systems with associated productivity and profitability to irrigators as well as downstream benefits. In additions, saved costs to water management agencies will accrue.

PROJECT CODE: DAV19

PROJECT TITLE: Prediction of sixty year trends in root-zone salinity

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: Mathew Bethune

STATUS: Completed

OBJECTIVES:

- (i) To predict sixty year trends in groundwater salinity for five representative aquifer categories in the Shepparton Region
- (ii) To predict 60 year trends in root-zone salinity for soils overlying the five representative aquifer categories in the Shepparton Region
- (iii) To predict root-zone salinities under different groundwater pumping, reuse and disposal management options

PRINCIPAL TARGET AUDIENCE: Murray Darling Basin Commission (MDBC)

OUTPUTS: This project operated as a short duration project to provide technical data for input into scenario building for the MDBC.

BENEFITS: The technical data have been used by the MDBC in improving components of the Land and Water Management Salinity Plan for the Shepparton Irrigation Region, and the data will also be applicable to the formulation and review of the Shepparton Irrigation Region Groundwater Management Plan. Improvements in these plans will provide potential benefits through delaying the impact of salinity in the Region.

PROJECT CODE: MDB6 (16053)

PROJECT TITLE: Salinity control with sustainable farm salt balance through integrated management

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: A Heuperman

STATUS: Ongoing

OBJECTIVES:

- (i) Demonstrate sustainable farm salt balance with groundwater pumping for areas with high groundwater salinity
- (ii) Develop and demonstrate the potential for integrating an on-farm evaporation basin into a farm salt management system
- (ii) Determine the cost effectiveness of integrating various salt disposal options into the farm-scale salt balance

- (iv) Run a replicated field experiment to determine whether high soil sodicity will result in poor soil water infiltration of rainfall
- (v) Develop a computer program to be used as an educational and extension tool to improve management of groundwater pumps
- (vi) Extend sustainable farm-scale salt management practices to community groups in the Murray-Darling Basin

PRINCIPAL TARGET AUDIENCE: Irrigators in the Shepparton Irrigation Area and those responsible for planning in the Shepparton Irrigation Area.

OUTPUTS: Improved evaporation basin designs and location, assessment of needs for soil ameliorants and overall improved ground water component of the Shepparton Irrigation Region Land and Water Salinity Plan

BENEFITS: Improved crop productivity and sustainability of irrigation farming in the Shepparton Irrigation Area through management of salinity across regions.

PROJECT CODE: SRW1

PROJECT TITLE: Best practice identification in irrigation providers through benchmarking

HOST ORGANISATION: Sunraysia Rural Water Authority, Barracrough and Co (Aust) Pty Ltd

PRINCIPAL INVESTIGATOR: John Wood

STATUS: Completed

OBJECTIVES:

- (i) Develop measures and processes to benchmark all aspects of the sustainable irrigation supply process incorporating sustainable resource use, ecological performance, water use efficiency and economic performance including productivity to establish the basis for benchmarking irrigation providers throughout Australia
- (ii) Measure the current performance level of each participant using outputs and process measures including those used by ICID, WSAA, the Victorian Water Industry and ABS
- (iii) Develop benchmarking skills in high potential employees from the participants and create linkages with the irrigation industries in SA, QLD, WA and MDBC for future involvement
- (iv) Communicate performance levels to motivate improved performance by each participant. Communicate results with wider water industry as appropriate

- (v) Undertake a high impact process over a short time frame to allow for further analysis and continuous improvement opportunities to commence.

PRINCIPAL TARGET AUDIENCE: Seven irrigation authorities that cover the Murray, Murrumbidgee and Goulburn River systems.

OUTPUTS: Comparative analysis between water authorities with regard to water use, farm revenue, hydraulic performance, environmental performance and business performance. The study has identified cost levels and best practice and identified areas for improvement within each authority.

BENEFITS: Potentially reduced costs to authorities and hence irrigators, improved level of services to irrigators by water authorities and reduced environmental impact of irrigation.

PROJECT CODE: JCU13

PROJECT TITLE: Best practice for new irrigation development in Australia

HOST ORGANISATION: James Cook University

PRINCIPAL INVESTIGATOR: George Lukacs

STATUS: Ongoing

OBJECTIVES:

- (i) To review the principal determinants of ecological sustainability in new irrigation schemes, with particular emphasis on biodiversity and conservation management
- (ii) To provide an issues paper which discusses ecological opportunities and limitations in the development of new irrigation schemes
- (iii) To scope the format and conduct a workshop to further develop best practice guidelines for sustainability of new irrigation development

PRINCIPAL TARGET AUDIENCE: Governments, irrigation scheme planners and regional communities.

OUTPUTS: Identification of improved development and operations of new irrigation schemes from the viewpoint of biodiversity and conservation management.

BENEFITS: Ultimately, guidelines for maximising ecological opportunities in the development of new irrigation schemes will be produced that may have an effect on the development and operations of new irrigation schemes. Benefits (as yet unidentified) could accrue to irrigators, the managers of irrigation schemes and the wider community.

PROJECT CODE: QNR1

PROJECT TITLE: A generic hydrological design model for the irrigation management of effluent disposal

HOST ORGANISATION: Queensland Department of Natural Resources

PRINCIPAL INVESTIGATOR: Ted Gardner

STATUS: Ongoing

OBJECTIVES:

To provide state regulators, municipal authorities and consultants with a generic, user friendly public domain computer model which will allow the scientific design of effluent irrigation schemes in which nutrient export and root zone salinity problems are minimised.

Specific objectives are:

- (i) To undertake further model validation and incorporate the validation results into the MEDLI users manual
- (ii) To modify MEDLI's algorithms where appropriate, so as to rectify programming and /or conceptual errors or omissions present in the computer code
- (iii) To investigate the feasibility of incorporating the CSIRO filter process into the MEDLI framework and if feasible to implement the incorporation
- (iv) To validate the pasture module in MEDLI using data from the Gatton pasture trials
- (v) To incorporate a pathogen module in MEDLI with field testing using data from the SIRP pathogen project
- (vi) To install a feedlot module into MEDLI and undertake limited validation
- (vii) To upgrade MEDLI to allow optimisation of pond volume/irrigation area combinations and reliability of supply analysis

PRINCIPAL TARGET AUDIENCE: State water regulators, municipal authorities and consultants Australia-wide.

OUTPUTS: Development of new modules and improvement and validation of existing modules within the MEDLI model so it is reliable and used with confidence by target audiences leading to improved design for effluent disposal systems that incorporate irrigation systems.

BENEFITS: Disposal of effluents in a cost effective manner that is sustainable in the long term. The use of the model will reduce costs of those enterprises producing effluents and will ensure that disposal minimises nutrient export and deep drainage movement of salts.

PROJECT CODE: UQL12

PROJECT TITLE: Review of existing Participatory Action Management (PAM) model projects and socio-economic issues affecting adoption of irrigation technology

HOST ORGANISATION: University of Queensland

PRINCIPAL INVESTIGATOR: Shankariah Chamala

STATUS: Completed

OBJECTIVES:

- (i) Review the five projects funded by NPIRD using the PAM models. Include other projects to compare method with previous approaches and the PAM model
- (ii) Identify the unique socio-economic differences that exist among the projects and how they are impacting on the projects
- (iii) Identify the institutional and stakeholder differences and the modifications made to the PAM model by the project teams and how these differences influenced the project success
- (iv) Analyse why some irrigators adopted best management practices and others did not adopt, given the similar agro-climatic industry conditions within the project
- (v) Evaluate the PAM model against previous models and approaches
- (vi) Develop future action research methodologies to achieve better transfer of technology models and compare cost-benefit analysis of PAM models with the traditional models

PRINCIPAL TARGET AUDIENCE: Research and extension officers associated with irrigation industries.

OUTPUTS: The review found the five projects were difficult to compare, and while each used components of the PAM approach, none used the whole range of components possible.

BENEFITS: While it was difficult to identify the extent of benefits from the participatory approach, the PAM methods have helped to involve large numbers of stakeholders and to facilitate the achievement of project goals, potentially leading to a higher level of adoption of irrigation technologies.

PROJECT CODE: CDH1

PROJECT TITLE: Improving the water use efficiency of horticulture crops

HOST ORGANISATION: CSIRO Horticulture

PRINCIPAL INVESTIGATOR: Brian Loveys

STATUS: Ongoing

OBJECTIVES:

- (i) To define the responsiveness of the major groups of irrigated horticultural crops (citrus, pome fruits and stone fruits) to partial root-zone drying (PRD) in pots or under field conditions
- (ii) To define the most appropriate irrigation regimes to establish sustainable PRD methodology for these crops using both pressurised water and flood/furrow irrigation systems
- (iii) To quantify the effects of PRD on
 - water savings
 - nutrient leaching
 - vegetative vigour
 - fruitfulness
 - product quality
- (iv) To increase water use efficiency, reduce nutrient leaching and increase productivity of horticultural crops across Australia

PRINCIPAL TARGET AUDIENCE: Irrigators of citrus, stone and pome fruits and annual row crops.

OUTPUTS: Improved irrigation practices through the use of novel irrigation methods such as the practice of PRD.

BENEFITS: Improved productivity and profitability for irrigators; less water use on farm, lowered nutrient export from farms, lowered accession to groundwater.

PROJECT CODE: DAN11

PROJECT TITLE: Improving water use efficiency by reducing groundwater recharge under irrigated pastures

HOST ORGANISATION: NSW Agriculture

PRINCIPAL INVESTIGATOR: Hayden Kingston

STATUS: Ongoing

OBJECTIVES:

- (i) Quantify groundwater recharge under well managed irrigated perennial pasture for a range of soil types
- (ii) Delineate and quantify the contribution of physical processes and management practices on groundwater recharge

- (iii) Test the ability of existing models to predict recharge under a range of field conditions using measured recharge levels
- (iv) Determine practices that minimise groundwater recharge while optimising pasture production and water use efficiency
- (v) Evaluate the sustainability of perennial pasture production under different scenarios
- (vi) Through a participative approach assist irrigation managers and farmers to develop sound water use policy and the adoption of improved irrigated pasture management practices

PRINCIPAL TARGET AUDIENCE: Irrigators (predominantly dairy farmers) and water agencies in the southern Murray Darling Basin

OUTPUTS: Quantification of groundwater recharge that is occurring and practices that will assist pasture irrigators to reduce groundwater recharge.

BENEFITS: The adoption of improved practices by irrigators should lead to improved profitability for dairy farmers. The development of improved policies by water authorities will ensure sustained farming system production across the community.

PROJECT CODE: CTC10

PROJECT TITLE: Guidelines for efficient and sustainable trickle irrigation systems

HOST ORGANISATION: CSIRO Tropical Agriculture

PRINCIPAL INVESTIGATOR: Peter Thorburn

STATUS: Ongoing

OBJECTIVES:

- (i) Determine the soil property/s primarily responsible for controlling the response of trickle irrigated systems to variations in management strategies (eg trickle, tape location, water application rate). Then, develop practical methods for rapid, field assessment of these property/s to allow optimisation of trickle irrigation design and management
- (ii) Determine the optimum location of soil water sensors relative to the three dimensional wetting patterns from trickle emitters in different soils and for different crop growth stages for designing systems to control water and nutrient application via trickle irrigation
- (iii) Investigate the utility of recent advances in sapflow sensors as indicators of plant stress for designing systems to schedule trickle irrigation
- (iv) Measure nitrogen leaching rates under trickle irrigation systems, and compare these with rates under conventional systems

- (v) Parameterise water, nitrogen and crop components of a cropping systems model (APSIM) across a range of soil types
- (vi) Assess the long-term environmental and production benefits of trickle irrigation for a range of agricultural systems in north-eastern Australia from the application of a cropping systems model (APSIM) with historical weather data to define the conditions under which trickle systems will be most beneficial in terms of production and water and nutrient use efficiency.

PRINCIPAL TARGET AUDIENCE: Existing irrigators in north-eastern Australia using trickle, and farming systems where future intention may be to use trickle irrigation

OUTPUTS: Production of widely applicable guidelines for design and management of trickle irrigation systems leading to increased water use efficiency and use of trickle irrigation in situations where it is best suited.

BENEFITS: Improved productivity and profitability of irrigators using trickle irrigation and improved decision making by others intending to convert to trickle irrigation in the future. In addition, improved efficiency of nutrient use and reduction of nitrate leaching.

PROJECT CODE: DAV23

PROJECT TITLE: Alternative irrigation technologies in field cropping to increase water use efficiency

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: Sam Lolicato

STATUS: Ongoing

OBJECTIVES:

- (i) To determine the value of alternative irrigation technologies (based on subsurface irrigation and surface micro-irrigation) for broad-acre cropping on both red duplex soils and grey self mulching clays - focussing on environmental benefits, yield advantages, economic advantages, convenience, and lifespan of the systems
- (ii) To develop irrigation systems to increase water use efficiency in broad-acre cropping systems
- (iii) To publish benchmarks and best management criteria for water application in broad-acre cropping systems
- (iv) To promote the use of improved irrigation technologies in commercial broad-acre cropping

PRINCIPAL TARGET AUDIENCE: Irrigators producing broad-acre crops in the southern Murray-Darling Basin irrigated cropping region.

OUTPUTS: Technical and economic knowledge base for new and innovative irrigation technologies based on long-term trickle irrigation concepts.

BENEFITS: Replacement of furrow surface irrigation with sub-surface irrigation producing improved crop yields, improvements in water use efficiency and reduced accessions to groundwater. Benefits will include improved profitability and productivity for irrigators and enhanced sustainability of irrigation systems.

PROJECT CODE: RM15

PROJECT TITLE: Conservation of water from open storages by minimising evaporation

HOST ORGANISATION: Royal Melbourne Institute of Technology

PRINCIPAL INVESTIGATOR: Aliakbar Akbarzadeh

STATUS: Ongoing

OBJECTIVES:

- (i) To reduce evaporation from open storage areas so that irrigation water may be used more efficiently
- (ii) Investigate the evaporation process to identify the most suitable means of reducing free water surface evaporation from open water storages in a way that is compatible with industry needs and environment factors
- (iii) Develop cost effective methods to minimise evaporation from open water storages by further development of the 'Aquacap' technique
- (iv) To test the technique in the laboratory and monitor performance in the field with a control pond
- (v) To involve clients in the research to ensure that the results are able to be translated into practical and possibly commercial application

PRINCIPAL TARGET AUDIENCE: Water users storing water in open storages for lengthy periods; of particular relevance to cotton irrigators

OUTPUTS: A commercially viable and practical method of conserving water resources using the developed 'Aquacap' (rings plus cap concept).

BENEFITS: Reduction in water loss from open storages will occur to irrigators with associated benefits from a higher level of water security, increased crop yields and a possible increase in irrigated areas.

PROJECT CODE: CWN13

PROJECT TITLE: Determination of optimal irrigation intensity for irrigation areas

HOST ORGANISATION: CSIRO Land and Water

PRINCIPAL INVESTIGATOR: Wayne Meyer

STATUS: Ongoing

OBJECTIVES:

- (i) Determine, with an integrated model, environmentally optimal irrigation intensity. The economic and physical impacts and tradeoffs between sustainability and profitability will be presented
- (ii) Develop a methodology to assist irrigation authorities (public and private) develop policy to achieve improved economic and natural resource sustainability
- (iii) Develop a methodology that allows farmers to simulate various farm development scenarios within the context of improving water use efficiency and managing salt. The methodology, incorporating water and salt auditing, will promote resource management understanding and integrates economic and water use efficiency

PRINCIPAL TARGET AUDIENCE: Farmers in Murray Irrigation Area; irrigation supply managers within Murray Irrigation Ltd

OUTPUTS: Models that allow individual irrigators and policy groups in the Murray Irrigation Area to assess alternative irrigation strategies.

BENEFITS: Improved water use efficiency in the Murray Irrigation Area through use of model outputs via benchmarking and education and new policy formation.

PROJECT CODE: AITS

PROJECT TITLE: Development of improved flow measurement in irrigation water supply

HOST ORGANISATION: Australian Irrigation Technology Centre

PRINCIPAL INVESTIGATOR: Jeremy Cape

STATUS: Ongoing

OBJECTIVES:

- (i) To help identify the most appropriate methods for measuring flow in irrigation systems
- (ii) To detail the range of conditions under which flow needs to be measured

- (iii) To estimate the number of sites for each condition to be measured
- (iv) To establish a common glossary of terms to be adopted by the Australian irrigation industry in flow measurement and control
- (v) To provide the facility to test and verify accurate farm inflow measuring devices
- (vi) To identify how rural water supply authorities can most efficiently communicate technical information between themselves
- (vii) To recommend how to establish this internal communications network

PRINCIPAL TARGET AUDIENCE: Irrigation water supply authorities and others involved in measuring water flows.

OUTPUTS: Improved flow measurement systems incorporating existing flow measurement devices so that accurate measurements of water flows into farms and other destinations are made and recorded.

BENEFITS: Improved water use efficiency through water authorities and others involved in measuring water flows being able to minimise water losses and wastage and meet water supply requirements in a more timely manner.

PROJECT CODE: MIL1

PROJECT TITLE: Improving hydraulic efficiency of irrigation and drainage systems through benchmarking

HOST ORGANISATION: Murray Irrigation Ltd (MIL)

PRINCIPAL INVESTIGATOR: David Watts

STATUS: Ongoing

OBJECTIVES:

- (i) To develop a practical set of hydraulic performance indicators for a gravity fed irrigation system which could be applied nationally and internationally
- (ii) To evaluate the economic benefits of the hydraulic performance indicators
- (iii) To evaluate different options to improve hydraulic performance giving consideration to river operation and water quality constraints, to model the economic benefits of on-line storages within MIL's infrastructure
- (iv) To raise channel hydraulic and drainage performance to farm productivity and farm economic performance
- (v) To develop incentives to encourage both water managers and irrigators to achieve optimum irrigation and drainage efficiency

PRINCIPAL TARGET AUDIENCE: Water managers in the NSW Murray Valley

OUTPUTS: Development of performance indicators and benchmarks for hydraulic performance and the identification and assessment of infrastructure options and incentive policies for water managers

BENEFITS: Improved water use efficiency through identification of existing losses and better delivery of water to irrigation farms. Lowered water loss and improved drainage resulting in less accessions to groundwater.

PROJECT CODE: GMW3

PROJECT TITLE: Benchmarking the distribution efficiency of an irrigation supply system

HOST ORGANISATION: Goulburn-Murray Water

PRINCIPAL INVESTIGATOR: Derek Poulton

STATUS: Ongoing

OBJECTIVES:

- (i) To benchmark the distribution efficiency (DE) of the various components of a small, open channel gravity irrigation system and irrigation return flows from farms to the surface drainage systems
- (ii) To develop strategies to overcome water losses in the distribution system, including the implementation of smart systems for improved channel operations, system planning and services to improve the integration of distribution systems and farm systems, measure the improved DE and document the environmental benefits that result

To improve the distribution efficiency of a small open channel gravity system by 5% over 10 years, and hence meet the future increases in demand

PRINCIPAL TARGET AUDIENCE: Management of Goulburn-Murray Water and associated irrigators.

OUTPUTS: Water use efficiency benchmarked at all stages of delivery, use and return which will allow measurement of future improvements and comparison of future strategies

BENEFITS: Improved management strategies for water delivery so improving water use efficiency and reducing high nutrient drainage waters.

PROJECT CODE: UQL16

PROJECT TITLE: Training R,D & E managers in PAM participatory methods

HOST ORGANISATION: University of Queensland

PRINCIPAL INVESTIGATOR: Shankariah Chamala

STATUS: Ongoing

OBJECTIVES:

- (i) To improve the relevance of R&D by increasing the knowledge of Participatory Action Management (PAM) techniques
- (ii) To involve research managers in the development of participatory techniques which will improve the development, planning and implementation of R&D projects
- (iii) To develop training materials for PAM methodology
- (iv) To improve the skills of R&D managers in the management of R,D&E outcomes by involving them in training workshops on PAM techniques; and
- (v) Develop and publicise PAM training material for use by R&D organisations

PRINCIPAL TARGET AUDIENCE: Research managers for irrigation R&D projects

OUTPUTS: Improved understanding by research managers of PAM techniques

BENEFITS: Enhanced research management through greater level of involvement of irrigators and other decision makers in problem definition, development of action plans for research and interpretation of results. This will lead to a higher level of uptake of research outputs in turn leading to increased profitability and sustainability of irrigation systems.

PROJECT CODE: UME58

PROJECT TITLE: Improving the efficiency and flexibility of contour irrigation design

HOST ORGANISATION: University of Melbourne

PRINCIPAL INVESTIGATOR: Hector Malano

STATUS: Ongoing

OBJECTIVES:

- The overall objective is to provide objective design criteria and establish best management practices for ponded contour irrigation layouts.

Specific objectives are:

- (i) To develop a hydraulic model for simulation of water flow and infiltration within contour irrigation
- (ii) To use the model to assess the efficiency of current irrigation practice
- (iii) To use the model to develop and demonstrate design and management guidelines for contour irrigation layouts
- (iv) To develop the model into a user friendly design and management software for use by practicing surveyors and designers

PRINCIPAL TARGET AUDIENCE: Surveyors and designers of irrigation systems where contour irrigation is used for dry-footed crops in rotation with rice.

OUTPUTS: A hydraulic model validated against commercial layouts, and guidelines for best design and management practices for flood irrigation contour layouts involving rice.

BENEFITS: Increased water use efficiency in flood irrigation contour layouts; reduced costs in land forming activities; and greater flexibility to rice growers in adopting more sustainable crop rotations and more efficient production of dry footed crops.

PROJECT CODE: GRD3

PROJECT TITLE: Irrigated cropping advance 2000: industry development and implementation of best practice

HOST ORGANISATION: Agriculture Victoria

PRINCIPAL INVESTIGATOR: David Ugalde

STATUS: Ongoing

OBJECTIVES:

- (i) To increase adoption of best management practices (BMPs) in the irrigated cropping industry
- (ii) To provide quality extension material and some field-based agronomic R&D as the technical base for improving production and environmental management in the irrigated cropping industry
- (iii) To sustain the Southern Murray Darling Basin Irrigated Cropping Forum in a manner that continues to develop the outcomes of the Forum's Industry Development Plans

PRINCIPAL TARGET AUDIENCE: Irrigated cropping farmers in all States in the southern Murray Darling Basin.

OUTPUTS: Strengthening of the Forum, improved coordination of R&D across the various groups included in the target audience, and facilitation of implementation of BMPs.

BENEFITS: More focused R&D and increased adoption of BMPs resulting in improved profitability and sustainability of irrigated cropping systems.