IRRIGATION RESEARCH ISSUES

A DISCUSSION PAPER

February 1996

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National Program *for*
Irrigation Research and Development

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EXECUTIVE SUMMARY

This document outlines the process followed to determine the current priority issues for a national irrigation research program.

Consultants were engaged to meet with stakeholders to determine their views on priority issues.

These views were obtained by faxing a questionnaire to industry representatives, face to face interviews and a series of discussion groups in key centres.

The level of response, greater than 60%, indicates a high level of interest amongst irrigators, their representatives, water supply agencies, the scientific community and others in the service sector.

The major R&D issues perceived by the industry can be classified as follows:

WATER MANAGEMENT
Off-Farm
Water supply systems
Infrastructure refurbishment
Ownership of irrigation assets
Water ownership, allocation and pricing regimes
On-Farm
Water distribution and application systems
Water use efficiency (yield/ ML)

ENVIRONMENTAL
Drainage
Nutrients
Salinity
Pesticides
Environmental flows

EDUCATION
Technology adoption by irrigators
Training - technical level
- professional level

These issues are very similar to those identified in the first phase of the NPIRD. It is clear however that the emphasis on the issues has changed as a result of the general reforms in the water industry.

An overriding single theme of efficiency is suggested as a way of developing the second phase of the program. It is argued that such a theme represents the existing goals of the NPIRD; it is a relatively simple message to sell to existing and potential supporting agencies; it provides a process for judging between competing projects and enables the committee to adopt an holistic approach.

1. INTRODUCTION

The Land and Water Resources Research and Development Corporation (LWRRDC) is one of fifteen R&D Corporations within the Commonwealth Primary Industries and Energy Portfolio. The Corporation's mission is:

"To improve the long term productive capacity, sustainable use, management and conservation of Australia's land, water, and vegetation resources through a directed, integrated and focused research and development effort."

The purpose of the Corporation is to identify and fund research and development activities aimed at maintaining the natural resource base used by, or affected by, the rural primary industries. The natural resources concerned include soils, water resources and vegetation. Most of the Corporation's programs now have collaboration by funding partners from a wide range of government and industry organisations.

The Corporation currently has a portfolio of about 300 projects allocated among 15 distinct national R&D programs. The NPIRD is one of the programs and is the focus of this consultancy.

The goals of NPIRD are;

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

The NPIRD has operated since 1993 in accord with a national irrigation and research development strategy that was commissioned by the National Irrigation Research Fund (NIRF) and published as "*Irrigation Research and Development in Australia - A National Strategy"* Stewart Wood and Len Banks, NIRF, June 1991. The national strategy was then translated into more specific projects for inclusion in a research program which was the basis of the first phase of the NPIRD.

The first phase of NPIRD is due to finish in June 1996 and the irrigation program management committee set up four step process to review the priorities of the first phase and establish the priorities for the second phase of NPIRD.

The framework is as follows;

1) Development of an irrigation R & D issues paper,
2) Set up a national workshop to establish and justify new irrigation R & D priorities over a five year period based on the issues paper.
3) Communication of the second phase priorities throughout the irrigation industry.

4) Implementation of the second phase of the irrigation R & D program based on the new priorities.

This paper is the issues paper that represents the first stage in the four stage process. The specific objectives of the consultancy were to;

"1) To summarise the irrigation R&D priorities of the first phase of the NPIRD, and briefly assess against those priorities, the irrigation R&D projects that have been undertaken.

2) To establish a range of criteria to help with the determination and justification of new irrigation R&D priorities.

3) To identify and describe the range of major issues considered to be the most significant and important for providing a sound basis for establishing a new set of irrigation R&D priorities, categorised by sub-program areas, for the five year period beginning July 1 1996.

4) To identify the key outcomes that would be sought as a result of addressing the priority issues and against which R&D (or other activities) would be commissioned to achieve the outcomes.

5) To prepare a discussion paper on the topic outlined above that will be used as the basic reference document for a national workshop where the new irrigation R&D priorities for the second phase of the NPIRD will be formulated."

2 METHODOLOGY

When establishing the initial priorities Wood and Banks consulted extremely widely with stakeholders and held more face to face interviews than were possible in the current study. The current project was conceived to be largely a desk top study. Accordingly a methodology was adopted which ensured the widest possible consultation within the time and budget constraints.

The process involved the following steps.

1. Identification of key stakeholders from all sectors of the agricultural irrigation industry including irrigators, researchers, manufacturers, educators, water supply agencies, government officials and private consultants. Care was taken to compile a list which represented a full range of geographical areas, irrigation methods and commodity types. A l list of those who responded is included in Appendix A.

2. A brief questionnaire was prepared which was designed to prompt a range of responses from interested organisations and individuals. The questionnaire was faxed directly to some 80 people. Additional copies of the questionnaire were sent to 30 members of the industry who responded to publicity about the study. A total of 66 questionnaires were returned, which represents a very high response rate indicating the importance of the issues to the industry. A copy of the questionnaire is included in Appendix B.

3. To ensure as much awareness as possible a press release was distributed to publicise the project. Articles appeared in numerous city and country papers and the ABC country radio network broadcast four interviews with the consultants. As a result some 30 organisations and individuals contacted the AITC seeking copies of the questionnaire.

4. A number of workshops and face to face interviews were held in strategic areas. Although these were restricted because of time and money constraints, they served a very useful purpose in clarifying many points raised in the survey. Discussions were held in Narrabri, Canberra, Tatura, Deniliquin, Mildura, Berri, Loxton and Adelaide.

5. The consultants also held discussions with LWRRDC staff and made use of their own knowledge of the industry to prepare the issues paper.

The timetable for the project was very tight and it was clear from several comments received that the timing of the project was also inappropriate. The project coincided with peak irrigation activities in Australia as well as the summer holiday period. In spite of this the high response rate and high level of interest shown in the study indicates that most people in the industry who wished to respond have been able to do so. However it is recommended that any future such exercises be timed for the winter months.

3 ASSESSMENT OF FIRST PHASE NPIRD

3.1 Evolution of Priorities

The Federal Government established the National Irrigation Research Fund (NIRF) in 1987, with funds from the Australian Water Research Advisory Council (AWRAC) and matching funds from the Queensland Water Resources Commission, the NSW Department of Water Resources, and the Rural Water Commission of Victoria. One of the tasks undertaken by NIRF was to develop a national strategy for irrigation research and development. The directors commissioned Stewart Woods and Len Banks of the South Australian and NSW Departments of Agriculture respectively to identify and prioritise the generic research and development needs of irrigated agriculture.

As a result, *Irrigation research and development in Australia - A national strategy* was published in June 1991. Seven issues of national significance were listed, with the recommended percentage of research funds to be allocated to each issue shown in Table 1 Otherwise, the issues were assigned no particular priority.

Table 1 National Irrigation Priority Issues established by NIRF (1991)

National Issues	% allocation required
Sustainable irrigated cropping systems	35
Water use efficiency	20
Drainage	15
Pollution	5
Salinity	5
Technology transfer	10
Education	10

The national strategy provided background information on each issue, together with targets for change, priorities for action, and costs.

The NPIRD was established in early 1993 with the same funding partners, but with AWRAC replaced by LWRRDC. The NPIRD operated generally in accord with the national strategy. However, a working group established by the Management Committee of NPIRD translated the strategy into more specific projects for inclusion in a research program.

This latter work was the basis of the first phase of NPIRD and was published as a *National Program for Irrigation Research and Development: Discussion Paper for a Proposed Research Strategy*, March 1993, Forster et al., LWRRDC Occasional Paper 02/93.

In the discussion paper, four priorities areas were identified, with a number of issues and programs noted in each area, as follows.

- Improvement in productivity output and environmental sustainability:

  - adaptation of property management planning techniques to irrigated agriculture
  - development of innovative sustainable irrigated agricultural systems.
- Increased water use efficiency including both off and on-farm water management
  - water supply system (infrastructure refurbishment, automation)
  - integrated water management systems
  - environmental allocations
- Drainage, pollution and salinity issues
- Technology adoption and education.

The Management Committee then divided these issues into a number of project areas and assigned priorities, which are summarised as follows.

High Priority

. Infrastructure refurbishment
. On and off-farm water supply automation
. Environmental flows
. Drainage, pollution and salinity
. Technology adoption and education

Medium Priority

. Property management planning
. Conjunctive use
. Integrated water management

Low Priority

. Innovative new crops
. Structural adjustment

3.2 First Phase Projects

The first phase of NPIRD commenced under NIRF and runs until 30th June 1996. Projects funded under the first phase are listed in Table 2.

Table 2 First Phase Projects of NPIRD

DESCRIPTION	REF	PROJECT	ORGANISATION	NPIRD BUDGET ($)
Conjunctive Water Use	DAV11	Control of irrigation salinity through conjunctive use of groundwaters and surface waters	Department of Agriculture, Energy & Mine	$199,330
	QPI27	Economic and environmental sustainable use of various water supply sources for irrigation	QLD Dept of Primary Industries	$331,222
Infrastructure Refurbishment	GMW1	Construction and refurbishment of earthen irrigation channel banks	Goulbourn-Murray Water	$200,000
	UNE23	Viability of irrigation infrastructure refurbishment and implications for private ownership	University of New England	$155,000
Water Supply Systems	UME12	Real-time monitoring and control of on-farm surface irrigation systems	University of Melbourne	$120,418
	RWC3	Crop check 500 - irrigation scheduling component	Water Ecoscience Pty Ltd	$58,105
	AIT1	Performance testing of automatic irrigation equipment for flood irrigation	Australian Irrigation Technology Centre	$32,588
	AIT2	Development of a value selection method for choosing between alternative soil moisture sensors	Australian Irrigation Technology Centre	$21,712
	BSE3	Effective irrigation of suitable soils on uneven surfaces	Bureau of Sugar Experiment Stations	$104,200

Drainage, Nutrients, Salinity & Pesticides	DAV7	Development of improved fertilisation techniques for irrigated horticulture	Department of Agriculture, Energy & Mine	$184,539
	DAV12	Environmental sustainable fertiliser use through improved flood irrigation	Department of Agriculture, Energy & Mine	$114,800
	QPI26	management techniques		$175,600
	RWC4	Nutrient control in irrigation drainage systems using artificial wetlands	QLD Dept Primary Industries	$225,345
	DAN8	Evaluation of enroute wetland systems for nutrient removal from irrigation	Water Ecoscience Pty Ltd	$77,457
	CPI4	drainage	NSW Agriculture	$170,171
	CWN5	Use of saline water in rice based farming systems	CSIRO Division of Plant Industry	$150,000
		On-site monitoring of agrochemical residues - a valuable tool for irrigation water management	CSIRO Water Resources - Griffith	
		River pollution with agricultural chemicals used in irrigation agriculture		
Technology Adoption and Education	CWN9	Adopting improved use of current water monitoring technology to manage recharge	CSIRO Water Resources - Griffith	$112,700
	BSE2	Increasing irrigation efficiency in the Australian	Bureau of Sugar Experiment Stations	$90,059
	DAV16	sugar industry	Department of Agriculture, Energy & Mine	$153,869
	UCQ1	Establishing a process to improve irrigation automation	Central Queensland University	$101,755
	DAV15	Local best practice among cotton producers in Central Queensland	Department of Agriculture, Energy & Mine	$74,500
		Towards excellence in dried vine fruit production		

Additional funding was provided for workshops, surveys and the irrigation program co-ordinator, and the IAA's National Irrigation Accreditation Program.

3.3 Comparison with Priorities

A comparison of the projects listed in Table 2 with the priorities outlined in Section 3.1 above shows that projects have been funded in all of the high priority areas.

An exception is environmental flows, which have been allocated to the River Management Program. In reviewing the evolution of priorities, it can be seen that environmental flows were not an issue at the time of establishment of NIRF. They are now perceived as a major issue by both irrigators and the community at large. NPIRD shall need to maintain close links with the River Management Program to ensure that irrigators' interests are represented.

Two projects have also been funded in the medium priority area of conjunctive use. However, the project DAV11 has strong salinity and technology transfer components, both of which are high priority areas. QPI27 is linked to economic and environmental sustainability (high priority) and integrated water management (medium priority).

No low priority projects were funded under the first phase of NPIRD.

Most projects are progressing satisfactorily. However, RWC3 was shortened from three to two years, due largely to low participation by farmers, limiting the achievement of objectives. There is a question whether RWC4 shall achieve worthwhile outcomes for the expenditure, and the project would appear stalled. DAN8 would also appear in some difficulty, with a backlog of data to be processed. On the other hand, CPI4 and CWN5 have been completed with entirely satisfactory results.

The five projects under Technology Adoption and Education are in their first year and at too early a stage to evaluate. The projects cover a range of crops and issues. Each project is to be independently evaluated, then compared to the performance of the other projects in the group, to assess their suitability as a technology transfer model both within the industry trialed and in other industries and regions. However, from the information provided, it is not always clear how the technology transfer process is to be achieved.

4 CRITERIA FOR IRRIGATION R & D PRIORITIES

This discussion paper seeks to elucidate and prioritise those issues which then can be addressed by appropriate research projects. In assessing research projects for funding, the NPIRD requires a set of criteria by which the competing projects can be evaluated. These criteria need to be communicated to potential applicants for funding, to allow a focussing of their proposals.

In establishing the appropriate criteria, considerable guidance has been obtained from what has gone before and from criteria used by other research funding organisations. However, every area of research has its own unique characteristics. The criteria listed below have been derived on the basis of the consultants' experience with the industry, and input from the industry as part of this consultancy. The policy and administrative requirements of LWRRDC have also been taken into account.

The criteria have been grouped under four headings which give an overview of the requirements. Separate criteria are listed under those headings. A given program might not necessarily meet all criteria, but would obviously be better regarded if it showed positive results against most criteria and no negative results.

CRITERIA:

Priority should be given to irrigation research and development projects which, in terms of

- **POLICY**
  - are consistent with LWRRDC's mission statement and goals of NPIRD
  - provide generic research of national and/or regional significance
  - do not duplicate work being done elsewhere

- **THE PHYSICAL ENVIRONMENT**
  - lead to greater ecological sustainability of irrigation farming
  - contribute significantly to overall environmental enhancement

- **FARM PRODUCTIVITY**
  - provide a holistic approach to irrigation systems
  - push forward frontiers of best practice
  - lead to greater adoption of best practice
  - lead to greater economic sustainability of irrigation farming
  - develop new skills in the human resources in the industry especially where it will enhance the rapid uptake of research results.

- **EXPECTATIONS OF A SUCCESSFUL RESEARCH OUTCOME**
  - have support and/or involvement of stakeholders/researchers
  - have resources available to undertake program (skills/facilities, etc)
  - have resources/processes available to ensure widespread adoption
  - are reasonably narrowly focussed, rather than trying to be too wide-ranging
  - have a high likelihood of a positive return on funds invested
  - are integrated and coordinated with other programs.

In addition, programs should be in accord with LWRRDC's template of questions applicable to all programs (see Appendix C). These questions are complementary to the above criteria but tend to be broader in scope.

5. FUTURE IRRIGATION R & D PROGRAMS

5.1 Water Policy Imperatives

Water policy changes since Wood and Banks have had a major impact on, and still have enormous implications for the irrigation industry. In the view of many, on-farm issues will be secondary to off-farm issues for the immediate future.

The decision by the Council of Australian Governments (COAG) to accept the recommendations of the Neal report has changed the water policy framework radically. The changes have major implications for the industry in general and for research and development programs affecting the industry. It is also clear that these changes are irrevocable for the foreseeable future, in part because the Hilmer recommendations on competition have encouraged the States to look for ways to expedite micro-economic reform.

The major changes which will impact on the industry in the future include:

. the move towards a national market for water which, while it is still some years away will facilitate the movement of water from some irrigation enterprises to others

. the decentralisation of control from State Government run water supply agencies to corporatised or private regionally based agencies

. in association with decentralisation the shift in responsibility for management from the States to regional agencies

. the fragmentation of the industry in some areas of the country and greater competition between irrigation areas

. the changed pricing structures which have had and will have a greater impact on the way in which water is viewed, not only by the irrigation industry but by the wider community as well. Water is a resource whose value is clearly rising.

. the greater obligations and greater opportunities for irrigators to control their future, as a result of the reforms, through their direct involvement in the management of water supply agencies.

These changes have in the main been initiated by Governments rather than by the industry and the full implications of the changes are still to be understood by significant sectors of the industry.

This political background means that water efficiency in the broadest sense has become a major national issue, and that the environmental issues that were identified by Wood and Banks are becoming even more critical issues for the industry to deal with.

5.2 Issues

5.2.1 Results of Consultations

A total of 66 responses were received from the questionnaire The information received was analysed along with information from the existing program priorities, the face to face interviews and the group discussions. The CSIRO Division of Water Resources has recently completed a brief survey to identify "critical water issues". The results of this survey were made available by the CSIRO and it served to confirm the issues identified in this study.

Table 3 below details the responses to the Question 1 of the questionnaire. Table 4 details the results from Question 2 which asked respondents to identify the priority issues. While the results of the questionnaire are valid in that they are indicative of the level of interest in different issues they should not be interpreted as a statistically rigorous analysis of the rankings.

Table 3 Response to the questionnaire detailing average ranking and number of respondents identifying a particular criterion.

Q1.	Average Rank	Count
Lead to greater ecological sustainability of irrigation farming	2.1	55
Lead to greater economic sustainability of irrigation farming	2.0	53
Lead to better utilisation of water on-farm	2.7	49
Develop better methods of managing irrigation supplies	3.6	40
Contribute significantly to overall environmental enhancement	3.2	22
Lead to reductions in water losses from water supply schemes	3.2	22
Demonstrate ways to rehabilitate irrigation areas	3.6	26
Develop new skills in the human resources of the industry	3.4	28
Contribute to regional development	3.9	20
Enhance the riverine habitat for native flora and fauna	4.0	14

The average rank is an average of the ranking between 1 (highest priority) and 5 (lowest priority) respondents were asked to indicate in the questionnaire. The count is the number of respondents who gave the issue any rank.

Table 4 Listing of the average ranking and number of responses for priority issues.

Q2	Avge Rank	Count
Reducing the contribution of irrigation to salinity problems	2.8	32
Improving water use efficiency on-farm	2.5	61
Improving water distribution efficiency on-farm	3.6	23
Provision of education and training to the industry	3.2	38
Understanding the impact on the environment of irrigation farming	3.2	32
Development of new water allocation and pricing schemes	2.9	30
Developing better irrigation management methods	3.2	42
Development and adoption of improved technology	3.0	48
Development of grassroots input into irrigation R&D priorities	3.3	10

The tables confirm the interest in water efficiency, drainage issues, technology adoption and some infrastructure issues. In addition to completing the specific questions respondents were asked to provide additional information if they wished. Nearly all respondents did this and a full summary of all responses is included in Appendix D.

5.2.2 Priority Issues.

The full range of issues is outlined in Appendix D. Priority issues were identified very strongly by industry. These issues are summarised below.

Water Use Efficiency. Most respondents highlighted water efficiency in the broadest sense as being very important. People nominated efficiency issues both on farm and off farm, in relation to application systems, in scheduling and water demand, and from a management perspective. A strong theme in this issue was the development of better technology to bring about more efficiency and a need to identify the contribution of the application of or potential of existing technologies.

Drainage Issues. Salinity, nutrients, and pollution was identified as an issues that needed to be addressed with a view to decreasing the contribution from irrigated agriculture to such problems. Concern was also expressed that insufficient was known about the longer term impact of irrigation drainage water on the environment and the impact of saline groundwaters on irrigation.

Education and Technology Adoption. The common perception that there is a significant gap between the technical possibilities and the actual performance on farm was expressed by respondents. In particular it was felt that better, more coordinated mechanisms should be developed to enable a better flow of technical information to and from irrigators. The clear message was that if irrigators were better educated about general irrigation principles they would be more likely to adopt new technology which was relevant to their situations.

Water Policy and Resource Management . Possibly in response to the COAG reforms the issue of how irrigation resources would be managed on the broad scale was raised. For example, examination of some of the socio-economic factors such as rehabilitation or decommissioning of irrigation areas were raised as potential research topics.

5.3 Developing a Theme

During the consultation process a number of issues were raised which are not researchable issues in themselves but which impact greatly on the effectiveness of any irrigation research program. These issues such as awareness of programs, adoption of the results of programs and coordination with programs operated by other agencies such as MDBC and Departments of Agriculture, were raised in all discussion groups. It is recommended therefore that any future program have a strong theme which is able to;

- differentiate the LWRRDC program from other programs
- highlight a clear message conveying the purpose of the program
- be strongly identified with the irrigation industry rather than the broader environment.

It was apparent that the work of the existing program was not well known and that LWRRDC itself had a much lower profile than say the commodity based R&D corporations. It also was suggested that LWRRDC had spent a great deal of time looking at the process of R&D rather than delivering practical results. While this view could be discounted to some extent, it is clear that the National Irrigation Program could and should have a much higher profile. The industry is very sympathetic to the cause and believes there are important issues that should

be addressed. If the program can develop in this way it was indicated that financial support would be more easily forthcoming. To paraphrase one respondent:

"We are concerned about sustainable irrigation and protection of the environment and I am happy to contribute to an R&D program if I can see potential for returns on my property or in my region which contribute to profitable enterprises as well as looking after the environment.

An irrigation program should be looking at issues from the irrigation perspective not from an environmental perspective."

The results of this consultation process clearly identified efficiency in the broad sense as the key issue. From a business perspective the irrigation industry has to be as efficient as possible in its use of all resources, land, water and human. It was recognised that the industry has to become more efficient to survive. Higher efficiency will contribute to reductions in any harmful environmental effects of drainage waters and it represents a logical business response to the increasing value society is placing on the water resource. Efficiency goals also require the accurate measurement of targets and progress, an issue which was raised by some respondents as an area of potential research projects. Efficiency as an overall objective also enables projects to be funded in all the areas of concern expressed by the industry. For example efficiency issues have been identified at the off-farm and on-farm levels, the impact of changing efficiency on drainage issues can be measured and made clear and such a theme also can encompass the required holistic and integrated approach.

The efficiency theme is also consistent with the stated goals of the NPIRD. The response of the industry to this round of consultation confirms the validity of the existing stated goals.

Although NPIRD is relatively young in organisational terms and it has not had time to establish a strong track record of successful research outcomes many respondents felt that it could sell its message better. It was argued that the program could or should be known more simply for example as the "Irrigation Research and Development Program" (IRDP). The inference being that *Irrigation* is the key word and should be highlighted. LWRRDC and National Program are of lesser importance; the industry is not as concerned with the image or existence of LWRRDC as with the results of well managed, relevant and directed research programs.

Another potential benefit of such a theme is that it can easily complement industry programs. For example an industry target to achieve say 80% application efficiency on all irrigation farms could easily be supported by a Research and Development program which had efficiency as its theme.

The MDBC is directing considerable effort towards measuring and establishing best practice and benchmarks with its irrigation investigations. The approach could be developed to differentiate the LWRRDC program from MDBC irrigation programs and to develop areas of complementarity.

5.4 Outcomes and Programs

This section describes the implications of adopting an efficiency theme for the program. Consideration has been given as to how such a program might work. Initially little time has been put into identifying particular projects or programs. The list in Appendix D gives a great deal of detail which is a useful source of such potential projects. This paper is more concerned to describe a possible process rather than identify particular programs.

A decision to develop a particular theme for the irrigation R&D program makes the identification of outcomes and potential programs simpler. If "efficiency" is the theme of the Irrigation R&D Program the desired outcomes are measured by changes in efficiency.

A general desired outcome could be higher dollar returns per megalitre of water delivered for example. By identifying such a goal a series of questions are raised, in particular questions of measurement and monitoring become very important. Table 5 below lists a range of efficiency measures which could be considered by the irrigation industry. The list is not meant to exhaustive, it is intended to indicate the range of measures that could be used. At this time no attempt has been made to rank them or assess their potential merit as research program outcomes. Under the efficiency theme scenario the IRDP operation might be as follows;

A call for projects is published which requests interested parties to lodge applications for funds for research projects, which if successful will lead to improvements in, say, an improvement in the proportion of water diverted from streams being delivered to irrigation properties. (Such a program would encourage projects looking at efficiencies in the water supply networks; potential research topics could include metering of open channels, automation of outlets, lining or pressurising channels and even potentially the economics of supply.)

On receipt of projects they could be assessed in terms of their potential to achieve improvements in the key efficiency indicator being targeted. Other criteria such as applicability of solutions to a wide audience, delivery mechanism of results, and congruence with policy and success objectives etc, would also be part of the assessment. A number of projects could be selected which complement each other by resolving different sub issues within the key issue.

Table 5 Measures of efficiency for the irrigation industry.

Measure	**Unit**
tonnes yield per meg delivered	t per ML
dollar yield per meg delivered	$ per ML
Megalitre delivered for each dollar of cost	ML per $
megalitres per area for a crop type	ML/ha
Depth applied per year	mm/yr
Application versus crop water requirement	mm/mm
Volume of drainage for volume applied	ML/ML
Disposal costs of saline, nutrient rich or polluted water	$ per ML
Dollars potential yield vs cost	$/$

As stated above Table 5 is not intended to be a comprehensive list. It serves to illustrate the range of efficiency measures that could be used in the irrigation industry. It also important to state that the use of such measures can tend to simplify issues which are complex and have many aspects. However it is argued that used in context such measures contribute to a greater understanding of the dynamics of irrigation systems.

The simplicity of the message also makes the selling of the benefits of the program easier and leaves the industry in no doubt as to the goals of IRDP.

APPENDIX A. 1 RESPONDENTS TO QUESTIONNAIRE

NAME	ORGANISATION
Robert Stevens	Primary Industries SA
Steven Page	Murray Farm Forestry
J.A. Thompson	NSW Agriculture
Steve Hallett	I.A.A. West Australian Division
Chris Stoltz	Sunraysia Rural Water Authority
Scott W Norton	Irrigated Crop Managment Service
George Gardiner	ORD River District Co-operative
Tony Thomson	PISA
Lillian Pombart	NSW Environment Protection Authority
Dennis Vice	Highbank Wines / S.E. Institute TAFE
John Cornish	I.A.A.
Dr. C.L. Noble	Agriculture Victoria
Stephen Mills	Goulburn Murray Water
Tanya Stoianoff	NSW Dairy Farmers' Association Ltd
Mike Smith	Dept. of Environment and Natural Resources
Bernard A.F. George	NM Rural Enterprises
Brendan George	Irricrop Technologies
Jerry Killen	Namdi Valley Water Users
Leon Broster	Murray Darling Association Inc.
Ken Davis	Controlled Sprinkler Supplies Pty Ltd
Mark Dale	I.A.A. Sunraysia Region / Agriculture Victoria
Lindsay Jones	Soil Solutions Pty Ltd
Kumar Narayan	CSIRO Water Resources
Bruce Simpson	F.S. Falkiner & Sons Pty Ltd
Colin Creighton	DPI Townsville
Ian C. McDonald	Colly Farms Ltd
Tony Meissner	Primary Industries SA
Darren Ferber	James Hardie Irrigation
Greg Luke	Agriculture Western Australia/ Eden Gate Blueberry Farm
Derek Poulton	Goulburn-Murray Water
Dr. Hector M. Malano	International Development Technologies Centre
W.I. Eastgate	DPI Queensland
Duncan Malcolm	IAA - Formerly Rural Water Corp. VIC
Eoin Wallis	Sugar Research and Development Corporation
Stephen Elliott	River Murray Water Resources Committee
Robert Hadler	National Farmers' Federation
Peter Hayes	Grape and Wine Reseach & Development Corp.
Elizabeth Humphreys	CSIRO Water Resources
Gary Donovan	NSW Irrigators' Council
Dr Dawn Fordham	Bureau of Resource Sciences
Don Marriott	Advanced Irrigation Consultants Pty Ltd
Mark Howden	Bureau of Resource Sciences
Jacqui Allen	Bureau of Resource Sciences
Volker Aeuckens	DPIE Land Resources
Dr S.A. Prathapar	CSIRO Division of Water Resources
Warren Muirhead	CSIRO Division of Water Resources
Dr Evan Christen	CSIRO Division of Water Resources
Greg Claudon	DPIE Land Resources
Ralph Schulze	Cotton R & D Corp.
Noel Dawson	DPI Queensland
Prof. J. Pratley	Charles Sturt University
Craig Findson	QUF Milk Supply

Peter Chudleigh	Agtrans / LWRRDC
John I. Kahlbetzer	Twynam Pastoral Company Pty Ltd
Frank Rennick	Frank Rennick & Co Pty Ltd
Ross Chapman	Australian Canegrowers
E.A. Rowlands	Colly Farms
Ian Bell	Department of Primary Industry & Fisheries TAS
Peter Cullens	CRC for Freshwater Ecology
Tony Read	Kinhill Engineers Pty Ltd
Prof. Wayne S. Meyer	CSU / CSIRO Water Resources
Dave Anthony	AUSCOIT, Narrabri
Greg Constable	CRC Sustainable Cotton Production
Scott Keyworth	Murray-Darling Basin Commission
Christine Forster	LWRRDC - Nat. Prog. Irrig. R & D Cttee
E.H. Churchward	

2 ATTENDEES AT DISCUSSION GROUPS

LOCATION	NAME	ORGANISATION
NARRABRI	Hugh Barrett	Barrett Purcell & Associates
	Russel Martin	Australian Cotton Research Institute
	Greg Constable	CRC for Sustainable Cotton Production
	Michael Bange	CSIRO Australian Cotton Research Inst.
	Ralph Schulze	Cotton Research & Development Corp.
	Robert Eveleigh	District Agronomist Narrabi
	Brendan George	Irricrop Technologies Narrabi
	Jeremy Killen	Namoi Valley Water Users
	Bucky Rowlands	Colly Farms Moree
CANBERRA	Nick Schefield	Program Manager
	Dave Wesney	Program Co-ordinator
	Jeremy Cape	Consultant
	Hugh Barrett	Consultant
	Jackie Allen	BRS
	Tony Byrne	DPIE
	Scott Keyworth	MDBC
	Drew Collins	ABARE
	Ian Pike	EPA
	Wendy Craik	NFF
	Rob Hadler	NFF
ADELAIDE	Alfred Cass	Research Scientist
	Mike Smith	Water Resources Group
	Judy Eastham	CRC for Soil & Land Management
	Peter Martin	CSIRO Division of Water Resources
	Dr Tom Hatton	CSIRO Division of Water Resources
TATURA	John Mapson	Goulburn Murray Water
	Ian Muirhead	Goulburn Murray Water
	Deck Poulton	Goulburn Murray Water
	Roger Standen	Victoria Agriculture
	Noel Russell	Dairy Farmer
MILDURA	Staff Sunraysia Horticulture Centre	
LOXTON	Staff ICMS, PISA.	

BERRI	Bob Newman	Dept Environment and Nat Resources
	Brian Caddy	
	Tony Meissner	PISA
	Dennis Sparrow	PISA
DENILIQUIN	Geoff Wright	Ricegrower
	Geoff McLeod	Murray Irrigation
	John Thompson	NSW Agriculture
	Gordon Bull	
	Steven Page	Farm Forestry, Murray Irrigation
	Lloyd Chesworth	

APPENDIX B. QUESTIONNAIRE

The purpose of the LWRRDC is to identify and fund research and development activities aimed at maintaining the natural resource base used by, or affected by, the rural primary industries. Within this context, the goals of the National Program for Irrigation Research and Development are:

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

Your answers to the following questions shall assist in achieving these goals.

Q1 As a first step, if you were a LWRRDC director, what *criteria* would you use to determine the priorities for irrigation research projects? Please look at the list below and choose the five most important criteria in your view. If possible, rank them by numbering the box from 1 (most important) to 5. You may have other criteria which you believe are more important. If so, please write them down and include them in your ranking.

Irrigation R & D projects that can be supported should:

- ☐ Lead to greater ecological sustainability of irrigation farming
- ☐ Lead to greater economic sustainability of irrigation farming
- ☐ Lead to better utilisation of water on-farm
- ☐ Develop improved methods of managing irrigation supplies
- ☐ Contribute significantly to overall environmental enhancement
- ☐ Lead to reductions in water losses from water supply schemes
- ☐ Demonstrate ways to rehabilitate irrigation areas

☐ Develop new skills in the human resources of the industry

☐ Contribute to regional development

☐ Enhance the riverine habitat for native flora and fauna

☐ _____

☐ _____

☐ _____

Q2 The existing R & D program was based on a range of issues that were identified at the time the NPIRD was established approximately 5 years ago. We would like your opinion of the *key issues* that should be addressed by the irrigation R & D program over the next five years. Please read the list below and indicate the five most important issues in your view and rank them if possible.

☐ Reducing the contribution of irrigation to salinity problems

☐ Improving water use efficiency on-farm

☐ Improving water distribution efficiency on-farm (reducing water losses)

☐ Provision of education and training to the industry

☐ Understanding the impact on the environment of irrigation farming

☐ Development of new water allocation and pricing regimes

☐ Developing better irrigation management methods

☐ Development and adoption of improved technology

☐ Development of grass roots input into irrigation R & D priorities

☐ _____

☐ _____

If you wish, you may add (on a separate sheet headed **ISSUES**) an assessment of the significance of each of your priority issues (optional).

Q3 Given the key issues you have identified in Q2 above would you please indicate what you consider the priority areas of research should be to tackle these issues. Please list these research areas on a separate sheet headed **IRRIGATION RESEARCH**.

Your considered opinion is obviously important to us (and the future of irrigation in Australia) so we would be grateful if you would fill in the following, as we may wish to discuss some aspects further with you. While your contribution shall be acknowledged in the Discussion Paper, your specific answers shall remain confidential.

Name:_____

Organisation:_____

Address:_____

_____

Phone:_____

Fax:_____

Your response **before** 12th January, 1996, would be appreciated to:

Mr Jeremy Cape
AITC
Fax: [08] 302 3373

APPENDIX C. QUESTIONS TO BE CONSIDERED IN ASSESSING COMPETING R & D FOR NATURAL RESOURCE MANAGEMENT

The aim of this exercise is that by applying the same set of questions in each case the LWRRDC Board and Program Management Committees will be able to improve both the rigour and consistency of their deliberations in allocating limited funds. The questions are also designed to be incorporated into scoping exercises and could be made public so that stakeholders can see the processes used in making funding decisions.

1. What is the national significance of the particular resource management issue?

This is an important question given the limited funding within R&D programs and clear direction to LWRRDC to take a national focus in R & D. In order to be nationally significant, resource management issues need not necessarily be national in extent. LWRRDC has made a start in developing information to help answer this question in the form of data sheets. The Board has agreed to publish these and to seek comments and further information in order to improve the accuracy and reliability of the data provided.

2. What is the underlying cause of the current failure to manage the resource sustainably ?

There are three potential classes of failure:

- *Technical failure* - we lack the required information (or it is not widely available to resource managers) about how to use or manage the resource in a sustainable fashion. Up until now researchers have focused almost exclusively on this category of failure.

- *Market failure* - the resource in question has little or no market value, or there is no direct cost to resource managers from its depletion or degradation. This is a common occurrence, and in many instances until market failure is addressed and rectified, further technical information will have little impact in improving resource management.

- *Institutional (and cultural) failure* - where various forms of intervention by governments and others through policies and programs either fail to effectively address unsustainable resource use, or may actually foster it. Again, this type of failure must be addressed adequately before value can be gained from the results of technical R & D.

3. What form of intervention to improve resource management is likely to be most successful, and what are the costs, anticipated benefits and risks?

Having identified the causes of failure in resource management, we next need to identify forms of intervention that are likely to be most effective and the resources and time scale required. The program committee may not necessarily need to support further R & D in every case. For example, simply publicising the cause and costs of resource depletion may be sufficient to galvanise other organisations or groups into action. This too is another essential question to apply in order to work out how to make best use of limited resources. It should become an essential part of scoping exercises undertaken by any R & D program.

4. How can the risks associated with intervention be managed?

There may be a whole set of risks involved, for example, in achieving the objectives of technical research or, often more significantly, in ensuring the uptake of new knowledge in order to improve resource management. Ex ante assessment of risk as well as costs and benefits can result in substantial improvement in R & D programs and projects.

In considering risk we need to distinguish between risk profile (programs may choose to support some high - risk projects because they have a high potential return), and the management of process risk (taking action to make sure project objectives are achieved and results implemented).

5. What role, if any, should the program play?

By the time program committees get to address this question, they should have sufficient information available to make an informed judgement about the likely impact of their involvement. It is quite likely that in many cases, once the underlying causes of failure have been identified and considered in some detail, it will become apparent that responsibility for intervention rests with another organisation. The additional information should also help the committee to focus more clearly on where it can have a major impact in achieving program goals

6. What is the potential return from the specific opportunities available for program investment?

Having made a decision to intervene and invest in a particular resource management issue, the program committee needs to make use of investment decision analysis or similar tools to help uncover how to maximise the return for a given risk profile from its limited resources. Some research agencies use a standard cost: benefit analysis to determine an internal rate of return, but this would be difficult for many ecological sustainability projects.

The application of these questions to existing and future programs will not be easy. However, the quality of the decisions and the return on investment of public funds will be advanced significantly if program management committees adopt this process (but remain pragmatic in doing so).

Appendix D List of responses to the questionnaire.

Q 2. Key issues to be addressed by the R&D program in next 5 years.

Water Management

Economic viability of irrigated farming.

Cost in $ terms.
Future profiles of irrigation areas. Environmental and economic.

Sustainability.

Decommissioning strategies for existing irrigation projects which are not economically or ecologically sustainable.

Land capability assessment including environmental criteria, for different irrigated industries and irrigation systems.

Assessment of land capability on a catchment/district/regional basis for long term sustainability of irrigation. Decision support techniques.
Definition of Regional Irrigation Area behaviour and recommendations for short and long term irrigation management.
Assessment of the impact of dam storage and water management on riverine and floodplane environments.
Processes for rehabilitation of degraded irrigation areas.

Subsurface drainage management at a regional level.

Effluent use in irrigation.

Impact of effluent irrigation on soils, crops.

Off-Farm

Water supply systems. Improving service delivery off-farm.
Integration of water delivery systems and on-farm systems to optimise water distribution both on and off farm..
Irrigation infrastructure asset management and ownership . Infrastructure refurbishment.
Water ownership, allocation and pricing schemes. Property water rights.

Economic options for water re-allocation, incl. socio-economic factors. Identifying equitable distribution arrangements considering the needs of irrigators, the community and the environment.
Development of water pricing policies to promote adoption of technology and improved irrigation efficiency. Full cost recovery pricing regimes and assessing their impact.
Pricing and allocation reforms which reflect security, quality, quantity and type of end use of irrigation water. Some current tariffs reflect these factors with sliding scale charges, disposal charges and application limits.
Strategies to establish water price equity between govt and private schemes.

On-Farm

Water distribution and application systems.

Development of integrated farm water management practices.
Irrigation methods, existing and alternative. Efficiencies for different crops and soils.
eg:Buried low pressure pipe irrigation systems.Subsurface micro irrigation of broad acre crops. High frequency pulse irrigation.
Improving water storage efficiency.
Recharge and subsurface drainage management at the farm level.
Irrigation practice to reduce groundwater accession.

Irrigation technology to improve efficiency of water and labour use, and maximise productivity.

Practical systems for on-farm implementation.
Development of reliable field monitoring and means for automation and control of irrigation. Flow measurement, crop water use and loss monitoring technology as an irrigation management tool. Real time irrigation control systems.
Use of satellite technology and it's impact on irrigation management and monitoring. Improved communication systems.
Soil moisture sensing. Evaluate soil moisture devices.

Site suitability for irrigation method and enterprise type. Sustainability.

Prevention of system water loss, giving consideration to soil characteristics, crop use characteristics and tail water return systems.
Options for harvesting, desalinisation and use of saline water.
Soil structure improvements.

Scheduling.

Integrated scheduling considering crop, field layout, distribution limitations.

Environmental

Environmental impact of farming.

Accreditation of exporters for environmental sustainability. (Would affect irrigation practices). Identify an environmental accreditation system for the irrigation industry.

Environmental impacts and on-farm management of**:**
Drainage. Nutrients. Pesticides. Plastic mulch.

Pesticide and fertiliser transport off farms. Water quality monitoring systems.
Cost-effective technology for monitoring of diffuse-source pollution. Radio tracer work to determine where tail water ends up. (irrigation runoff). Pesticides and nutrients in runoff and deep drainage water. Avoiding or overcoming these problems.

Salinity.

Development of productive and profitable irrigation systems in a saline environment.

Development of strategies to support high level salinity control. eg: decommissioning some schemes, salinity management and amelioration.
Re-use of saline or nutrient rich water on-farm.
Drainage water and effluent disposal and effects on irrigation efficiency and soils. Reduce accession to waterlogging, salinity and nutrient runoff.

Environment.

Enhance riverine habitat. Means to reduce European carp in rivers. Scientific determination of the elements of river flow characteristics which stimulate particular ecological processes.
Environmental impact of irrigation compared with other causes. eg: river salinity due to land clearing and erosion in upper catchment areas. Impact on river ecology compared with the increase of River Carp and weed infestation.

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Area and volume requirements for wetlands.
Catchment hydrology.

Education.

Technology adoption by irrigators.

Institutional and social barriers to change/tech. transfer.
Lift the profile of the irrigation industry and improve the level of training.

Provision of single co-ordinated education and training to the industry.
Training. Technical level, professional level. School to management.
Development of benchmarks and best management practices.

Development of an irrigation module for PMP (property management planning).
Measure/demonstrate water use efficiency at the farm/field scale.
Practical farm scaleswater balances. Techniques for on farm measurement of water use efficiency.
Efficiency of different types of irrigation and documentation of the advantages of changing system type.

Crops.

Matching available water to crop requirements by identifying links between field characteristics, irrigation frequency, water balance and crop needs.
Crop water demand models.

Other

Socio-economic impact of alternative irrigation technologies.
Markets. High value production.
Improved climate prediction abilities.