Land & Water Resources

Research & Development Corporation

Audit and Strategy on Irrigation Education and Skills Development in Australia

Occasional Paper No 21/98

Occasional Paper Series

Audit and Strategy on Irrigation Education and Skills Development in Australia

Charles Sturt University
Wagga Wagga

Land & Water Resources
Research & Development Corporation

The information contained in this report was gained through numerous personal communications and various references. As such, some of the information may be based on general themes built from expressions of opinions from sector leaders. Appreciation is due to all those who gave of their time and opinion.
Acknowledgment is also due to John Kent and Peter Donnan from the Farrer Centre, CSU, who provided valuable guidance, suggestions and checking for this report.

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Published by: Land and Water Resources Research and Development Corporation
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Publication data: 'Audit and Strategy on Irrigation Education and Skills Development in Australia' by Wayne Meyer and Andrew Taylor, LWRRDC Occasional Paper Series No. 21/98.

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ISSN 1320–0992
ISBN 0 642 26736 7

Editing and layout: Green Words, Canberra

Printing: Panther Printing

November 1998

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Recommendations

Recommendations in this report encourage focus, concentration and collaboration.

- It is recommended that Australian irrigation activity be represented as a complex **sector** rather than an '**industry**'.
- Sector leaders must unequivocally promote education and training across the whole sector as the primary way of securing a sustainable sector and its rightful place as a major contributor to Australian prosperity.
- It is recommended that the Australian Irrigation Council (AIC) be strengthened by sector and institutional support. This national peak body must be made to work since it is essential for effective lobbying of recognition and resources.
- Under the auspices of the AIC (and its constituent members), the National Irrigation Education Committee (NIEC) should provide leadership to ensure education and training opportunities from a national perspective, it should encourage a range of providers, it should assist in garnering funds to support education programs, and it should provide a national forum for information exchange.
- It is recommended that, for the present, no further effort be put into refining the competency standards or in the conduct of further skills audits and needs analysis.
- It is recommended that a mapping exercise be undertaken so that the connection among 'competency standards', 'curriculum' and 'certification' be established and be easily apparent to those undertaking training.
- It is recommended that an education officer be appointed to facilitate coordination and provide focus for education and training initiatives which complement and extend the work of the current Irrigation Association of Australia (IAA) education officer.
- It is recommended that universities proposing to develop irrigation-related courses be encouraged to seek external sector input for course design.
- It is recommended that only a limited number of universities be encouraged to offer undergraduate courses in irrigation. These should cover tropical and sub-tropical irrigation, temperate irrigation and urban/peri-urban irrigation.
- Universities should be encouraged to exchange subjects and credits for subjects which are common to irrigation, irrespective of the geographic focus or irrigation system.
- It is recommended that the NIEC exert its influence to have the university system rationalise specialist postgraduate irrigation training to three institutions.
- It is recommended that support be given to the concept of a National Irrigation Science Network to bring together education, research and irrigation sector companies and agencies interested in promoting research and education opportunities.
- Teaching in the following subject areas is currently deficient and will be vitally important to the future of irrigation: irrigation system modelling, both at the resource management planning and policy level; rural sociology and modern extension methods; soil physics and management; opportunities for irrigation engineers; improved understanding of agricultural meteorology; expertise in quantitative aquatic ecology; urban, recreational and amenity irrigation.
- It is recommended that more courses be designed which can be delivered as part-time distance education units. Workplace assessment and the capacity to gain recognition for prior learning are important elements in vocational training programs.
- It is important that training and education programs for Land and Water Management Plan areas be developed with local participation to ensure ownership.
- It is recommended that irrigation education funds be used as 'capital investment' to develop training packages from accredited providers consistent with national competency standards.

Executive Summary

- Irrigation education and training in Australia is characterised by fragmented, sporadic and diverse attempts at provision. However, there is no lack of goodwill, nor a lack of recognition of the need for education and training provision. Indeed, the concentration on identifying and refining the need in the last few years has overshadowed and delayed the provision of onground courses and training provision. Many people now recognise the need and are attempting to fulfil a real demand. Recommendations in this report encourage focus, concentration and collaboration.
- To help overcome the fragmentation and sporadic nature of the education and training effort, there is need for a strong, well-led, national overview body. Such a body already exists in the Australian Irrigation Council (AIC) and, provided it can take up the challenge and provide leadership, it could more than adequately fill the role of providing a national overview of irrigation sector education and training needs. It could very effectively do this by influencing its constituent organisations, namely the National Farmers' Federation, the Irrigation Association of Australia (IAA) and the Australian National Committee on Irrigation and Drainage. The AIC needs a sub-committee whose responsibility is to provide high-level input to Commonwealth and State agencies and education and training providers. It should encourage and assist them in providing a wide range of educational opportunities. By using its influence, it can ensure that all areas of education and training, from vocational through to research-level irrigation specialists, are covered within the Australian context. It will need to recognise the needs of different irrigation regions throughout Australia. The AIC should lobby Federal and State agencies to provide funds for the development of suitable education and training courses; they should provide a level of leadership and vision which foreshadows and anticipates the training and skill needs for the irrigation sector into the twenty-first century. Such a national body may need, certainly in the first instance, to 'anoint' particular groups and training providers by giving them the mandate to develop, maintain and promote courses and training programs that are needed for the rapid development and continuance of the diverse irrigation sector.
- Given the diversity and complexity of the irrigation sector, bearing in mind its urban and rural needs, and taking account of the climatic variation from tropical, sub-tropical through to temperate irrigation, the diversity of irrigation systems and the diversity of crops that are irrigated, it follows that a range of education providers must be encouraged within the irrigation sector. There is a need for many providers. However, to be effective and efficient, these training providers need to see themselves within the broad context of the Australian irrigation sector. To be consistent with the requirements of the National Training Authority, there must be recognition of the definition of competencies which has been done by the Australian Irrigation Training Project (AITP) and currently by the IAA.
- In education and training delivery, all of the current providers have a role. For example, the TAFE network has a role in the provision of vocationally oriented short and longer term courses. One of the features of these courses is that they need to be very regionally oriented. That is, they need to use case studies which are relevant to the crop and soil types and to the irrigation systems which are predominant in those regions. There is a role for the industry association, the IAA, which is developing an education program, particularly in the field of accreditation associated with the design, installation and maintenance of both urban and rural irrigation systems. The IAA is to be commended for its persistence in adapting United States training packages to Australian conditions. Such accreditation programs need to be encouraged and widely supported throughout Australia.
- As has been indicated from a number of surveys of irrigators and people involved in the irrigation sector, particularly the rural sector, there is a demand for short-course, distance education material. New courses developed using curriculums based on competency standards need to bear this in mind and structure their material accordingly. Universities have a role in developing undergraduate and postgraduate opportunities which are relevant to irrigation. In

Australia, there needs to be several universities that provide undergraduate specialisation to ensure that the different geographic and agronomic regions are suitably serviced. In particular, there needs to be a university that focuses on the semi-arid tropical and sub-tropical regions. There needs to be a university that looks at the semi-arid winter rainfall environments and, because of geographic separation, some opportunity for that provision in Western Australia. The demand for irrigation expertise within Australia is currently not large enough for more than three universities to support a comprehensive postgraduate specialisation in irrigation.

- In considering education needs, there is a matrix of needs that should be borne in mind. On the first level, there is the need for provision for different client groups: vocational practitioners, service sector personnel, advisory people, through to researchers. At a second level, there are geo-climatic differences, with the broadest division between summer-dominant and winter-dominant rainfall areas. This second level is strongly related to another level associated with irrigation systems, that is, the way in which water is applied through surface irrigation, pressurised systems or highly controlled systems and which, in turn, is strongly related to the type of crops that are grown.
- Special mention must be made of the irrigation service sector, that is, suppliers of hardware: everything from channel stops through to pumps, pipes, micro-systems and including supplies of fertilisers and chemicals. We know from surveys that this group is particularly influential in their interactions with irrigators and that, in general, the knowledge levels of many of the suppliers are rudimentary.
- A major influence in the medium and long-term provision of adequate skills for the Australian irrigation sector will be the break-up of the State water agencies, such as NSW Water Resources and the Rural Water Corporation of Victoria. These organisations provided training opportunities and experience for many irrigation system engineers and resource officers who have overseen both the development and maintenance of large irrigation areas. These opportunities are now limited and it is of concern that, unless the emerging regional irrigation authorities take on this responsibility, training experience opportunities for these people will not be available. Again, this is an area where a national overview and a degree of national leadership from an organisation like the AIC is sorely needed.

Recommendations and Explanation

Overview

- It is recommended that Australian irrigation activity be represented as a complex **sector** rather than an '**industry**'. Its unity is in the universality of applying water or facilitating water application to growing plants. The sector has a large influence across many commodities: it has design, manufacturing, installation, production and waste management components. It is geographically diverse. It follows, therefore, that education and training needs are diverse.
- Surveys over the last decade have repeatedly demonstrated the chronically poor state of skills development in irrigation practitioners, retailers and advisers, while a shortage of qualified and experienced teachers, technicians, managers and researchers has limited progress in irrigated productivity, its expansion and its response to environmental challenges. Changing this will require a conscious commitment to a learning culture. This commitment must start with sector leaders unequivocally promoting education and training across the whole sector as the primary way of securing sector activity and its rightful place as a major contributor to Australian prosperity.

Organisation

- It is recommended that the AIC be strengthened by sector and institutional support. This national peak body must be made to work since it is essential for effective lobbying of recognition and resources. The AIC must be supported with financial resources from the sector if it is to credibly represent Australian irrigation. A levy on irrigation water is needed to raise funds.
- It is recommended that an AIC committee, the National Irrigation Education Committee (NIEC), oversee education and training needs for the sector. This committee must represent sector and provider interests. Through its networking, influencing and endorsement, it needs to assist in securing funds for

competency and curriculum development and for delivery. This committee must strive to present a national perspective and be supportive of initiatives which are beneficial for the Australian irrigation sector. To give effect to improved education and training opportunities, it is recommended that an education officer be appointed to facilitate coordination and provide focus for education and training initiatives which complement and extend the work of the current IAA education officer.

- Under the auspices of the AIC (and its constituent members), the NIEC should provide a national forum for information exchange. Two mechanisms are proposed: (i) a register of courses, subjects and providers which is kept current and available by electronic and (limited) hard copy; and (ii) a biennial 'expo' of irrigation education and training initiatives probably associated with the IAA National Irrigation Conference.

Accreditation and Competency Standards

- It is recommended that, for the present, no further effort be put into refining the competency standards or in the conduct of further skills audits and needs analysis. The competency descriptions developed by the AITP and the refinements being developed by the IAA are more than adequate for curriculum development suitable to the Australian National Training Authority, and to describe most vocational competencies associated with the irrigation sector.
- It is important that nationally approved competency standards from the AITP and IAA be made readily available so that many more people in the sector become familiar with these descriptions and that training providers can develop curriculums to meet the standards.
- It is recommended that a mapping exercise be undertaken so that the connection among 'competency standards', 'curriculum' and 'certification' be established and be easily apparent to those undertaking training. If someone needs or wants to attain a certain competency level, they need to know what path will lead to it. At this stage, parts of the skills development framework exist, but there is still a need to fuse these parts into a coordinated system. If people are able to see that the competency standard pathway leads to improved skills and job advancement prospects, they will see a feasible career path and some career development security.
- It is recommended that universities proposing to develop irrigation-related courses be encouraged to seek external sector input for course design. Endorsement of such courses from the NIEC should depend on demonstrating appropriate sector involvement.

Education Providers – Universities

- It is recommended that only a limited number of universities be encouraged to offer undergraduate courses in irrigation. It is unlikely that the demand for university graduates from a specialist irrigation course would warrant more than three universities offering such a course. These universities should direct their courses so that each one covers one of tropical and sub-tropical irrigation, temperate irrigation and urban/peri-urban irrigation. Universities should be encouraged to exchange subjects and credits for subjects which are common to irrigation, irrespective of the geographic focus or irrigation system. The arrangement above should not preclude other universities or associated institutions from developing regionally relevant irrigation subjects, particularly at postgraduate level. Again, education providers should be encouraged to share subjects and to work collaboratively to constantly update subject content. It would be appropriate to have one university in each State offer subjects relevant to irrigation through schools of agriculture, environmental science and engineering.
- It is recommended that the NIEC provide input to the Australian Vice-Chancellors' Committee to ensure that within the university network there remains active teaching and research which cover the broad areas of irrigation engineering, crop physiology and production, soil physics and management, agricultural meteorology, rural sociology and agricultural business management. It would be sensible to have the NIEC negotiate with particular universities to direct their courses to an irrigation bias to ensure a supply of graduates with a wide range of educational experience into the irrigation sector.

Postgraduate Opportunities

- It is recommended that the NIEC exert its influence to have the university system rationalise specialist postgraduate irrigation training to three institutions.

This will enable these institutions to market their specialty and target both Australian and international graduates for additional education in irrigation.

- It is recommended that support be given to the concept of a National Irrigation Science Network to bring together education, research and irrigation sector companies and agencies interested in promoting research and education opportunities. Such a network will raise the profile of Australian irrigation, help focus the sector's attention on research, education and training, and provide considerable opportunities for research training.

Subject Areas

Teaching in the following subject areas is currently deficient and will be vitally important to the future of irrigation.

- Development and use of irrigation system modelling at both the resource management planning and policy level and at the decision support system crop management level. There is a chronic shortage of strategic thinking from the sector anticipating and directing the use of information technology in the irrigation sector. The opportunities to use decision support systems of various kinds, precision farming, remote sensing, spatial databases and real time monitoring can increase irrigation productivity very substantially. Too few teachers and lecturers are attuned to educating students in these areas.
- To make the best use of these tools, there is a need to increase the number of students in rural sociology and modern extension methods that incorporate using new information sources. Irrigation is an energy, capital and knowledge-intensive activity. This makes the interface between the biophysics of the system and the socioeconomic factors which control change important, and more concentrated than in dryland agriculture.
- There is a general demise of quality teaching in soil physics and management within Australia. This is evident from the scarcity of Australian-trained applicants for lecturing and research positions in these fields and the very limited subject offerings now available at Australian universities. The lack of career opportunities within these fields is not commensurate with the long-term need for the irrigation sector to manage the soil resource. The lack of commitment to train Australian graduates in soils (and irrigation subjects, generally) is being partly offset by an immigration policy which encourages overseas-trained graduates into the country. In turn, this situation reinforces the impression that there is not a well-defined and supported career path for Australian graduates.
- There is a well-defined lack of training opportunities for irrigation engineers within Australia. This situation has been exacerbated by the downsizing and reorganisation of the State water agencies. It can be confidently predicted that there will be a shortage of experienced water system delivery engineers within 20 years. Similarly, the teaching and training opportunities for on-farm design engineers have progressively declined and the skills currently residing at the University of Southern Queensland and University of Melbourne must be maintained.
- There is a need to encourage the inclusion of the improved understanding of agricultural meteorology into teaching programs on irrigation crop physiology and management. This needs to be set in the context of improved use of risk management systems.
- The general areas of irrigation within the environment and its interaction (including impacts of water extraction and drainage) are reasonably well catered for, both in agricultural and environmental science courses. However, what is sadly lacking is the availability of expertise in quantitative aquatic ecology which can help answer such fundamental and pressing questions as what is an adequate 'environmental flow' or what constitutes a 'healthy' river. In this regard, it is certain that the answers will not be defined only by biophysical interpretations but also by socioeconomic concerns. It is recommended that the connection between irrigation water requirement and the impact on river and riverine ecology be promoted by overt recognition in irrigation education and research programs.
- The network of research and training opportunities for groundwater specialists is adequate currently, but will need careful monitoring.
- The areas of financial management, agricultural economics (including resource economics) and marketing are well catered for through many schools, although a couple of courses specifically for irrigation would be desirable.
- The developing opportunities in urban, recreational and amenity irrigation have been identified by several

institutions, and courses are available and adequate. These areas are being supported by the development of vocational training courses for irrigation designers, installers and inspectors.

Vocational Training

- The recent developments regulated through the Australian National Training Authority, while considerably increasing bureaucracy, will provide a structured and adequate guide for training in the irrigation sector. Needs surveys in the vocational field and in the postgraduate specialist area consistently request that courses must be designed which can be delivered as part-time distance education units. Short-course formats are also favoured, especially if these can be delivered on location.

  Another frequent request is for articulation – the capability of previous courses, subjects and experience to be accounted for and credited towards completion of other courses. It is recommended that the NIEC provide endorsement for those short courses and subject arrangements which facilitate training for the Australian irrigation sector through flexible delivery and prior learning recognition.

- The present activities of the IAA in defining and providing certificated courses for designers, installers, operators and maintainers of irrigation systems should be encouraged. A rapidly emerging area for training is associated with Land and Water Management Plans (or the equivalent) in irrigated regions. Training is needed for both irrigation delivery system staff as well as irrigators and service personnel. It is important that training and education programs for these areas be developed with local participation to ensure ownership. This does not mean that every regional educational program needs to be developed independently of other regional offerings. Rather, generic material should be shared between regions and local case studies and specific regional conditions added in.

- There appears to be more than adequate education and training providers, both with existing institutions (vocational colleges, TAFE, private agencies) and industry groups. From an irrigation sector perspective, it would be helpful if these institutions and groups were to concentrate their energies and resources more on delivery rather than on definition of what they are going to do and on staking territory.

- Previous surveys have highlighted the importance of the retailing component of the irrigation sector as a primary source of information for irrigators – whether rural or urban. Unfortunately, the knowledge levels and competency standards of people in this component are not commensurate with their pivotal role in providing accurate, up-to-date advice. There are encouraging signs that some larger retailing chains (for example, the rural equipment and service company, IAMA) will use existing educational institutions to help develop, provide and deliver training material. Similarly, some equipment manufacturers have sought help to develop training courses for their sales and support staff. This enquiry must be encouraged since some in the commercial sector have realised the importance of having their training courses affiliated and, when appropriate, delivered by an accredited education provider. The reason for this is that trained staff obtain a qualification which is widely recognised and transferable. Education and training is a repetitive and continuing activity. Many businesses, whether retail or manufacturing, do not have large numbers of staff needing training at any one time but, rather, a continual, small number requiring training.

- Development of suitable training material consistent with Australian National Training Authority competency standards requires a capital investment – an investment which is not readily borne by commercial interests and which, increasingly, is very difficult for education and training providers to fund. It is recommended that irrigation education funds be used as 'capital investment' to develop training packages from accredited providers consistent with national competency standards, especially where specific irrigation businesses are involved in formulating and using such packages.

List of Abbreviations

AIC	Australian Irrigation Council
AITC	Australian Irrigation Technology Centre
AITP	Australian Irrigation Training Project
ANCID	Australian National Committee on Irrigation and Drainage
ANTA	Australian National Training Authority
AQF	Australian Qualifications Framework
ASF	Australian Standards Framework
AVCC	Australian Vice-Chancellors' Committee
AWWA	Australian Water and Wastewater Association
CI	Coleambally Irrigation
CQU	Central Queensland University
CRC	Cooperative Research Centre
CSU	Charles Sturt University (Wagga Wagga, Albury, Bathurst)
DEET	Department of Education, Employment and Training
DLWC	Department of Land and Water Conservation (NSW)
DIRETFE	Department of Industrial Relations, Employment, Training and Further Education (NSW)
DPIE	Department of Primary Industries and Energy
DWR	Department of Water Resources
EAC	Emerald Agricultural College
GCSAA	Golf Course Superintendents Association of Australia
GMW	Goulburn Murray Water
IAA	Irrigation Association of Australia
ICDP	Irrigation Competencies Development Project
ICID	International Commission on Irrigation and Drainage
ITAB	Industry Training Advisory Board
JCU	James Cook University
LWRRDC	Land and Water Resources Research and Development Corporation
MCA	Murrumbidgee College of Agriculture
MDBC	Murray-Darling Basin Commission
MI	Murray Irrigation
NBCITC	National Building and Construction Industry Training Council
NFF	National Farmers' Federation
NICCDP	National Irrigation Competency and Curriculum Development Project
NIEC	National Irrigation Education Council
NIREC	National Irrigation Research Education Centre
NIRF	National Irrigation Research Fund
NLGITC	National Local Government Industry Training Council
NPIRD	National Program for Irrigation Research and Development
NSWAg.	New South Wales Agriculture
NTB	National Training Board (now defunct)
NTU	Northern Territory University
RAIPR	Royal Australian Institute of Parks and Recreation
RITC	Rural Industry Training Council
RTCA	Rural Training Council of Australia
RTCCSB	Rural Training Council Competency Standards Body
SCC	Standards and Curriculum Council
UNE	University of New England (Armidale, NSW)
U Qld.	University of Queensland (Brisbane, Qld)
USQ	University of Southern Queensland (Toowoomba, Qld)
UWA	University of Western Australia (Perth)
UWRA	Urban Water and Research Association
VCAH	Victorian College of Agriculture and Horticulture
VET	Vocational Education Training
VETEC	Vocational Education, Training and Employment Commission
WIETA	Water Industry Education and Training Association

Introduction

Irrigation is the major user of water in Australia. Water is becoming more expensive and less accessible. Irrigators will therefore need to become better managers. This is set in the context that "the sustainable management of our water resources is one of the major environmental issues of the 1990s. There is no higher priority than improving the condition of our rivers and catchments through enhanced wastewater treatment and better land and water management ... Our use of water must be sustainable – it is an imperative" (Crean, 1992, as cited by Breen & Foley, 1994). This statement is commonly used to emphasise the importance of treating the problem of river, wetland, water and catchment degradation seriously and, until recently, this problem may have been perceived largely as an environmental imperative. However, with the current dynamic political climate as far as the water reform package is concerned, this drive for sustainability and increased wateruse efficiency has become more of a financial priority to irrigators.

The potential for greatly improved economic output from the irrigation sector indicates that improving the overall performance of the irrigation sector should be a national priority (AITP, 1994). The potential impact of better irrigation practices has been undersold. The savings in water from better wateruse efficiency are small relative to the large potential increases in yield that may result from providing water to the plant when and in the amounts that the plant requires the water.

"Irrigation practices have undergone little change in the last 50 years – yet pressure on resource use, availability, and realisations of inefficient wateruse have changed. The future sustainability of the land and water resources used for irrigation will in large part be a function of the decisions individual irrigators take, or fail to take, and the consequences of those decisions or omissions" (AITP, 1994). Regardless of the environmental impact, either long or short term, that irrigation-related decisions have, the financial imperative ensures instant incentive to become more environmentally responsible. This responsibility is directed at the irrigation sector as a whole, both agricultural and urban irrigators. Urban salinity is a high-profile legacy of inefficient wateruse in the urban environment, though this is not the sole cause. Urban irrigation and drainage also significantly contribute to nitrogen run-off into the river systems (AITP, 1994).

An essential part of increasing the sustainability and efficiency of the irrigation sector is through education and training. Poor management due to poor management skills has been a major contributor to land and water degradation. The recognition that there is a need for improved education across all occupations concerned with the irrigation sector is increasing. Although the practices and lifestyles of irrigators have changed, the rate of change must increase to meet the challenge of a vibrant and productive irrigation sector. "Successful education and industry development is heavily dependent on the recognition and recruitment of all key stakeholders and developing a process whereby those stakeholders gain ownership of industry developments. The procurement of a clear understanding of the motives, needs, constraints of the participating parties is essential, ie. we must know the client" (Coats, 1994, as cited by Graf, Meacham & Meyer, 1996).

Despite the regular and unanimous call for direction of efforts towards a coordinated, holistic education strategy within the irrigation sector, the approach is still disjointed, sporadic and, as described by Meyer (1995), of a "piece-meal" nature. The perceived needs and evident gaps have not been comprehensively and clearly identified and much of the action taken in education development has been on the basis of meeting isolated demand.

The irrigation sector is a multifaceted matrix embracing people with different occupational roles, and different skills and education levels, irrigating for different reasons in geographical conditions all across Australia. While each group has its own specific technologies, structure, economics and management which directly influence occupational activities and training requirements, all are tied together by basic plant/soil/water relationships and hydrology and by the fact that the primary purpose is to apply water to plants to improve their growth and enhance the quantity and quality of production (Sloane, Cook & King Pty Ltd, 1993).

The congruity of the basic needs and principles of irrigation practice means that the diverse irrigation sector has a unity of purpose. This unity is in the universality of applying water or facilitating water application to growing plants. Therefore, improving education standards, increasing management skill and having more informed operators will be beneficial to the Australian sector as a whole.

This report presents an overview of recent past and current activities and strategies aimed at meeting these perceived requirements, identifies the training and education needs of the groups within the sector, and subsequently quantifies the current and likely future shortfalls in training and education providers, educators and researchers. A broad national strategy is outlined, identifying key organisations that would be required to support the strategy and achieve its aims. The feasibility and utility of developing a national contact network among agencies and organisations that are involved in irrigation education and training are also discussed.

Structure of the Irrigation Sector

Although the irrigation sector is characterised primarily by the application of water to plants, it largely remains a **commodity-driven** pursuit. As such, it is not recognised as a separate entity or industry in its own right but, rather, as a system, or a series of overlapping systems all with common characteristics (Sloane, Cook & King Pty Ltd, 1993). This lack of recognition extends to the highest levels of government bureaucracy. The Australian Bureau of Statistics has no classification, even at the finest level, for irrigation activity (Australian Bureau of Statistics, 1993). The Irrigation Association of Australia (IAA) *National Irrigation Industry Training Plan* (1996) recognises that there has been fragmentation because irrigation is not recognised as a distinct occupation. As a result, there have been conflicting definitions and duplication: no distinct competencies and common standards have been developed for curriculums, and no specific, coordinated training developed to meet these needs. The theme has been to learn how to grow, for example, more cotton or better turf, rather than how to irrigate more efficiently and effectively. Perhaps this perception needs to change so that more emphasis is placed on improving irrigation education.

Sloane, Cook & King Pty Ltd (1993) describe the range of **issues** facing the irrigation sector in Table 1, highlighting the fact that the sector is highly diverse and demands a wide range of expertise among those employed. Many of the roles and issues involved overlap so it is often the case that vertical integration of skills is required to ensure that a particular person is suited to a particular role (that is, a person may require skills from a number of different levels of training to perform a particular task).

To assist in identifying the needs of irrigation education, the sector may be divided into a matrix of interacting **groups** (Figure 1). These are:

1. type of irrigation (delivery and on-farm);
2. type of production/commodity;
3. type of occupation;
4. level of education/training;
5. education provider;
6. climate, soil type, water supply; and
7. geographic location.

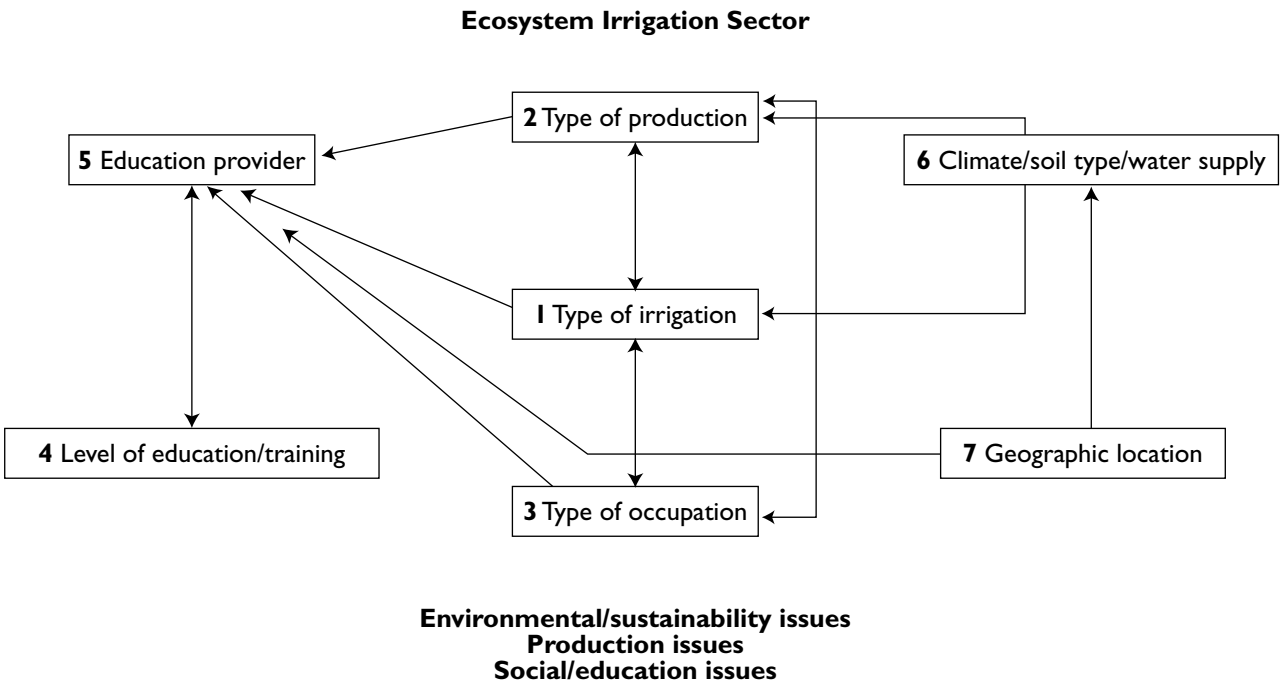
Intertwined with this matrix is the need for an interactive education and training system which provides for a range of training levels, curriculum requirements, accreditation and geographic spread.

Table 1. Summary of issues in irrigation education and training

Type	Issue	Implication
Technical	Water supply and use	Water conservation/management training
	Natural resource issues	Recognition of community attitudes
	Environmental management	Environmental training
	Salinity and watertables	Drainage and irrigation management
	Efficiency of wateruse	Water management and planning
	New technology	Upgrading delivery by refresher/short courses
	Economics of irrigation	Economics and business management courses
Educational	Uneven spread of training	Re-evaluation of educational delivery
	Uneven standard of training	Accreditation of course modules
	Accreditation	NTB-related accreditation system
	Upgrade farm-level skills	Improve scope of educational delivery
	Technology delivery	Take technology training to trainees
	Educational delivery	Farm training be localised, seasonal and short
	Levels of competency	Industry-wide competency standards (NTB)
Employment	Many employment activities overlap	Difficulties created for training delivery
	Irrigation is mostly small business	Range of training needs is wide
	Prior training inadequate for job	Establish refresher/upgrade courses
	Skilled farm workforce needed	A wide range of skills need upgrading
	Irrigation needs multi-skilled workforce	Multi-skilled training systems established
	Competency-based training	Identify/classify workforce
	Cross-disciplinary/multi-skilling	Identify bodies to resolve issues

Source: Sloane, Cook & King (1993)

Figure 1. Model of major factors operating and interacting in the irrigation sector



Type of Irrigation

Initially, Sloane, Cook & King Pty Ltd (1993) divided irrigation activities in Australia into seven sectors based on types of production. In 1994 the Australian Irrigation Training Project (AITP) was established at the Murrumbidgee College of Agriculture (MCA) at Yanco to develop national competency standards for the Australian irrigation sector. It was originally decided to use the same seven divisions for the purpose of developing these competency standards and curriculum. However, it was later (in 1996) decided that the most logical way to divide the sector was on the basis of types of irrigation. This ensures that any progression or development was irrigation oriented rather than commodity oriented. Three basic divisions were made:

1. surface: border check, contour bay, basin and furrow;
2. spray: travelling, centre pivot, linear move, side roll, hand move and solid set; and
3. micro: drip, trickle, micro jet and mini.

Type of Production

Commodity orientation is still an important consideration in the irrigation sector and six of the original seven divisions made by the AITP cover the basic areas of production in the sector.

a. **Irrigated broad area crop/pasture**
(more than 8 million hectares)
Involves flood irrigated pasture/crop systems of inland Australia producing rice, prime lambs, sheep, dairy/beef cattle and irrigated cereals. Competencies to tie in with those of the crop and pasture/dairy industries.

b. **Irrigated intensive inland horticultural**
(about 60,000 hectares)
Involves the intensive cultivation of fruit, vegetables and grapes. Competencies to tie in with those of production horticulture.

c. **Large-scale mechanised irrigation farming**
(more than 200,000 hectares)
Characterised by mechanised methods of row cropping to produce cotton, soybeans, maize, grain sorghum, sunflowers and some wheat. Competencies to tie in with those of the cotton, grains and oilseeds industries.

d. **Irrigated intensive specialty farming**
(170,000 hectares)
Characterised by the integrated production and processing of intensive commercial horticulture such as fruit, vegetables, lucerne, dairy products and sugar. Competencies to tie in with those of production horticulture and the pastoral and sugar industries.

e. **Irrigated small-scale intensive farming**
(about 50,000 hectares)
Involves small commercial and hobby farms, including irrigated market gardens and some amenities horticulture enterprises such as flowers. Competencies to tie in with those of production and amenities horticulture.

f. **Urban irrigation**
Consists of suburban, industrial and local government landscaping, and passive and active recreation areas. Competencies to be developed by the Water Industry Education and Training Association (WIETA), National Building and Construction Industry Training Council (NBCITC) and National Local Government Industry Training Council (NLGITC). Some of that which is developed here will be applicable to agricultural irrigation systems.

The seventh division made by the AITP was the irrigation industry specialist services area. While this does not directly represent an area of production, it includes services to all areas of production by activities.

Type of Occupation

The irrigation sector draws people from various backgrounds and expertise, all of whom have vital input to a plethora of steps that combine to enable the functioning of any irrigation system. As such, the large picture of how these occupations interact and overlap has to be studied before irrigation education can be broken into its simpler, more specific components. The list of occupations involved with the irrigation sector includes:

- irrigators (owners and managers);
- irrigation workers (many of whom are seasonal);
- designers, installers, constructors, operators, monitors, maintainers and repairers of irrigation systems and infrastructure;
- retailers, distributors and manufacturers of irrigation hardware;

– regulatory government staff who regulate the price and distribution of water (local, State, Federal);
– researchers improving irrigation technology;
– environmental scientists who improve those areas affected and avoid further impact on the irrigation environment;
– private sector consultants and government advisory officers (extension officers) who advise irrigators on installation and management (AITP, 1994);
– managers and administrators;
– educators and trainers (Graf, Meacham & Meyer, 1996);
– engineers;
– geologists;
– water supply agency personnel (IAA);
– financial management experts for farmers;
– economic/marketing experts to maintain secure export and local markets for the products (therefore contacts overseas);
– responsible policy makers;
– urban irrigators and all concerned (that is, with parks, sporting fields, golf courses, large yards, nurseries, etc.); and
– urban drainage people, especially in terms of water quality and contamination of surface and sub-surface water sources.

Level of Education/Training

For the irrigation sector to operate effectively, people at all levels of education are required to work together in a coordinated way. It was decided that the best way to enforce a high standard and comprehensive coverage of education levels was through the introduction of national competency standards, giving a standard index of performance and best practice for the irrigation sector.

Education Provider

Education in the irrigation sector can be provided from a number of different levels. Five major levels can be identified:

1. university;
2. other tertiary level providers (for example, Tocal and Murrumbidgee College of Agriculture);
3. TAFE;
4. industry providers (for example, IAA); and
5. correspondence courses offered through, for example, nursery or golf associations.

Type of irrigation, type of production, type of occupation, geographical location, specific provider expertise and the level of education/training required all affect who is well placed to be a provider.

Climate, Soil Type, Water Supply

Climate, soil type and water supply have large effects on the type of production and the method of irrigation used to apply water to the plant. These physical characteristics are, in turn, affected largely by geographical location and perhaps by site history.

Geographic Location

Australia is characterised by large distances between irrigation areas and major education institutions. Subsequently, these areas operate under varying geographic and climatic characteristics and with varying population and facility access. The situation in sub-tropical northern Australia is greatly different to that in temperate southern Australia, in terms of both irrigation and access to education. The isolation of Western Australia also presents problems in terms of access and equity in education. It is imperative, therefore, that irrigation education is offered nationally in a variety of forms so that people in all areas of Australia have access to it and that the specifics of the curriculum are adapted to suit the various geographical areas.

One part of the sector that this model perhaps does not sufficiently accommodate is **urban** irrigation, with its pressurised systems and unique characteristics. Almost all sporting facilities (especially golf courses) depend on irrigation, many parks are irrigated and, in the home, about 50% of the potable drinking supply is used to water the garden. This area of urban irrigation is often overlooked. It is imperative that this area of the sector is not neglected in any progressions made in education and training. The IAA has identified this significant part of the sector in recognising that urban irrigators should be adequately represented.

Timeline of Recent Major Events

Table 2. Timeline of recent major events

Date	Event	Comments
1989	Report commissioned by the National Irrigation Research Fund (NIRF)	Identifies 'education' as requiring 10% of irrigation research and development allocation (Graf, Meacham & Meyer, 1996). Education issue rising on national agenda.
1989	AITC set up in combination with the IAA and Roseworthy. Scholarship fund established.	
1990	McColl, Robson & Chudleigh report into agricultural and related education.	Recommended that CSU should pursue a major role in irrigation education because of its proximity to the major irrigation areas in Australia.
1990	The IAA applied to the National Building and Construction Industry Training Council for funds to prepare National Core Curriculum and pilot courses for irrigation installers. DEET supplied $47,000 and Holmsglen TAFE in Melbourne was contracted to develop the Basic Irrigation Installers course.	Modules from this course were to become extensions of the standard plumbing trade modules. Good example of cross industry development and course articulation.
June 1991	Wood & Banks report (NIRF), *Irrigation research and development in Australia, a national strategy*.	Identified technology transfer and education among seven national priority issues of irrigation research and development.
Sept. 1991	UWS, Hawkesbury, obtained $40,000 from the NSW DIRETFE to conduct a skills audit with the vision of using this information to develop courses and market them commercially. The IAA then approached UWS to form a partnership.	The IAA saw this as a good opportunity to procure the information and UWS saw it as a good opportunity to gain commercial advantage in offering courses. IAA supplemented the funding with money from Qld. VETEC. HAWKAID (the commercial consulting arm of UWS) enlisted Sloane, Cook and King Pty. Ltd. to conduct the skills audit.
Oct. 1991	An IAA Education Status Report recommended that a consultant be commissioned to develop a National Irrigation Accreditation Strategy. Funds were applied for through LWRRDC, UWRA and DEET. LWRRDC provided $25,000. WIETA (Water Industry Education and Training Association) (Qld based) was formed and given the status of a Competency Standards Board (CSB), representing water managers (not waterusers or installers).	The Education Status Report found that the slow transfer of technology to and within the irrigation sector was partly attributable to gaps in education and training services. The IAA planned to identify occupations and standard competencies, and develop career paths through articulation of courses and a certification process.
Oct. 1991	An MCA training needs analysis of the Riverina and cotton growing areas of NSW (which cover over 60% of the area under irrigated agriculture in Australia).	Established the need for national competencies and curriculum to improve the performance of those working in these areas.
1992	IAA approached RTCA to coordinate competency development in urban as well as rural irrigation.	It was envisaged that the connection to the RTCA would allow irrigation competency development to be coordinated with other competencies required by occupations in the irrigation sector.

continued…

Table 2. Timeline of recent major events *continued*

Date	Event	Comments
Jan. 1992	A meeting between ICDP, RTCA, NBCITC, IAA, a consortium of agricultural colleges and State departments of agriculture and water resources gave the ICDP national focus and led to the formation of the NICCDP.	The goals of the NICCDP were to build on the progress made in the irrigation industry, ie. to develop competencies and curriculum and take on a coordinating role.
May 1992	A meeting was held between ICDP, RTCA and DEET.	DEET pointed out that there seemed to be some duplication among the skills audits being conducted and that they would only pledge money ($126,000) if the NICCDP did not overlap inefficiently with other projects. It took until December 1992, for the RTCA (through the NSW RITC) to supposedly clarify the situation.
Nov. 1992	The NICCDP applied for funding from DEET and RTCA.	
Dec. 1992	NSW Agriculture applied for and received funding from DPIE, based on the NICCDP proposal to DEET. The AITP was established at Yanco under the auspices of NSW Agriculture to achieve the objectives of NICCDP. Those organisations in the NICCDP were invited to join the AITP.	The aim was to develop irrigation competency standards and then coordinate the development of generic curriculum guidelines based on these competency standards.
1993	Sloane, Cook & King Pty Ltd report (IAA and UWS), *Skills audit of the irrigation industry*.	This report reinforced the need to develop and clarify competencies for urban and agricultural irrigation and to develop a wide range of vocational education and training services for the 'six sectors' of the irrigation industry.
Feb. 1994	The inaugural meeting of the AITP took place over a year after establishment because of slow transfer of funds from the Commonwealth and the necessity to readvertise a position for Executive Officer according to departmental regulations.	This meeting between AITP and WIETA (IAA) agreed that their two programs were complementary and that ideas and information should be transferred readily. Intentions were good.
Mar. 1994	A further meeting at Yanco with the RTCA and the ANTB further stressed the importance of coordination.	All present agreed that the AITP competency standards would be forwarded to the NTB for endorsement through the RTCCSB. The fact that all were not present presents some problems on coordination.
Feb. 1996	The AITP released competency standards and curriculum guidelines.	
Mar. 1996	The AITP competency standards were endorsed.	
1996	Graf, Meacham & Meyer report (CSU and CSIRO), *University courses in irrigation education, a needs analysis*.	Points out that many in the irrigation sector are under-educated or under-trained, and also that many are interested in further study to improve their knowledge base.
1996	Meacham & Arrow report, *An analysis of irrigation education in Australian universities*.	This report basically suggests that higher level irrigation education, in particular, is "fragmented and unfocussed", with irrigation education often only appearing as minor subjects in a larger agriculture, engineering or environmental style course. The report acknowledges that there is a market demand for such education but that it is not being met by existing provision.

continued…

Table 2. Timeline of recent major events *continued*

Date	Event	Comments
1996	Graduate Certificate course in Irrigation established at CSU, Wagga Wagga.	This course was first offered in the Spring session (July to November) 1997 but was developed during 1996.
Nov. 1996	IAA report. The IAA put proposal in for a National Certificate in Irrigation (denied by ANTA in this round of funding, awaiting next round, or may be put up before this).	This certificate is to be vocationally oriented.
1997	Formation of NIEC, operation of which is quite stagnated.	Plan to be seen as figurehead to enable provision of funding.
18/19 Nov. 1997	Irrigation forum held in November 1997 in Melbourne (organised by the IAA, funded by MDBC and NPIRD and supported by AIC and Waterwise on the Farm). Day 1: Irrigation Training for Farmers Day 2: Irrigation Education – a National Approach	This forum gathered all major stakeholders providing short courses, and established what they have done and what they are planning (see IAA, 1997).
1998	IAA biennial Irrigation Conference in Brisbane.	
2000	Australasian Irrigation Conference in Melbourne.	

Education – The Current Situation

Graf, Meacham & Meyer (1996) state that there is no **authoritative source** covering current educational offerings on a national scale. However, the IAA is currently undertaking the task of collating a national register of irrigation education in Australia (continuation of which is subject to funding).

Why do we need Improved Education?

The need for increased emphasis and specialisation in irrigation education from vocational training through to university training has been stressed by many who have looked into the state of irrigation education in Australia (Pratley, 1993; AITP, 1994; Meyer, 1995; Graf, Meacham & Meyer, 1996; Meacham & Arrow, 1996; IAA, 1996). The IAA, in its *National Irrigation Industry Training Plan* (Wilson & Associates, 1996), recognises that there is "compelling economic, environment and social imperative to dramatically increase wateruse efficiency and to adopt best irrigation management practices". It also recognises that this will require a huge education and training effort in all areas of the sector (large/small, private/public). Although action in this field is occurring, it is not occurring at a rate proportional to the rate of land and water degradation in Australia and it is not occurring in a coordinated, efficient manner. This degradation should be a determining factor which should drive the push towards improved education at a rate faster than that of the degradation. Attaining sustainability while maintaining profitability is a priority and the only ways to ensure this are to increase education (both availability/accessibility and participation) and awareness (AITP, 1994).

Another factor which should be driving the sector towards developing an improved education system is the fact that, in 1991, irrigation used more than 73% of Australia's developed water resources to produce more than $4.5 billion of produce (Wood & Banks, 1991). By 1994–95, irrigated produce represented approximately $8 billion (30% of the total farm gate value of Australia's agricultural output). Growth in the output of the sector is obviously rapid, and the growth in irrigation education development is not nearly proportional. With this **level of production**, increased spending on irrigation R&D and education is certainly justified.

The value of farm gate produce is multiplied significantly when the value to the Australian economy of all the **subsidiary and support organisations** (both pre- and post-farm gate) involved with irrigation is taken into account. The AITP (1996) states that, although the end users of water (the irrigators) are the single largest group within the irrigation industry, 75% of the occupational groups within the industry are not end users. In addition, the value of urban irrigation, although extremely difficult to quantify, also definitely needs to be taken into account.

Additionally, Australia has a huge opportunity on the international stage in more efficiently and sustainably producing products for the ever increasing world population. There is extensive **international competition** to deal with producing more food with less water. Increased education and training in irrigation management will help Australia to compete effectively on this world market.

The fact that there is only one **professor of irrigation** in Australia is probably indicative of the state of irrigation education here, especially with regard to research/university-based education. A study by Meacham & Arrow (1996) suggests that higher level irrigation education is "fragmented and unfocussed", with irrigation education often only appearing as minor subjects in a larger science, agricultural, environmental or engineering-based course. Graduates from these traditional backgrounds do not have the well-rounded balance of specialist skills required for irrigation-management research projects (Anon., undated).

Seven **national priority issues** regarding irrigation research and development were identified by Wood & Banks (1991), along with their view of the proportion of future total national investment required by all stakeholders in irrigation R&D for each priority issue (Table 3). This list may underestimate the importance of education in the complexity of issues involved with the irrigation sector.

Table 3. National priority issues of irrigation research and development

National issues	Percentage of allocation required
Sustainable irrigated cropping systems	35
Wateruse efficiency	20
Drainage	15
Pollution	5
Salinity	5
Technology transfer	10
Education	10

Although technical issues such as sustainable irrigated cropping systems and wateruse efficiency are regarded as the priority issues, educating the sector as a whole through technology transfer and extension is of vital importance if best management practice with regard to these technical issues is to accrue. At a recent Australian National Committee on Irrigation and Drainage (ANCID) conference in Deniliquin (September, 1997), drainage system development and management were regarded as perhaps the most important technical issue and challenge facing the irrigation sector today. A continuing, coordinated national education program for all stakeholders in the irrigation sector is essential. "Without a clear understanding by researchers, extension officers, and irrigators of the complex systems with which they work, then sustainable improvements in management will not be achieved" (Anon. undated). All people in the sector, from educators to irrigators, need to be educated as to the complexity of the system in which they work.

Taking this emphasis into account, along with the fact that the irrigation sector is of such importance to the Australian economy, it is surprising that so little has been done in terms of establishing and developing a holistic, coordinated irrigation education system. Although education and training at the vocational level is perhaps more widespread, duplication and inefficiencies within this system have led to gaps in the training. All levels of education provision need to be addressed and treated as parts of a whole.

Demand for Irrigation Education/Training

Market demand for irrigation education and training is an important influence in determining what is eventually provided. While it is true to say that education and training must be geared towards what is required by the people in the irrigation sector, it is equally true to say that developments based on this approach may not ultimately be in the best interests of the irrigation sector as a whole. It may sometimes be necessary to educate people within the sector as to the gaps in their education base and the potentially collective gaps in the sector as a whole, that is, educate people as to where they need educating.

Needs Analysis

Graf, Meacham & Meyer (1996) canvassed opinions from various groups within the irrigation sector on their demands as far as further study was concerned. Although the survey could not be used to interpret a comprehensive picture of the overall sector demands, it does give a good indication of what is demanded by the respondent group surveyed.

The main results from the survey (to which 25% of respondents replied) were as follows:

- Regardless of location, occupation or previous qualifications, there was strong demand (nearly 70% of respondents) for **short courses**, with 10% interested in graduate diplomas, 7.2% interested in graduate certificates, 8% in bachelor degrees and 5.2% interested in masters with coursework.
- 43% of respondents want **distance education**.
- 32% of respondents want courses to be conducted at **local centres**.
- Course components and composition outlined in the survey were approved by the vast majority of respondents.
- It was found that there was a large degree of homogeneity of responses among various sectors of the respondent groups (graduates, farmers, installers, etc.) as far as education needs go.
- The feeling among the sector was that there was a general lack of consideration of **formal programs** in irrigation in the tertiary education system.

In summary, most people preferred distance education or short courses conducted at local centres, with full-time on-campus study being the least popular. People did not want to be taken away from their workplace for long periods of time. This is regardless of the work role held by the respondent. Accordingly, modes of study need not be tailored to the different groups within the sector. It was found that "there are significant areas of demand from respondents exhibiting a wide range of existing qualifications" (Graf, Meacham & Meyer, 1996). Considerable interest also extends across many areas of work (though the majority of the demand comes from those fields closely associated with irrigation). This suggests that irrigation education should be aimed at people across the board, to a large extent not discriminating amongst people with different qualifications or different careers. This also suggests that there needs to be a range of courses offered at different levels to cater for cross-disciplinary needs.

Graf, Meacham & Meyer (1996) then divide the irrigation sector into various roles and indicate the interest of each role group in further study. There are a number of issues that need to be considered here as reasons for interest in further study:

- Are competency standards in that group low and the group therefore sees this as a problem and wants to do something about it?
- Does the group not recognise that their competency standards are low and, therefore, is not interested?
- Are the competency standards of a group high enough so that further study is not warranted?
- Does a group perceive that the type of further training that would be available would not be suitable for their needs?
- Is a particular group content with the status quo?

The introduction of the competency standards and some degree of coercion to attain these competency standards will, to some degree, ensure that 'best practice' is the aim and, hopefully, will be achieved. Of all the role groups surveyed (although the sample size in some of the groups was small), those with the highest proportion interested in further study/training were: equipment design, equipment sales and service, equipment installation and extension/advisory groups. Although

demand in these groups is high, there must also be some regard given to other groups, especially those whose competency levels are deemed to be low and in need of improvement by some governing body. Some extension work may need to be done to encourage some groups to undertake further training. Alternatively, regulations may need to be enforced to make group members attain a certain competency level.

Certainly, supply and demand need to govern provision of some education, but the governing body needs to make informed decisions about the direction that education needs to take. Setting of priorities for direction of funding needs to be addressed in the context of working for the good of the sector as a whole. Supply and demand of small groups of the sector are not always truly reflective of the needs of the sector as a whole in terms of what is best for the sector. Course content preference needs to be given to the areas of least competence, particularly if they correlate with areas of high perceived importance.

What Needs to be Addressed

(in order of importance according to respondents)

1. **Management of water resources**
   - there are environment-conscious irrigation practitioners, realising that water is a finite resource;
   - reduce waste – recycle;
   - sustainability;
   - understand effect on river system and groundwater;
   - promote voluntary process to protect water supply – personal interest.
2. **Suggested course content**
   - practical experience is paramount;
   - basic understanding of hydrogeology and environmental water cycle;
   - most agree that the course should not be too difficult and that it should not be too in-depth;
   - but, 'the industry needs multi-level training, from farm labourers up';
   - stress management and counselling – the social/personal aspect of farming needs to be addressed increasingly more;
   - ideally, those at the upper end of the chain need to know all that is below them, and those at the lower end of the chain need to have some idea of why.
3. **Practical experience**
   - unanimous about its importance, especially for university graduates.
4. **Irrigation design and communication skills**
   - design to combat salinity and 'simple', user-friendly communication among designers, specialists and farmers;
   - efficiency of wateruse and water quality monitoring;
   - extension issues related to breakdown in technology transfer.
5. **Salinity control and drainage**
   - salinity control and drainage important;
   - relate to/learn from problems in other countries;
   - understand salinity – causes, effects and control;
   - research of other systems, for example, trickle, sub-surface.
6. **Incompetent 'experts'**
   - make this a research priority – this is what irrigation education is about;
   - too much academic knowledge and not enough practical knowledge.
7. **Opinions on survey format**
   - need to include **horticulturalists**, **nursery** people and **landscapers**;
   - more on environmental issues and water quality/chemistry, effects of lasering on soil properties.
8. **Learning from and sharing with other irrigators**
   - learn to avoid repetition of mistakes;
   - bulletin board of latest tips and research – keep people informed;
   - apply current knowledge through better communication;
   - 'blow the whistle' on bad farmers and ideas.

AITP Competency Standard Development

In December 1992, the **Australian Irrigation Training Project** (AITP) was established at Yanco, New South Wales, under the auspices of the Murrumbidgee College of Agriculture (MCA). It was managed by NSW Agriculture and funding support was provided by the Department of Primary Industries and Energy. The aim was to develop irrigation competency standards and then coordinate the development of generic curriculum guidelines based on these competency standards. The inaugural meeting of the AITP did not take place until February 1994, because of slow transfer of funds from the Commonwealth and the necessity to readvertise a position for Executive Officer according to departmental regulations. It was not until March 1996 that the competency standards were endorsed, and this had occurred after the release of the curriculum guidelines in February 1996.

The need for irrigation competency standards was borne through the rapid increases of pressure on resource use and availability, coupled with the fact that irrigation practices had not responded to these dynamics on the resource end of the equation. Highlighted by this disequilibrium between the almost static scene on the practices end of the spectrum and the highly dynamic scene on the resources end of the spectrum was the inefficient way in which the resources were being used. It was becoming detrimental, both to the survival of the resource and the irrigator, that practices needed to improve to decrease the gap between resource use and availability. This was driven by environmental and financial agendas. The government's water reform package (levies and limits on wateruse) increased the financial pressure. The call for the development of irrigation competency standards was widespread across the irrigation sector (Sloane, Cook & King Pty Ltd, 1993; AITP, 1994).

Although the irrigation sector is a **broad tapestry** of integrated parties, the future sustainability of the land and water resources used for irrigation will, in large part, be a function of the decisions individual irrigators take, or fail to take, and the consequences of those decisions or omissions (AITP, 1994). For this reason, the performance of individual irrigators, urban or agricultural, must be monitored and improved. The only way to improve this performance to the level of competency deemed adequate for 'best practice' is through increased education. This must be done, firstly, on an individual basis, but must also be encompassed into an overall system of education that best serves to improve the performance of all parties involved with the irrigation sector in a coordinated and compatible manner. Sustainability will only be achieved if practices change across the board.

What are Competency Standards?

Competency standards are described as 'statements of the level of skills, knowledge and attitude expected of people in various positions and roles in the workplace'. They give an idea of the standards of performance that are required for each occupation and relate to 'best practice' in that occupation which guide design and development (AITP, 1996). The standards give a progression of competence from simple tasks to complex tasks. Competency standards are designed to be **adaptable** and able to be reviewed on a regular basis to ensure they reflect changes in technologies and work practices. In this way, they are an essential component of any longer term education strategy. There must be a constant contact between researchers, policy makers and those who monitor the competency standards. There must be no breakdown in communication or in the transfer of technology to ensure that the competency standards are relevant and 'modern'.

The idea was to relate industry expectations to the Australian Standards Framework (ASF), now called the Australian Quality Framework (AQF). The Australian Quality Framework is a set of eight generic competency levels which provide a benchmark for development and recognition of competency standards in relation to work across the Australian economy. They are then adapted and moulded according to the distinguishing features of the irrigation industry (AITP, 1996). Although there are eight generic competency levels, the AITP developed five competency standards specific to irrigation, with the idea that the higher level competency standards were themselves more generic and more likely to be met through vertical integration and by multi-skilled personnel. People acquiring these levels would be adopting more of a management role, but would still be assumed to have met the expectations of the lower

competency standards. Table 4 is a summary of the irrigation competency standards.

Attaining a certain competency also means to gain **recognition** for relevant skills and knowledge. This enables people within the irrigation sector to move between jobs, industries and States while maintaining this recognition. Portability of skills is an important aim of the competency standard framework.

Adoption of the AITP Competency Standards

The AITP applied for funding for the development of irrigation competency standards through the Federal Department of Primary Industries and Energy. This was along different paths to those taken by the developers of other competency standards who had received funding through the Department of Employment, Education and Training (DEET). Originally, the National Irrigation Competency and Curriculum Development Project (NICCDP) had applied for joint funding to do the job that the AITP was eventually established to perform. The NICCDP proposal was denied by the Rural Training Council of Australia (RTCA) and the Department of Employment, Education and Training and later, based on the same proposal, the Murrumbidgee College of Agriculture, Yanco, was successful with an application for funding through the Department of Primary Industries and Energy. It seemed illogical to many that a separate course was followed for the development of a system that was to be designed to conform to and be accommodated by national framework of competency standards from other industries. However, this was the route taken.

Table 4. Overview of irrigation competency standards

ASF	Planning	Designing	Installing	Operating	Maintaining	Monitoring	Evaluating
1			IRR1 Carry out basic construction and installation	IRR2 Operate basic elements of an irrigation system	IRR3 Perform basic repairs and maintenance on a system		
2			IRR4 Install and/ or modify designated irrigation system components	IRR5 Operate an irrigation system	IRR6 Carry out system maintenance program		
3			IRR7 Install and/ or modify irrigation system	IRR8 Operate an irrigation system	IRR9 Implement system maintenance program		
4			IRR10 Oversee system modification and installation activities	IRR11 Oversee irrigation system operation	IRR12 Oversee implementation of maintenance program	IRR13 Implement irrigation system monitoring program	
5	IRR14 Assess irrigation potential	IRR15 Determine design requirements IRR16 Design irrigation system IRR17 Assess irrigation system design	IRR18 Construct/ install/modify an irrigation system		IRR19 Design maintenance program, calendar and budget	IRR20 Design monitoring program	IRR21 Evaluate system

Source: AITP (1996) Adoption of the AITP competency standards.

The original process of **consultation** across the sector by the AITP was extensive (meetings and focus groups, etc.). Gradually, however, communication seemed to break down to some extent and the AITP seemed to act more in isolation, with the wider consultation process being reduced. The role of the organising committee kept changing until some board members felt that they were no longer included to the degree that they were initially intended to be. Because the training needs of the various parts of the irrigation sector vary considerably, people from as many representative groups as possible needed to be involved in the original development and in the ongoing running of the project. The IAA is particularly disappointed that communication between it and the Murrumbidgee Agricultural College has deteriorated and is keen to be heavily involved in any further initiatives of the college.

These two factors, coupled with the fact that the completion and endorsement of the competency standards was slow to be realised (and completed at considerable cost), have meant that a degree of **suspicion** exists in the minds of many and that there has not been widespread adoption of these standards by the irrigation sector as a whole. The final stage of the project's aims, curriculum development, has not yet been completed. Consequently, there has been no implementation stage for the competency standards. This has also caused some hesitation in people who might adopt or recognise the standards. There is, however, general agreement among those who are aware of their existence, that the competency standards themselves are quite adequate as a framework on which to base further development.

With the AITP having been so **regionally placed** at the Murrumbidgee College of Agriculture and managed by NSW Agriculture, a perception has developed among some that outcomes may not be truly nationally applicable because of the thought that anything that comes out of one State may cater disproportionately for that State because of vested interests. This problem can be avoided as long as the developments are flexible for adaptation to different areas. The IAA does not see the fact that the AITP is closely aligned with NSW Agriculture as a problem as long as industry support/approval is sought, gained and maintained. With regard to curriculum development, the extent to which this national applicability is being emphasised is unclear. The AITP states that the curriculum is being developed primarily for the Murrumbidgee College of Agriculture and the other institutions can buy the resource material from NSW Agriculture. The Murrumbidgee College of Agriculture curriculums would have to be refined to suit other areas.

The competency standards developed by the AITP claim to **represent** comprehensively all stakeholders in the irrigation sector. Specifically mentioned are irrigation users, people who work in irrigation projects and areas, and people who provide end users with advice, a regulatory environment, research information, specialist services and irrigation hardware. When compared to the list of stakeholders in the irrigation sector on pages 12–13, the above list seems to be deficient in a number of important groups. The AITP competency standards document also seems to be geared more towards agricultural irrigators, not being representative of urban irrigators in any great detail. The 1994 AITP document stated that the 1992 Irrigation Competencies Development Project (ICDP) submission covered more than 75% of Australia's irrigated agriculture. This makes no mention of urban or horticultural irrigation.

The original intention of the AITP was not to represent the **urban irrigators**, and this is stated clearly in the aims. However, the competency standards and curriculum guidelines developed by the AITP cannot then claim to be representative of the irrigation sector as a whole. Either representation of this part of the sector needs to be covered by the AITP documents or the responsibility needs to lie with another body, for example, the IAA, with cooperation and common material sharing occurring.

IAA Industry Training Plan, 1997–2001

The Irrigation Association of Australia (IAA) is the other major stakeholder in irrigation education in Australia. It is an industry-based association that purports to be representative of the irrigation sector as a whole. Being a **national** organisation, the IAA is well represented across the country, though at present it is seen by some to be disproportionately representative of the manufacturing/service/urban side of the irrigation sector. The formation of the NSW Irrigation Council (farmer-based) and the Water sub-committee of the Victorian Farmers' Federation is seen as proof that irrigators do not feel that they have full representation by organisations such as the IAA. Disproportionate representation is not a problem as long as other parts of the sector are represented by another body and the various representative bodies work in a complementary manner. The IAA, however, is working towards equity in representation and realises that it is a large task both to achieve this and to be seen to be achieving this (by the people they purport to represent and by funding bodies).

National Education Plan

There are a number of factors that are important in provision of education to the irrigation sector in Australia. The IAA has defined four major themes on which to base an education strategy in the irrigation sector:

- **Responsiveness**;
- **Quality**;
- **Accessibility**; and
- **Efficiency**.

These themes are applicable to any education strategy. A provider must be able to ensure that they can provide these if the education is going to benefit the participant and the irrigation sector in a holistic sense. The IAA plans to make sure that the programs are accessible by establishing regional locations at which training programs are developed and offered.

The IAA commissioned the **national education plan** (Wilson & Associates, 1996) because "it was felt that, unless the irrigation industry provided a set of priorities and general guidance to education specialists, unnecessary duplication and the lack of relevance would result". The aim of the national education plan was to "provide a national focus and direction for the management of irrigation education" by setting irrigation industry training needs and future priorities. "This plan recommends the formalisation of a process to coordinate the development of training standards, training, training resources and facilities for irrigation training across these broad sectors. This will achieve **consistent**, **effective** and **relevant** skill development outcomes' result". The result will enable workers within the sector to attain **common**, **portable** irrigation skills and qualifications. They have put forward a number of 'training development initiatives' designed to meet the industry's needs.

In development of the plan, a draft report was sent to all the **major organisations** representing members of the 'irrigation **industry**'. The questions have to be asked: To which groups was the draft actually sent and were they truly representative of the sector as a whole? 'Peak body' support of the plan was gained from the following organisations:

- ANCID;
- Australian Water and Wastewater Association (AWWA);
- Royal Australian Institute of Parks and Recreation (RAIPR);
- National Farmers' Federation (NFF);
- Golf Course Superintendents Association of Australia (GCSAA); and
- IAA.

This list seems deficient if it is to be truly indicative of a 'peak body' list. Of particular note is that NSW Agriculture and the AITP were omitted, given that they were the other main group involved with irrigation education developments. Most of the enterprises which are said to endorse the IAA vocational education training plan are either irrigation equipment suppliers, processors or urban irrigators – and not a very comprehensive list at that. It seems that, either there is a **bias** towards these groups in terms of the aim of who they want to represent, or there has not been a wide enough cross-section of the irrigation community consulted.

It was disappointing that this AITP/IAA communication was originally poor during early AITP developments, but the problem is only perpetuated if the IAA then fails to attempt to remedy the problem during their activities.

The IAA report advocates the formation of a National Council "to oversee and coordinate education initiatives for the irrigation industry". Skills must be developed in parallel and must be complementary (Wilson & Associates, 1996), and this can only be ensured if there is a controlling, overseeing body which directs developments to fill the gaps in the education system.

The IAA lists as its priorities for 1996–1997 the following:

- Formalisation of the AIC as irrigation industry training committee to advise on:
  - career path structures;
  - competency standards;
  - syllabus;
  - training facilities and resources;
  - training delivery issues (extension).
- Develop **national** competency standards for **various levels** of training within the industry.
- Assist in coordination of investment in irrigation training to ensure that maximum advantage is gained from investments made.
- Commence development of training programs:
  - certified irrigation manager;
  - certified irrigation contractor; and
  - certified irrigation retailer.
- Other priorities which may be identified by the proposed NIEC.

It is obvious that many of the aims of groups such as the IAA and the AITP are similar. This is also applicable to many of the stakeholders in irrigation education in Australia. Most people have similar ideas on where they believe irrigation education and the sector as a whole should be heading, but there are differences in opinion and lack of communication as to who should be involved in the realisation of such aims. For example, in November 1996 the IAA listed as one of its priorities for 1996–1997 the development of **national** competency standards for **various levels** of training within the industry, thereby establishing potential for duplication with the activities of the AITP. The AITP competency standards were completed and endorsed in March 1996. There seems to have been a lack of communication between the two parties on this issue. Having said this, the AITP has been quite tardy in both developing these competency standards and following them up with closely aligned curriculum development. The IAA may have seen that hastening the completion of this development needed to be emphasised.

There is no real definition of who they are planning to train – they do mention that they are catering for both 'rural' and 'urban' irrigators. The IAA are basing the training program on the United States Irrigation Association system, which provides certificate recognition for:

- designer;
- contractor;
- manager; and
- landscape irrigation auditor.

This suggests that, without expansion, the IAA may not be catering for the whole sector.

The IAA believes that the irrigation industry can draw from a range of information, expertise and practical experience in manufacturers, distributors, State and regional service organisations through to irrigation installers, designers and users. There is no mention of researchers and educators.

The IAA suggests that irrigation practices in Australia are world class and that there is the opportunity to export training, expertise and technology to Asia. There is a repository of expertise in the Australian irrigation sector but problems arising from fragmentation need to be resolved before an export culture can be fully developed. Sure enough, we may have individual expertise but, as a whole, it seems a fair bit of improvement in practice is required.

IAA Education Action Plan

The IAA released a draft **Education Action Plan** (for July 1997 to June 1998) in which their main objective is "that there be a range of training packages and delivery methods available to the irrigation industry". With the variety of people and occupations involved in the irrigation sector, there is obviously a place for many different sorts of delivery mechanisms. The IAA also mentions funding objectives and the desire to ensure

that any developments in the educational requirements of the irrigation sector are describable using the federal education policy format. These sentiments are positive, however, more intense communication must ensue between the IAA and the Murrumbidgee College of Agriculture at Yanco, which is also developing curriculum, based on their own AITP competency standards.

Nowhere in the IAA draft Education Action Plan is there any mention of the endorsed AITP competency standards on which any new curriculum or training plans which are to form part of a holistic approach to education should be based. The sentiment at the IAA is that the AITP competency standards have not been '**ground tested**' and, until they have been, hesitation will be prevalent. The IAA explains that the AITP competency standards are not the 'be all and end all' on which curriculum development has to be stringently based. There are competency standards from other industries that are useful to the irrigation sector and which could be adapted to suit and used to complement the AITP irrigation competency standards.

A large part of the draft Education Action Plan is the proposal for the establishment of a **National Certificate in Irrigation Training**. The national certificate is to be designed to cover all levels and be generic across different types of production and irrigation. Commodity-specific case studies would be attached to the end of this training program to make it more regionally applicable. A submission for funding for this certificate, which was forwarded to the Australian National Training Authority by the Rural Training Council of Australia in February 1997, has since been passed over. The IAA plans to continue to lobby for funding for this certificate through the Rural Training Council of Australia and the Australian National Training Authority. Again, with the Murrumbidgee College of Agriculture progressing along similar lines towards curriculum development (lines which, at the time of writing this report, had not been thoroughly clarified), the IAA and the college must be very careful to ensure regular and comprehensive communication about each other's intentions as regards curriculum development. Communication with Charles Sturt University (CSU), which has recently established the Graduate Certificate in Irrigation, should also ensue. The IAA-suggested certificate must be flexibly based on the AITP competency standards.

It seems that the IAA has taken it upon itself to take the initiative in sector **representation** in education provision especially. The IAA is to be commended for taking this initiative, perhaps seeing it as an area that was lacking activity. Certainly, it saw the area of curriculum development as lacking in forward action, particularly since the AITP (whose aim it was to develop curriculum based on the competency standards) had apparently stalled after Paul Foley had departed. It almost seemed an imperative to them that someone take the initiative. Since then, however, the AITP has been reborn and, through NSW Agriculture, is keen to show the sector that it is moving forward. There now seems to exist some sort of unnecessary and undesirable (as far as the long-term goals of the sector are concerned) **competition** between these two parties which can only lead to duplication and inefficiency. Whether or not this competition is deliberate, it needs to be resolved so the two parties can work together within the realms of an overall strategy.

IAA Role

The IAA does not purport to be an education provider or a curriculum designer. Rather, it sees itself as a potential **regulatory body** to direct the various duties required to provide comprehensive education to the sector as a whole. It would advise institutions such as the Murrumbidgee College of Agriculture which have the experience in curriculum development about the areas lacking in attention and requiring curriculum development. At this stage, the IAA would recommend that the Murrumbidgee College of Agriculture develop diploma-level education as well as distance education packages. Having said this, the IAA does seem to be moving towards curriculum development in the Certificate in Irrigation Training. There are some inherent dangers in allowing an organisation such as the IAA too much overall influence in coordinating the irrigation sector's education policy, but these will be discussed later.

Conversely, the IAA does have an important role to play in coordination, mainly because of its well-established **national profile**. The aim is to transcend State boundaries so that there is a universal standard that can be recognised. Its role may lie particularly in the field of accreditation associated with the design, installation and maintenance of both urban and rural irrigation systems. Provision of advice and direction on course development and also in assessing whether a course is adequate is an important charter of the IAA.

It could also serve as an effective communication network for these parts of the sector. The IAA also adapts United States training packages to Australian conditions. Such accreditation programs need to be encouraged and widely supported throughout Australia.

IAA Achievement Claims:

- Developed and administrated a certification program for the irrigation industry (based on United States system).
- Researched training requirements and needs of industry (and its sectors).
- Developed short-course programs on irrigation and advised in the development of programs in related industry sectors (for example, urban irrigation training program by the building and construction industry).
- Developed public sector training initiatives for regional and urban water supply authorities (IAA, 1996).

Key Issues and Strategies

Lack of Coordination

The provision of irrigation education and training in Australia is characterised by **fragmented, sporadic, uncommunicated** and **diverse** attempts at provision. This does not mean that there is a lack of goodwill or a lack of recognition of the need for such education and training provision. Indeed, the concentration on identifying and refining the need in the last few years has overshadowed and delayed the implementation of provision of onground courses and training provision. This **duplication** of needs analyses and skills audits was first documented in May 1992 by the Department of Employment, Education and Training after a meeting with the Irrigation Competencies Development Project and the Rural Training Council of Australia. Many people now recognise the need and are attempting to fulfil a real demand. It is recommended that, for the moment, there should be no further effort put into refining the competency standards. Rather, resources should be put into using these competency standards to develop suitable curriculums and, from that, suitable delivery packages.

Coordinating/Representative Body – AIC

To help overcome the fragmentation and sporadic nature of the education and training effort, there is a need for a strong, well-led, national **overview body**. The structure for such a body already exists in the AIC and, provided it can take up the challenge and provide leadership, it could more than adequately fill the role of providing a national overview of irrigation sector education and training needs. It could very effectively do this by influencing its constituent organisations, namely the National Farmers' Federation (NFF), the IAA and ANCID. At this stage, there is good agreement among the IAA, the Murray-Darling Basin Commission (MDBC) and the National Program for Irrigation Research and Development (NPIRD) managed by the Land and Water Resources R&D Corporation. However, this agreement needs to extend to other organisations, for example, ANCID and NSW Agriculture. It is only through rigorous consultation and communication that such agreement will flourish. Lack of resources and lack of a formal secretariat or director are other hindering factors to the operation of the AIC as an effective coordinating body.

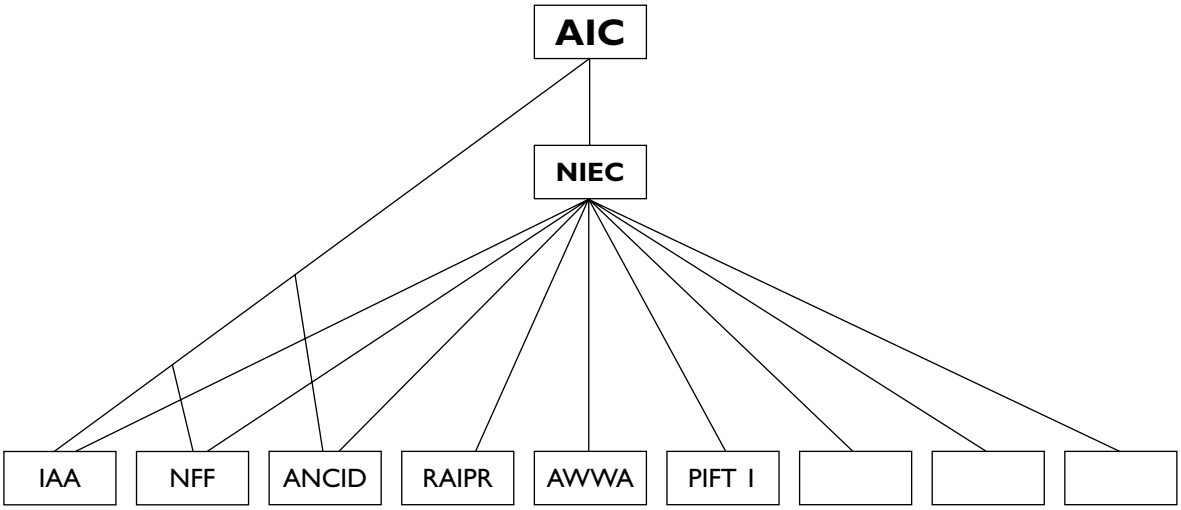
Sub-committee Structure under the AIC

Australia cannot afford to have too much **competition** or overlap as far as representative bodies in irrigation go. There is a need to assign groups to different parts of the irrigation sector, making sure they are **complementary** and **comprehensive** in covering all parts of the sector, with little duplication. Perhaps competition (that is, tender the responsibilities) before the assigning stage would be healthy to determine which group would be best suited to provide a particular service effectively. Obviously, certain bodies possess certain expertise. Ultimately, there needs to be **mutual agreement** on who undertakes which jobs.

The AIC needs to set up a **sub-committee** structure whose responsibility it is to provide high-level input to Commonwealth and State agencies and education and training providers. It is strongly recommended that the sub-committee structure, through the AIC or the NIEC, gives relevant and regular advice to the Australian National Training Authority and other key Federal and State government organisations. It should encourage and assist them in providing a wide range of educational opportunities. By using its influence, the NIEC can ensure that all areas of education and training, from vocational through to research-level irrigation specialisation, are covered within the Australian context. The NIEC will need to recognise the different needs of irrigation regions throughout Australia. Kilpatrick (1997) recommends that local education and training committees be established to facilitate provision of formal and non-formal post-secondary education and training in rural Australia. These committees should have thorough representation from all relevant stakeholders in the local area. The sub-committee structure needs to operate on a number of levels:

1. the regional level;
2. the State level; and
3. the national level.

Figure 2. Sub-group structure of the AIC and the NIEC



This sub-group set-up has the potential to operate effectively by conveying legitimacy to the activities of the various sub-groups to perform certain tasks or represent certain areas. However, more groups need to be included in this structure. This need is acknowledged by the NIEC and its chief driver, the IAA, but more needs to be done to make people aware of such a body. This deficiency in the NIEC cannot, however, be attributed entirely to the IAA. Groups that are not involved or not aware need to put themselves into a position of involvement or awareness such that they can have an input. Notable groups that are absent from representation by the NIEC are NSW Agriculture (AITP), the Murray-Darling Basin Commission and educational institutions.

The NFF

The **AIC** is well placed to be potentially an effective representative of the irrigation sector on a **national** basis, as long as each of its constituent bodies fulfils their respective responsibilities. The **NFF** has the mandate to represent farmers or irrigators on a national basis, and has to achieve this to ensure there is a voice for the end users. Perhaps more **interaction** needs to occur among the State and local bodies (for example, Coleambally Irrigation) who directly represent the irrigators and have closer contact with this group on a day-to-day basis. Subsequently, increased interaction and communication then need to occur between these groups and the NFF so that farmers' views are accurately represented on a national basis. Control must be retained to a certain degree by the industry itself.

The IAA

The **IAA** is recognised as providing comprehensive representation of the service/construction side of the irrigation sector, that is, the industry side of the sector. Despite the fact that the IAA purports to be truly representative of the sector as a whole, there is still a feeling within the sector that it is disproportionately representative of the urban and service parts of the irrigation sector, and not the farmers. This feeling may have developed partly because of the fact that the IAA has established (through certain associations) various urban installer type training packages while not giving attention to the agricultural side of irrigation education. Purcell (pers. comm.) counters this impression by stating that the only reason these courses have been established first is that they were the easiest to set up because:

1. the scale of urban irrigation is smaller; and
2. urban irrigation basically comprises pressurised systems. Therefore, why not establish them as soon as possible.

The IAA needs to ensure that communication of its activities (and the activities of any associated groups) to non-members of the association is improved. At this

stage, members are made aware of what is transpiring through the publication, *Backwash,* and through regional IAA committees, but there seems little way that non-members would be kept aware. This is not a problem isolated to the IAA; it is prevalent across most groups in the sector. The IAA is potentially an effective vehicle for dissemination of information on a national basis.

ANCID

ANCID's role in representation is sometimes questioned because of the fact that it has been seen to be almost inactive in its responsibilities; however, ANCID's recent employment of an education officer is a positive initiative which should help in this regard. ANCID has an important role to play in being a voice for the sector on the political scene. With the increasing costs involved with delivering education and training to rural Australia, ANCID could be integral in ensuring that this is acknowledged and addressed in government policy relating to access and equity in education and training (Kilpatrick, 1997). One of the biggest hindrances to ANCID's activity to this stage has been that the constituent bodies have simply found it hard to find the time to put into the activities of ANCID.

The NIEC

The **National Irrigation Education Committee** (NIEC) has been established as a sub-group of the AIC to basically provide a coordinating role in irrigation education. The IAA has been the catalyst in the formation of the NIEC. The NIEC mandate is largely political, ensuring that there is a link to provide coordinated and strategic advice to the Australian National Training Authority and to national and State Industry Training Advisory Boards. It is focused on outcomes rather than on the process followed to achieve these outcomes. Whether or not the NIEC is actually representative of the entire irrigation sector at this stage is not the issue; it needs to be seen to be so by the policy makers and fund providers. The policy makers and fund providers will not take advice from a body which is not seen to be **representative**. The formation of the NIEC, whether or not it is an artificial construct to be seen as a 'figurehead' and is lacking widespread representation at this stage, is a positive step towards coordination. The aim is to ensure that the NIEC (in its present form or under a different name) becomes more broadly representative and does become 'owned' by more people and will, therefore, be able to act effectively in its intended role. It has the credible **political structure** required upon which broader representation can be based. The NIEC welcomes other groups to become involved.

The formation of the NIEC has given some much-needed 'spark' and direction to the development of a coordinating body. Until this stage, the AIC has had difficulty in defining its projected role in the irrigation sector, especially with regard to irrigation education.

There has been some conjecture about whether or not there should be some direct representation of **educational institutions** on the NIEC board and/or, in that case, the AIC. Such representation was deliberately avoided by those who established the NIEC on the grounds that it should be the industry itself (all those involved) who should decide what is required in terms of education, and not the education providers. At first glance it seems incongruous that this be the case if it is education provision that is the main aim, but the IAA believes that this may be the only practical course of action.

Those involved with the NIEC are of the opinion that it is the **industry's role** to plan the priorities and the process required to achieve these priorities. As long as regular and informed consultation occurs between the NIEC and the education providers (perhaps through the proposed national communication network) and the providers are seen as a vital link, then the NIEC should be successful in its aims. Another issue connected with having educational institution representation on the NIEC board is the problem of selecting representatives. If a single representative is chosen, they alone cannot be truly representative of the education providers as a whole. With the increased competition among education providers, no one representative will be seen as an impartial choice. The NIEC and the IAA also believe that the bureaucracy involved with education providers is too large to allow a simple choice to be made. Furthermore, as soon as an education provider is added to the board, a vested interest appears. This is not a problem in itself if the end result is impartial, but it does create the potential for problems. This is the view of the NIEC and the IAA.

It is, however, recommended that education providers (from all levels of eduction) be represented on the NIEC board. Education providers are seen as a vital link, but not as a body which should be directly represented on the board. Excluding education providers

from the board, however, is perpetuating the problem of lack of communication and broad representation that the IAA claimed the AITP had originally initiated in the mid-1990s. If the NIEC is to command influence and finance, it will need to access the resources to which the education providers have access. Currently, those who will provide the education and training are not directly involved in the process. Despite the inherent problems associated with such a move, involvement of education providers on the board is the best way to ensure the necessary close interaction and working relationship between industry and education providers. Having said this, ANCID is currently looking to place another representative, probably an education provider, on the AIC. This should extend education provider influence in the NIEC.

Leadership and Direction

The AIC should provide a level of **leadership** and vision which foreshadows and anticipates the training and skill needs for the irrigation sector into the twenty-first century. Such a national body may need, certainly in the first instance, to officially endorse particular groups and training providers by giving them the mandate to develop, maintain and promote courses and training programs that are needed for the rapid development and continuance of the diverse irrigation sector. Whoever becomes the provider is not the issue but, rather, are the skills and education across the board covered? That is, does the irrigation sector have well-trained people in all areas of the sector? For this to be realised, a range of education types is required for the different levels of the sector. An organisation such as the IAA may be anointed for the installers, and the University of Western Sydney for peri-urban irrigators.

Funding Provision

A national body such as the AIC should lobby Federal and State agencies to provide **funds** for the development of suitable education and training courses. At this stage, the AIC is limited in funding and resources and this limits the influence it is able to have across the irrigation sector. Influence is always enabled by money, and it is this that the AIC is lacking. Reasons for this lack of resources are varied, but it has been said that the NFF, as the administrative arm of the AIC, is stagnating the progress by blocking funding to the AIC for what can only be seen as political reasons (perhaps the NFF does not see a mandate for the AIC in representation). The National Irrigation Research Fund (NIRF) (through a report by Wood and Banks, 1991) suggested that a **levy on all waterusers** would be the best option in ensuring continuing money to research in irrigation. Irrigator groups, particularly the larger groups with political interests, strongly disagreed. This may be a method of securing funds to aid in the effective operation of an overseeing body.

NSW Agriculture believe that it is this **lack of funds** that will hamper the ongoing effectiveness of bodies such as the AIC or IAA in their efforts to adopt a coordinating role in the irrigation sector. NSW Agriculture believe that they have sufficient resources themselves.

Range of Educators Required

At present, the pattern of offering of irrigation education and training (especially with non-vocational training where irrigation specifics are only offered as components of more generalised courses) is "at odds with emerging demand for workers within the industry who require specific instruction in relation to their irrigation expectations" (Meacham & Arrow, 1996). Mills (pers. comm.) agrees with this statement on a personal level in commenting as a dairy farmer on the fact that there are very few workers graduating from various courses who have the skills required to perform the basic, yet specialised, tasks required to function as a dairy/stock/irrigation hand. He believes that people are not being trained enough with an 'end occupation' or workplace role in mind.

Centres that in the past have offered **vocational/** skills/competency-based training are being taken over by universities and becoming more scientific in their training approach, leaving gaps in the para-professional-level training (for example, the Murrumbidgee College of Agriculture and Tocal are the only two independent colleges remaining in New South Wales. In Victoria, the Victorian College of Agriculture and Horticulture has become part of Melbourne University; in Queensland, Gatton College has been enveloped by Queensland University). To some extent, TAFE is covering this loss, though it must be ensured that efficiency and comprehensiveness are upheld in this huge federally funded education body (TAFE).

A **range of education providers** must be encouraged within the irrigation sector for a number of reasons:

1. the diversity and complexity of the irrigation sector;

2. the urban and rural needs of the irrigation sector;
3. the climatic variation from tropical, sub-tropical through to temperate irrigation;
4. the diversity of irrigation systems;
5. the diversity of crops that are irrigated; and
6. the wide array of levels of education required to enable smooth operation of the sector as a unit.

There is room for many providers. However, to be effective and efficient, these training providers need to see themselves within the broad context of the overall Australian irrigation sector need. To be consistent with the requirements of the Australian National Training Authority, there must be recognition of the definition of competencies which have been established by the AITP and endorsed by the training authority.

In terms of education and training delivery, all of the current education providers (listed on page 13) have a role to play.

University-level Education

The **university level** has a very important and almost exclusive role to play in the provision of tertiary education and **postgraduate** opportunities extending to **research**. Graf, Meacham & Meyer (1996), through a needs analysis reflecting the commitment of Charles Sturt University to provide appropriate courses to suit the demand and needs of the irrigation sector, outline the priorities that tertiary-level education should be aspiring to:

– produce course material to support the introduction of tertiary institution courses;
– expand training opportunities for irrigators, advisers, consultants, researchers and water engineers in the form of short courses, exchange visits and study tours;
– support postgraduate training;
– establish links between educational institutions and research advisory services (government and private) ensuring no duplication, consistency of advice and transfer of technology.

Universities have a role in developing undergraduate courses where the agricultural and environmental science degree streams which teach a level of irrigation design, practice and maintenance do not cover broad-based irrigation education. In the Australian context, there clearly needs to be three or four universities that provide this **undergraduate** specialisation to ensure that the different geographic and agronomic regions are suitably serviced. In particular, there needs to be somewhere that focuses on the semi-arid tropical and sub-tropical regions. There needs to be a university which looks at the semi-arid winter rainfall environments and, because of geographic separation, some opportunity for that provision in Western Australia. The demand for irrigation expertise within Australia is currently not large enough for more than three universities to support a comprehensive **postgraduate** specialisation in irrigation.

The situation in Queensland reinforces the fact that there is not enough demand for more than about three universities to support this undergraduate market. Demand for tertiary or sub-tertiary courses in irrigation education in Queensland is quite low. Central Queensland University had attempted to establish a course in conjunction with TAFE, but low enrolment numbers led to its demise. The major requirement is for short courses for those already established in the industry (there is currently very little education available for 'older people' involved with irrigation).

Meacham & Arrow (1996) acknowledge that there is a market demand for courses in irrigation, but this demand is not being met by existing provision. Meacham & Arrow (1996) go on to document all university courses in irrigation as well as courses that contain subjects on irrigation (Table 5). Of all the courses offered, there were only three courses offered with topics related wholly to irrigation. These were:

– University of Technology, Sydney: Graduate Diploma in Hydrology and Groundwater Management (postgraduate);
– Flinders University (South Australia): Graduate Certificate and Master of Science in Hydrology and Water Resources (postgraduate); and
– Nedlands, Perth: Bachelor of Science with a major in Land and Water Management (undergraduate).

Two of these courses are postgraduate and one is a major. At the time of the Meacham & Arrow report, there were no courses specifically and wholly devoted to irrigation in a course-based sense. The Sydney course is basically related to groundwater hydrology and, perhaps, more concerned with the theoretical ground processes rather than directly with irrigation. The Flinders University course incorporates more depth and is more extensive and specific to irrigation and water resources. Again, it is related to groundwater hydrology. The Nedlands course is more concerned with water management in an agronomic sense. There are obvious

gaps in this level of education. Additionally, none of the courses mentioned in Table 5 seem to articulate so that people can choose subjects from different courses to attain a more rounded irrigation education.

The University of Adelaide offers three one-semester units which are presented as part of a four-year undergraduate degree:

– Basic Irrigation;
– Irrigation Science; and
– Irrigation Systems Design.

A one-semester unit called 'Irrigation' has also been prepared and run by all three South Australian Universities (Adelaide University, University of South Australia and Flinders University) as part of a joint university masters program.

CSU Graduate Certificate in Irrigation

Since the completion of the Meacham & Arrow report, however, Charles Sturt University, Wagga Wagga, has established a **Graduate Certificate in Irrigation**. Charles Sturt University is well placed to provide such a course, largely due to its geographical position (close to the southern Murray-Darling Basin irrigation areas and the Coleambally Irrigation Area) and because of its educational expertise. McColl (1990) emphasised the fact that Charles Sturt University was ideally placed to become an education centre for irrigation, especially with regard to undergraduate and postgraduate studies. The aim at Charles Sturt University is to focus on undergraduate and graduate-level training, with the intention to train graduates with general education in agriculture and irrigation fields. Following this, suitable candidates would be attracted as postgraduates to specialise in irrigation to take on research/teaching and senior advisory roles. Charles Sturt University also aims to provide to students "additional scientific training to become critical thinkers and leaders and promoters of new technology and ideas".

The Charles Sturt University postgraduate course embraces three broad themes as far as subject matter is concerned:

1. Irrigated crop management – how water is used and how irrigation practices affect productivity and resource management.
2. Irrigation engineering – planning and design concepts to provide graduates with better appreciation of irrigation in more specific detail.
3. Composite subject – environmental impacts, sociology of irrigation areas, interaction with resource economics.

Subjects from other courses such as environmental science may also be drawn upon to provide subject matter.

Charles Sturt University aims to offer specialist study of irrigation at all levels through both full-time and distance modes. Specifically, the aims of the university with regard to the Graduate Certificate in Irrigation are as follows:

– The value and importance of Australian irrigation industry will be stressed to undergraduates.
– Postgraduate places and training will be increased through CSIRO and industry-supported scholarships.
– Postgraduate training for overseas graduates (particularly in South-East Asia) offered through short specialist courses.
– Specialist short-course workshops for further training for irrigation personnel.

NIREC – Short Courses

The National Irrigation Research and Education Centre at the University of Western Sydney, Hawkesbury, is providing nine **irrigation-specific short courses** in 1997–1998 (offered over three days each) which operate separately to the agriculture degree or diploma. Despite this, the courses are able to operate in a tertiary-level education framework by matriculating towards a graduate diploma or masters degree in irrigation at the University of Western Sydney. At this stage, these two postgraduate courses are subject to approval from the Academic Board of Studies and, as such, their establishment is not yet completed. The nine courses are:

1. Basics of soil-water-plant relationship;
2. Applications of computer software in irrigation design and management;
3. Step-by-step design of a micro-irrigation system;
4. Understanding water quality in irrigation;
5. Basics of pumps and pumping;
6. Hydraulics of water flow in pipes and pipe networks;
7. Basics of irrigation scheduling;
8. Designing water storage on farm; and
9. Designing surface irrigation methods.

The International Development Technical Centre at the University of Melbourne offers postgraduate studies in Water Resources and Irrigation Management in the form of a graduate certificate, postgraduate diploma or a masters degree.

Table 5. Summary table of courses at universities dealing with irrigation subjects across Australia

Institution	Faculty	Course	Award level	Subjects	Descriptions
University of Adelaide	Science and Agriculture	BAppSc (Ag); BAppSc(N.R.Man't)	Undergraduate		See Appendix
University of New England	The Sciences	BAgr; BNat Res; BRurSc; BSc	Undergraduate		See Appendix
University of New England	The Sciences	DRurSc; DSc; MNatRes; MResSc GDipNatRes; GDipScAg; GCertRurSc GradCertEnvMgt;GradCertNatRes GradDipEng	Postgraduate		See Appendix
University of New England	The Sciences		Distance Education		See Appendix
University of Sydney: Orange Agricultural College	Science and Agriculture	DipLandMgt	Undergraduate		See Appendix
University of Tasmania	Science and Agriculture	BAgrSc; BAppSc(Agr.); BAppSc(Hort.)	Undergraduate		See Appendix
University of Technology, Sydney	Science	GradDip. in Hydrology and Groundwater Management	Postgraduate		See Appendix
Charles Sturt University, Wagga Wagga	Science and Agriculture	BAppSc(Ag); AssDipAppSc.(ParkMgt.); BAppSc(EnvStud.); BAppSc(Ag); AssDipAppSc.(Wine Growing); BAppSc(Wine Sc.); BAppSc(viticulture)	Undergraduate		See Appendix
Charles Sturt University, Wagga Wagga	Science and Agriculture	GradDipAppSc.(Ag Studs)	Postgraduate		See Appendix
University of Melbourne, Main Campus	Agriculture, Forestry and Horticulture	BEng.(Env)	Undergraduate		See Appendix
University of Melbourne, Main Campus	Agriculture, Forestry and Horticulture	GCertEnvEnvStud.(by c'work) PGDipEnvStud.(by c'work); MSc; MEngSc; MAppSc; PhD; MHortSc; MAgSc	Postgraduate		See Appendix

continued…

Table 5. Summary table of courses at universities dealing with irrigation subjects across Australia *continued*

Institution	Faculty	Course	Award level	Subjects	Descriptions
University of Queensland	Agriculture	AssDipAppSc; PhD(by thesis); PGDipSc. (EarthSc.); GradCertAppSc; PGDipAppSc MAgStud; GCertLandResourceStud MLandResourceStud	Postgraduate		See Appendix
University of Sydney, Main Campus	Science	BScAg; BHortSc.	Undergraduate		See Appendix
Flinders University, Adelaide	Science and Engineering	GradCertHydWRes; MSc; MScHydWRes; MEng; PhD	Postgraduate		See Appendix
James Cook University, Townsville	Science	BAppSc	Undergraduate		See Appendix
University of Canberra	Science	BAppSc(Resource & Env Sc. – Land & Earth Resources)	Undergraduate		See Appendix
University of Wollongong	Science	BEnvSc; BSc.(Hons)(Advance Program) BEng.(Mining & Env Engineering)	Undergraduate		See Appendix
University of Wollongong	Science	Honours Master of Environmental Science	Postgraduate		See Appendix
Curtin University of Technology, Perth	Science	AssocDegAg.(Farm Mgt.); BAg.(Farm Mgt.)	Undergraduate		See Appendix
Deakin University, Burwood	Science and Technology	BAppSc(majors EnvMgt., EnvMgt. of Hazardous Materials, NResMgt.); BEng.(Env)	Undergraduate		See Appendix
Australia Nedlands, Perth	Agriculture	BSc.(Ag); BSc.(EnvSc.); BScMajor (Land & Water Mgt.); BSc.(NResMgt.)	Undergraduate		See Appendix

Source: Meacham & Arrow (1996)

In addition to those courses listed by Meacham & Arrow (1996), Meyer (1995) has identified the following courses in irrigation training and made the following comments.

Table 6. Additional courses at universities dealing with irrigation subjects across Australia

State	Institution	Course/comments
South Australia	University of South Australia	– The IAA and the AITC have been involved in developing course content and subjects
Victoria	University of Melbourne	– Agriculture degree (Prof David Connor) – Agricultural Engineering degree (Prof Tom McMahon) – International School for Irrigation Engineering Training. David Constable (ex-president of ICID) and others were keen to develop this school operating out of Melbourne. It had the support of the Rural Water Corporation but the effort waned and nothing was realised.
	Dookie (University of Melbourne)	– Irrigation is only represented in subjects in the Agricultural Degree.
New South Wales	University of Sydney	– Meyer (1995) comments that, as far as irrigation is concerned, the degrees here concentrate on irrigation and vegetables and market gardens at its Camden site (Dr Bruce Sutcliffe)
	University of New England	– relationship developed through Cotton CRC to look at irrigation issues in northern NSW. UNE is active on the environmental side as far as resource policy issues which influence irrigation in a water limited environment.
Queensland	University of Queensland	– part of some subjects in the Agriculture degree – Gatton has expertise in vegetable production and nutrition with an emphasis on irrigation (concentrates on the production side of irrigation).
	University of Southern Queensland (Toowoomba)	– displays an engineering emphasis in any dealings with irrigation.
	James Cook University (Townsville)	– together with Sugar Industry, they have started to develop a focus on research into some of the issues associated with irrigation in the sugar industry.

Pratley (1993) summarised the following on the availability of irrigation education.

Table 7. Additional courses at universities dealing with irrigation subjects across Australia

Level	Comments
Secondary	– Restricted to general reference in syllabuses. May be a case study or special topic (in agriculture, geology or environmental science). – Studied more in terms of environmental degradation than in terms of the production issues.
Sub-tertiary	**New South Wales** – Moree and Warren Colleges of TAFE offer Advanced Certificate in Cotton Production with major irrigation component. – MCA Certificate of Agriculture (contains aspects of irrigation); The Advanced Certificate in Irrigation (one-year full-time); regular short courses in irrigation scheduling and irrigated pastures. – Tocal dairy certificate program and spray irrigation of pastures (covers some aspects) **Victoria** – Irrigation scheduling and land layout for flood irrigation are two statewide accredited courses offered by TAFE.
Tertiary	– No complete irrigation courses. – Students are expected to relate information across foundation subjects such as soil science and crop physiology. There are also electives within certain courses and opportunities for project work and industry experience.

Cooperation among the Universities

At this stage, there is not enough **coordination** or **communication** among the tertiary institutions and tertiary based courses. As an example of this; at the time of writing this report, one prominent university was not aware that Charles Sturt University had established the Graduate Certificate in Irrigation and another (University of Western Sydney) had only just been made aware. Although the Charles Sturt University course is only in its first session of offering, other universities with an interest in irrigation education should be either made aware or make themselves aware of developments at fellow universities. This is a publicity and networking issue. If the approach to irrigation education is to be coordinated and holistic, the establishment and development stages of courses need to involve many interested and key stakeholders so that the spectrum of influence is broad. There may be a need for a central register which circulates the proposed development to all key groups and fellow educators through a network so that everyone knows what is transpiring.

University-level Course Accreditation

At the university level, course accreditation is based on a series of internal stages of course approval, although many universities have a course advisory committee that has an obligatory industry representatives component. Control and coordination of this process can be facilitated by the NIEC or the AIC informally endorsing certain courses they believe form an integral part of their overall education plan. It is important that this active input by such a coordinating body is based purely on the merits of the course.

Vocationally Oriented Tertiary Colleges

Vocationally oriented tertiary colleges, such as the Murrumbidgee College of Agriculture and Burdekin, have an important role to play in diploma and certificate-level education. Their role is most likely similar to that of the TAFE system. Having indicated the importance of this level of education, the enrolments in courses in Queensland with irrigation subjects has been quite low. The institutions offering such courses in Queensland are: Emerald (a cotton-based course), Burdekin (sugarcane/horticultural-based course) and Dalby (a struggling course due to the fact that they run out of water seasonally).

TAFE

The **TAFE** network has a role in the provision of vocationally oriented short and longer-term courses, for example, the Sunraysia Irrigation Management Course developed by the Mildura TAFE in association with the Mildura First Irrigation Trust. This course is operating through Sunraysia TAFE horticultural laboratories in Mildura.

Industry

There is a role for the **industry** itself, for example the IAA, in providing education and training. The IAA has had some success in association with the University of Western Sydney, Hawkesbury, and the National Irrigation Research Education Centre in conducting an Urban Irrigation Installers Program as well as the Certified Irrigation Designer course. Again, it is important that these courses align themselves as part of a larger framework of holistic irrigation education based on the AITP competency standards. Kilpatrick (1997), in her report on "Effective delivery methodologies for education and training to rural Australia", recommends that there is a role for discussion groups, workshops and non-accredited courses in upskilling the existing workforce. She suggests that non-formal training and informal learning experiences are more attractive to the large group who may feel intimidated by the formal training system of TAFE and universities. On-farm operators, in particular, are often generally not interested in formal education or accreditation. While realising this, however, it must also be realised that semi-formal to formal education programs and an accreditation system are the main ways in which increasing the overall education level of the sector may be monitored and achieved. Flexibility in an organised system of accreditation is the key issue. Education aims and paths still have to be well defined and clear to the students potentially utilising this type of training.

Complementary Role Sharing

There is obviously a certain degree of **overlapping of roles** and duties among the varying education developers and providers which could, should and does occur. For example, the main roles of the universities are to provide undergraduate and graduate research education and training, though this role may extend to the provision of short courses which articulate towards higher awards. This short-course role could equally be shared by colleges, TAFEs and industry. Communication and coordination, both inter- and intra-education stakeholders, are paramount to ensure that demand is being met and gaps are being filled.

Role sharing is emphasised in the AITP guidelines regarding which institutions would deliver their curriculum when it is developed. Obviously, on a national level, the AITP is keen for anyone to adopt the curriculums, but the direct plan is to aim towards TAFE in Victoria, South Australia and Western Australia (Muresque and Northam), the agricultural colleges in Queensland (Dalby, Emerald, Burdekin) as well as Gatton and the University of Southern Queensland at the university level, and the Rural Training College in the Northern Territory (Katherine). The AITP is projecting its development towards the Department of Agriculture in New South Wales. Due to the fact that it is NSW Agriculture that manages the AITP, this may present **vested interests**. There is no problem with this, as long as it is managed correctly. NSW Agriculture is forging effective ties with CSIRO and Charles Sturt University and hoping to bring DLWR on board, so dissemination of information through these channels should be effective. NSW Agriculture believes that more of its departmental staff will take on the role of extension officers in an effort to disseminate this information.

The **Coleambally Irrigation Education Program** is an interesting case study of where CSIRO, a university (Charles Sturt University) and Department of Agriculture (Murrumbidgee College of Agriculture) are working on a collaborative basis to deliver a farmer/community education program to support the objectives of the *Coleambally Land and Water Management Plan*. There are 10 units in the program which have been or are presently being developed to address major issues and recommendations in the plan. Generic information has been tailored to address specific local conditions; excursions and on-farm data add to the local relevance. The early units have been offered on a voluntary basis and records of attendance have been maintained. The program is being offered in stages, with repetition of units, and this will extend over years. An important aspect is to secure as wide a participation as possible in the program, with an emphasis on on-farm options outlined in the plan. Assessors will be employed to see whether the education is being put into action. This system of coercion/incentives and monitoring through assessors seems to be an affective way to work towards an increase in the education base.

Geographic Location

Geographic location has a large role to play in determining who is well placed to provide irrigation education in Australia. Although occupations and basic concepts in the sector are similar across Australia, their roles vary, as do the types of irrigation, plants grown and markets targeted, amounts of water applied, soil types, availability and proximity of education providers, and level of training of the irrigation personnel. Urban irrigation possibly does not vary as much in its technical aspects as geographic location varies, but urban irrigators are under similar pressure as far as availability and proximity of education providers are concerned, especially in country towns and isolated cities such as Darwin and Perth.

It must be determined where the largest geographical demand (and what sort of demand) for irrigation education courses exists. Graf, Meacham & Meyer (1996) attempt to divide demand into States, but admit that their survey was not random (geographically) across the country and that the sample size was not large enough. It was found, however, that the highest levels of relative demand (proportional interest) are in the areas most remote from NSW (for example, Western Australia). Distance education should be offered nationally and educational institutions need to be geographically positioned to enable efficient and close contact with the education user. Consultative workshops need to be held nationally, especially in the major areas of irrigated agriculture in each State and Territory. The workshops should be conducted according to irrigation type (that is, surface, spray, micro) as in the consultative process employed by the AITP. It is suggested that from a national perspective, separation between **tropical** and **sub-tropical** regions and the **temperate regions** would be a reasonable division.

Short Courses Crediting towards Higher Awards

The university scene (as well as other levels of education providers) is also very well placed to provide **short courses** on specifics in irrigation. As has been indicated from a number of surveys of irrigators and people involved in the irrigation sector, particularly the rural sector, there is a demand for short-course, distance education materials (Graf, Meacham & Meyer, 1996). Developers of new courses using the competency standards or curriculums as a basis need to bear this in mind and structure their material accordingly. Being based on the competency standards, these short courses need to show some degree of articulation towards a further recognised achievement. The short courses program at the University of Western Sydney, Hawkesbury, through the National Irrigation Research Education Centre is a good example of this where, subject to the approval of the Academic Board of Studies, the short courses will **credit** towards a graduate diploma or masters degree in irrigation. People are then more likely to see that there is an ultimate aim in completing these short courses, rather than merely receiving recognition for completing each course individually. This process is also in the best interests of the sector as a whole because it provides a framework for progressing towards a well-rounded, complete education for irrigation personnel.

Course Articulation

Articulation among various institutions/education providers is an essential part of the move towards a coordinated approach in irrigation education. Universities throughout the country have expertise in or concentrate on various aspects associated with irrigation. For example, the University of New England is oriented towards the economics approach, the University of Southern Queensland is oriented towards the engineering approach, the University of Queensland is oriented towards the pest management and catchment planning approach, the University of Central Queensland at Rockhampton is oriented towards a wateruse efficiency approach, Griffith University is oriented towards an environmental approach and Charles Sturt University is oriented towards the agronomic approach. These expertise orientations, coupled with geographic location, logically suggest the concept of course and resource/course **material sharing** amongst these institutions. If a combination of these courses, along with the various subjects in other less specific courses could be combined in a coordinated way, then an effective, broad-based irrigation course for the university/graduate level could result. Different universities would offer different modules of a course designed to encompass a comprehensive range of irrigation issues. The course would either be offered by distance education from the various universities or, more ideally, course material would be shared and it would be offered from a centrally or sensibly located institution,

for example, Charles Sturt University in the east and the University of Western Australia in the west. Despite the recent increased competition among universities, support for this idea of articulation and **course sharing** is endorsed by the majority of education providers throughout Australia. If, for example, too many universities compete for student numbers, courses will not be viable and will languish in time because the total catchment of student numbers is limited.

Such articulation of courses has also been suggested between NSW Agriculture and Charles Sturt University. NSW Agriculture is keen to push connection with the university, as is the university with NSW Agriculture. Having an accredited education provider, such as a university, deliver course material adds credibility to the course and enables it to form part of the overall education strategy.

Course Design

Graf, Meacham & Meyer (1996) have outlined five major issues to which attention must be paid to ensure relevant and effective **course design** at the tertiary level.

1. **Content** needs to be shaped both by the level of incompetence and the perceived importance of that issue. It also needs to be guided by an educated, holistic view of a governing body.
2. **Level** of the course needs to be adapted according to the education level of the person – the courses should have ostensibly the same content offered at different levels.
3. **Mode** of study needs to be distance or at local centres, though contact should be high, both with lecturers and among students. Some higher level courses will require full-time study.
4. **Length** of courses needs to be variable. Short-term certificate courses should constitute a component of the longer formal courses. The idea is to provide a 'lifelong learning experience with stop-off points'.
5. **Structure**: 'Spiral curriculum' is the description of the desired model. Each module represents a standalone treatment of a particular issue with higher level modules involving a more in-depth look at that issue.

Courses need to cater for both the person who is already educated to some degree in irrigation or related topics and those with little or no previous knowledge. People can enter the education ladder at different levels. Encouraging people who have either never been in the post-secondary education system or have been out of the system for a number of years to re-enter the system is an important but difficult step in moving towards widespread improved education in the sector. In some cases it will be necessary to educate people that they need to be educated – they may not be aware that their skills and education are lacking.

Important steps in the process are to:

1. identify skills, knowledge and qualifications currently held;
2. identify skills, knowledge and qualifications that should be provided; and
3. measure the need and demand for university education (Meyer, 1996, cited in Graf, Meacham & Meyer, 1996).

In approaching the process, several steps were involved:

1. Define what the people do (for example, installers, etc.).
2. What skills do these people require to do these job?
3. Are the people competent?
4. If competent, give them a certificate.

Having done this, it was found that a lot of people were not competent and therefore not up to certification standard.

Curriculum Sharing

The instigators of the Sunraysia Irrigation Management Course, the Sunraysia Salinity Plan community group, borrowed the curriculum from the Riverlink partners in South Australia, who already had a successful course in operation. This is a good example of avoiding duplication of effort. A number of reasons have been presented as to why this course has been so successful, and it seems that these reasons are important to any developments in courses at this level:

– The presenters are all well trained and skilled in their particular aspect and have the practical know-how.
– The course is continually updated to keep it topical.
– The course is run over two days, separated by a week when the irrigators do some investigation on their own block.
– As much as possible, the course is done in the field.

– The soils aspect, in particular, is fresh and novel to most irrigators.
– The course is free for irrigators in the Sunraysia Plan area. In addition, any irrigators who wish to earn any one of the rebates available under the plan have to attend (Riverlink Newsletter, 1997).

TAFE must ensure that efficiency is maintained (or developed where it is deficient) in any of the irrigation education programs.

Local Relevance

One of the features of irrigation education programs is that they need to be regionally oriented. That is, while being based on basically generic irrigation principles and competency standards, they need to use case studies which are relevant to the cropping systems, to the soil types and to the irrigation systems which are predominant in those regions. The concept of basing curriculum development on the generic competency standards and refining them with specific case studies is relevant to irrigation education at all levels

Variety of Educational Needs

There should also be some place for separation between a postgraduate irrigation specialty with an emphasis on engineering aspects and in another case, a specialty focus towards environmental and plant production components. In looking at the education needs, we need to recognise that there is a matrix of needs that should be borne in mind. On the first level, there is the need for provision for different client groups from vocational through to the service sector through to advisory through to research capabilities. Included in the service sector are those specialty areas, for example, associated with pressurised systems and pump and pipe systems.

At a second level, there is a regional need where the broadest categories are between summer-dominant and winter-dominant geographic areas and further subdivisions associated with different broad irrigation needs, depending on their geographic location. This second level is strongly interrelated with another level associated with irrigation systems, that is, the way in which water is applied through surface irrigation, pressurised systems or highly controlled systems and which, in turn, is strongly interrelated with the type of crops that are grown. Special mention must be made of the irrigation service sector, which includes suppliers of hardware, everything from channel stops through to pumps, pipes, micro systems and including supplies of fertilisers and chemicals. Surveys indicate that this group is particularly influential in their interactions with irrigators and that, in general, the knowledge levels of the suppliers are rudimentary.

Education in Marketing

As well as the necessity for education and training in all the obvious areas of the sector (for example, design, installing, wateruse, research, testing), there is also a necessity to educate those working in the **marketing/ trade** side of the irrigation sector. Establishing, maintaining and strengthening a market for irrigated produce (whether it be cotton, turf or a golf course) is perhaps the most important deciding factor as regards the ongoing financial success and, therefore, the amount of money that can be re-invested in research and education in any particular production and the irrigation sector as a whole. The government has made major changes to water policy, creating a national market for water whereby interstate and intrastate water entitlement trading is allowed. This makes competition for water a lot stronger. People well trained in marketing, especially with regards to irrigation, will also be required to implement and act under these policies (IAA, 1996).

National Communication Network

There is definitely a need to establish a **national network** to enable easy communication (IAA, 1996; Graf, Meacham & Meyer, 1996) among stakeholders involved with the development and delivery of education and the users of the education. "The first phase of this is to establish a network of key personnel and key institutions representing government and industry who are concerned about the deficiencies in education and training services available to the irrigation industry and who are sufficiently qualified, experienced and interested to assist in the development of ... curriculum" (based on the original aims of the AITP, 1994). This network should enable a cooperative approach to be facilitated and will also ensure that all key groups are aware of any actions taken by other groups. The Internet would be an effective tool to employ to facilitate this national network.

Although not a mainstream form of irrigation education and training provision, the **Internet** is

accessible and useful for some in terms of irrigation information dissemination. There are two significant providers on the Internet:

1. Utah State University – Irrigation Training and Research Centre; and
2. California Polytechnic State University – Irrigation Training and Research Centre.

The Farrer Centre at Charles Sturt University also offers a potential Internet site (in the form of its 'SILO' site) to disseminate specialist information on various aspects of irrigation.

Key Groups

Government, industry and education providers need to work together to establish mutual agreement on the approach to be taken towards achieving a coordinated, holistic irrigation education framework across all levels of education. Table 8 lists the key groups that need to establish close contact and constructive discussion. The IAA forum held in Melbourne on 18–19 November 1997 provided an excellent opportunity for these key groups to congregate, initiate discussion and establish a national network.

Table 8. Key groups in irrigation education

Government	Industry	Educators
ANCID	IAA	MCA
NFF	AIC	CSU
AITP/NSW Agriculture	NIEC	NIREC (UWS)
MDBC	AITC	NTU
DLWC	CI	USQ
DEET	MI	UWA
ICID	GMW	U Melb.
RTCA		CQU
VETEC		UNE
WIETA		JCU
ANTA		EAC
NPIRD		TAFE
State Industry Training Boards		Vocational colleges – Burdekin – Dalby – Katherine Rural College
R&D Corporations – Cotton – Dairy – Grape and Wine – Horticulture – Land and Water Resources – Rural Industries – Sugar		

Links among Stakeholders

Links need to be strengthened between educational institutions and research and advisory services to ensure consistency of advice, education and training, and transfer of technology. Retailers, through their regular contact with the end users, have a very important role to play in communication of what is required, both in education provision and supply of materials and services. Retailers are an important link between irrigators and manufacturers as well as between irrigators and education providers and developers. This link must be strengthened, maybe through compulsory or voluntary reporting of irrigator opinions back to the educators and manufacturers on a regular basis. Enforcement of this may be difficult.

Additionally, manufacturers are the only established contact with the retailers from a theoretical design or policy point of view. Retailers rely on technical information directly from the manufacturers. This may present a problem if, for example, the manufacturers are in Melbourne and the farm with which the retailers are dealing is in Queensland. NSW Agriculture is adamant that improved education is necessary for the resellers to upgrade their theoretical and practical training so that they can be a more effective link and provider of information to the end user. One of the current problems is that many people working in the sector have grown up in the sector and progressed up the career ladder with no formal training. Obviously, in these situations, there is a case for workplace assessment of skills and accreditation, but there is also a case for drawing (encouraging) such people into the education system, especially if their workplace-acquired skills are inadequate for the job they are performing.

National Register of Courses

A **register of courses**, course materials and providers needs to be established on a national basis (Kilpatrick, 1997; Wilson & Associates, 1996). This is especially necessary in the vocational education scene due to the TAFE monopoly on such education being loosened. As a result, the number of courses and competition for participants has increased. Not only will this register provide a list to potential students of what is available, therefore giving them a choice, it will also act as a resource for those seeking to develop new programs. This will help to avoid duplication of effort and encourage modification of existing programs and other resources, especially flexible delivery materials, in preference to developing new programs. This national register, coupled with the national network, should also enable suitable arrangements for cost and curriculum sharing to be negotiated. Training providers and other stakeholders should combine to use facilities and expertise available in rural areas as flexibly and creatively as possible. (Kilpatrick, 1997). As mentioned earlier, the IAA is currently undertaking the task of collating such a list of courses available in irrigation education throughout Australia. It is envisaged that the NIEC will be the body that will maintain such a list.

It is a good sign that the AITP suggests that it will maintain open lines of communication among all parties involved in the curriculum development to ensure no duplication of effort. This will align the curriculum developed by the AITP with other curriculum information being developed for other rural industry sectors. Only through a national network of all involved with the development of curriculum and delivery packages and all those who will eventually utilise the curriculum will this be achieved. Despite the intentions of the AITP to ensure these open lines, at the stage of writing of this report, communication between the two major players in irrigation education (the AITP and the IAA) was very poor, even to the extent that it was only through a third, independent party that information was being transferred between the two regarding their intentions.

At the university level, similar links and networks should be established and maintained so that any curriculum developed is relevant and complementary and so that efficient resource cost and development sharing occurs. University-developed curriculum does not have to undergo external accreditation from a governing body, such as the Rural Training Council of Australia, so it is the responsibility of the universities themselves that these links are established and/or strengthened.

Mapping a Path among Competencies, Curriculum, Training and Certification

A **mapping exercise** needs to be undertaken so that the connection among 'competency standards', 'curriculum' and 'certification' can be established and become clear to those undertaking training (Table 9). If someone needs or wants to attain a certain competency level, they need to know what path is required to be taken to attain it. At

this stage, the various parts of the framework seem to exist to some degree, but there are gaps in how the parts constitute a coordinated system. The largest gaps seem to be prevalent between the competency standards and the curriculum development.

The construction industry has already committed funding to such a mapping project. A committee has been created on which the IAA has been given two advisory seats and the project is about to go up for tender. One of the aims of this project is to adapt the United States system of education and training (short courses) to Australian settings.

Table 9.

Competencies	Curriculum	Training	Certification
AITP (levels 1–5) based on ASF/AQF levels 1–8	Universities (through to) workplace	Gained in numerous ways	Setting the criteria whereby someone is competent to a certain level

Competency may be Gained without Formal Training

Industry and certification authorities need to recognise that there are a variety of ways in which someone can become competent. A person can become competent without actually receiving training from an institution. **Skills gained in the workplace** need to be recognised as an important alternative to skills gained through formal courses or training workshops. There needs to be less emphasis on how people acquire the competency and more on whether or not they have the competency. This may seem to remove some emphasis from educational institutions as providers of competency, but it is mainly at the vocational end of training. In many cases, what is required by the sector is best learnt whilst working in the sector/industry. Often, set curriculum is seen as too sterile, inflexible and involving too much bureaucracy.

Workplace Assessment and Recognition of Prior Learning

Workplace assessment is a part of government policy whereby the skills gained by people while working in the industry (these skills may be gained in a number of ways) can be assessed by 'qualified' workplace assessors and then recognised through an accreditation program. This **recognition of prior learning** is an important part of discerning what the education needs of the sector are. Contention exists on the issue of whether or not this philosophy is an effective way to go but, while it is government policy, it must be a path followed. Warwick Moore (pers. comm.) of NSW Agriculture lists a number of potential problems with workplace assessment, but these problems have been dealt with in other industries, such as the sugar industry, so, if the system is managed correctly, there is no major reason why it could not be effectively employed in the irrigation sector. (Check the legitimacy of this claim.) These potential problems are:

– cost – who pays in private industry;
– willingness of industry to adopt concept;
– quality control;
– access and equity; and
– small business may be hard to monitor.

The Rural Training Council of Australia is adamant that vocational qualifications should not necessarily be issued against curriculum but that the workplace assessors should assess knowledge, and that there should be adequate flexibility to retain 'flair' within any accreditation program. They believe that, if left in the hands of the industry, market forces will ensure that effective programs for skills development are established and maintained in the best interests of the sector. It is in the best interests of the sector if industry itself ensures this is the case. The IAA is also supportive of this philosophy. The IAA believes that a major challenge for the irrigation sector (which must be addressed in the next few years) is the implementation of an effective

workplace assessment model which is based on a regional network. The assessment must be undertaken at the worksite so that the people requiring the training do actually access it (Wilson & Associates, 1996). As stated before, however, NSW Agriculture strongly disagrees, stating that the place of assessment is at the start and the end of the education process and that the education should be left up to the educational institutions. As a registered VETAB provider, however, the Murrumbidgee College of Agriculture participates in workplace assessment and the recognition of prior learning.

The drive to industry assessment as an important part of the education system also extends to university-level education. The idea has been suggested that graduation from a specific course does not occur until one proves oneself in the workplace. In the case of the management field, because of the fact that it may sometimes takes 10 years to reach this management stage, it would be a long time until any proving can be achieved. University graduates will always have to integrate the knowledge acquired through their study with the realities of the working world and this has always been the case and is unlikely to change. Industry assessment has a more obvious role to play in vocational education.

Subsidiary Industries

The irrigation sector also has a responsibility to a range of **other industries** to adopt a coordinated education approach and to be operating at an efficient level because of the concomitant, flow-on effect it has on these related industries, for example, building and construction industry, rural industry, water management industry, local government, general manufacturing and the consumer (IAA, 1996). For this reason, no group (for example, the IAA) can afford to be narrow in its representation – it must cover the whole sector. The IAA recognises that it has to work closely with all these industries to ensure relevance and complementarity in education. As such, it recognises that flexibility must be a high priority in developing any education or training schemes. It may sometimes be necessary and relevant for certain occupations to **borrow competency standards** from other industries, for example, the building and construction industry. A prime example of this is the South Australian situation where Primary Industries in that State performed curriculum development based on the building and construction industry competency standards and has been running courses for the last two years. The national competency standards are designed to guide the formation of training modules to offer individual occupations within the industry. Occupations may also wish to complete modules developed by other sectors (for example, building and construction) to acquire a range of competencies required for that specific occupation. This is why it is important to work with other industries.

Other industries, for example, the grain and dairy industries, also have a reciprocal responsibility to spend money on R&D and education within the irrigation sector. The irrigation sector is not seen politically as a separate entity and should, therefore, not be required to operate as one in terms of funding and outcomes, unless funding for R&D and education to the sector itself is relatively equitable with other industries.

The irrigation sector is already represented on a number of training advisory boards, for example:

– building and construction;

– rural and amenity horticulture; and

– water industry.

The plan is in place to also seek representation on curriculum advisory committees to establish training and competencies. This is a positive step that is a major part of the IAA strategy.

Break-up of the State Water Agencies

In looking at the Australian irrigation sector and the medium and long-term provision of adequate skills, a major influence will be the break-up of the **State water agencies**, such as NSW Water Resources and the Rural Water Corporation of Victoria. These organisations provided training opportunities and experience for many irrigation system engineers and resource officers who have overseen both the development and maintenance of large irrigation areas. These opportunities are now limited and it is of concern that unless the emerging regional irrigation authorities (for example Goulburn-Murray Irrigation and Coleambally Irrigation) take on this responsibility, training experience opportunities for these engineers will not be available. Again, this is an area where a national overview and a degree of national leadership from an organisation like the NIEC is sorely needed.

Another impact of this move towards local water control and local boards is that the irrigators themselves will have **closer communication** with the authorities. Such local boards, for example, the Water Services Committees (part of Goulburn-Murray Irrigation), become representative bodies who have direct contact with ANCID. Communication and extension must be a priority of such boards.

Important Social Issues

Social issues are an important and sometimes under-emphasised part in the development of education. There is a need to ensure that there are career opportunities for those who have completed the training. There is current talk that the minimum wage in the irrigation sector may be reduced. Despite people potentially having to start on lower wages, there will still be a positive feeling if people can see that there is a career path and **incentive** towards higher salaries. If people see that the competency standards are a path that they can ascend and that, as they rise, the salary will rise too, people will see a continuance of the career path and see **career development security**. Because of this, they will be attracted to the sector and to education/training and become committed towards furthering their education in irrigation. At this stage, there are many people who are not moving through the education system or who have already moved through the system. Encouragement needs to be provided so that such people will enter or re-enter the system so that the desired standard may be attained.

Hopefully, in that case, enforcement of the competency standards through government control (which, in the minds of many, immediately assigns a negative image to the issue) will not be so necessary but, rather, **encouraged**. Employers also need to support the concept of rising through the Australian Standards Framework levels. Without this support, the system will not operate effectively. Also, the **lifestyle** that an irrigator, or anyone working in the sector, can afford (both in terms of time spent working or through financial gain) is important to their overall well-being. This positive individual state of well-being will have flow-on effects to the sector as a whole.

Improving Local Education Levels to Employ Locals

There is a problem prevalent in Australian industry, particularly in manufacturing (also in, for example, universities), that there is a shortage of well-trained Australians and as soon as prospective employers are confronted with this they look **offshore** for employees. The industry or employer needs to have a long-term commitment to investment in training so that they can fill the positions with well-trained Australians. It is in the interests of the sector as a whole.

Environmental Image

It is also important for the irrigation sector to establish a clean and responsible **environmental** reputation/image in the eyes of the community and to be proactive rather than reactive. The IAA agrees with this.

Major Gaps

- Lack of overseeing/controlling body to coordinate the sector in its irrigation education needs.
- Gaps in various levels of skills and education:
  - Diploma-level education.
  - Broad-based degree course in irrigation, maybe with various universities inputting their specific expertise.
  - A particular deficiency in the post-secondary training in irrigation on agricultural courses, that is, irrigation training within courses such as agriculture is lacking.
  - Lack of lower level skills-based training which is 'outcomes-based'. Many believe that the training provided is not based on sector expectations or requirements. Studies show that only 8% of irrigation workers have appropriate irrigation knowledge/skills (Wilson & Associates, 1996). There is a priority to educate these lower skilled farm workers.
  - Lack of options for those already established in the irrigation sector to enter or re-enter the education system to update their skills and knowledge. Short courses would be appropriate.
  - Lack of distance education material and, in that case, options for flexible modes of study.
  - Land and Water Resources Research and Development Corporation (LWRRDC) has identified a particular deficiency in the post-secondary training in irrigation, especially in agricultural courses. Links need to be strengthened between educational institutions and research and advisory services to ensure consistency of advice, education and training, and transfer of technology.
- Lack of cohesion among the various levels of education. There needs to be more contact and holism over the entire education system so that all levels are working towards the same general aims.
- Wilson & Associates (1996) recognise that there are skills gaps in virtually all occupations in the sector. Specifically listed are:
  - farmer and farm manager;
  - agricultural extension officer;
  - environmental scientist;
  - soil scientist;
  - landscape architect;
  - surveyor;
  - agricultural engineer;
  - urban and regional planner;
  - agricultural technical officer and technician;
  - civil engineering associate and technician;
  - surveying associate;
  - park ranger;
  - nursery person;
  - greenkeeper;
  - gardener;
  - florist;
  - sales representative;
  - sales assistant;
  - trades assistant and factoryhand/assembler, metal and metal products assembler;
  - supervisor, farmhand and assistant;
  - livestock and field crop farmhand;
  - fruit, vegetable and nut farmhand;
  - farmhand and assistant not elsewhere classified;
  - forestry labourer;
  - nursery and garden labourer;
  - agricultural labourer and related worker not elsewhere classified;
  - water service employees.

- Lack of scope in irrigation education for:
  - women;
  - Aboriginal peoples and Torres Strait Islanders;
  - people from non-English-speaking backgrounds;
  - people with disabilities (Wilson & Associates, 1996).
- Lack of contact, communication and networking among the stakeholders in the irrigation sector, leading to duplication, gaps in the education, inefficient use of resources for course and curriculum development, unnecessary competition, poor representation to potential funding bodies ... which leads to a lower than adequate overall education level and, ultimately, inefficient irrigation practices (which have a host of concomitant effects on the environment, production and the sustainability of irrigation in general).
  - most of the key groups mentioned earlier (for example, the IAA and the AITP);
  - the education providers (both within and among)
  - the tertiary institutions, the vocational colleges, the TAFE organisations and the industry providers;
  - the researchers, designers, manufacturers, retailers and the end users;
  - the sector as a representative whole and the politicians.
- Lack of effective model for workplace assessment and recognition of prior learning.
- Lack of national register of education and training courses available.
- Lack of cohesiveness and correlation between competencies, curriculum, training and certification.
- Lack of education provider representation on the NIEC board.
- Compared to the southern irrigation areas, there is an inequitable lack of extension, research and development in the northern and western areas of the country.
- Lack of articulation among various courses.
- Lack of education in the features of the recently introduced Water Reform Package and the necessity to implement a plan such as this. Following this, people are not prepared to adopt a levy system whereby users pay some percentage of funding towards irrigation sustainability as part of a long-term plan. It seems that users are still not aware enough of the need to think in the long term to maintain sustainability, and high production still seems to be the key issue in the minds of many. This extends to urban irrigators too. Education must be, in part, to blame for this shortfall in awareness.
- Lack of education in marketing as far as irrigation is concerned.
- Lack of adoption of aspects of education and training programs from other industries, such as the construction industry, and lack of recognition of prior learning from other industries – lack of cross-industry collaboration.
- Basic competencies for irrigation have been developed. These need to be more clearly defined for specific occupations, for example, greenkeepers, landscape architects and gardeners.
- Lack of volume of public vocational education and training availability to the industry. This requirement for public vocational education and training will increase at a rate of 5% to 10% per annum over the next three years (Wilson & Associates, 1996) so the problem will only increase if something is not done.

Strategies to Deal with Gaps

Table 10. Summary table of shortfall and relevant strategy to amend the shortfall

Shortfall	Strategy to deal with shortfall
Lack of overseeing/controlling body	Endorse AIC as controlling body and NIEC as irrigation education coordinator.
Gaps in various levels of skills and education	Part of overall strategy.
Skills gaps in virtually all occupations in the sector	Establish strategically placed regional skills centres as well as a key resource and development centre in somewhere such as Griffith or Mildura.
Lack of scope in irrigation education for: – women – Aboriginal peoples and Torres Strait Islanders – people from non-English-speaking backgrounds – people with disabilities	Actively encourage and market careers for women, offer flexible training programs (various times, self paced and requiring little previous study or knowledge), develop specific programs for Aboriginal peoples and Torres Strait Islanders and non-English speakers.
Lack of contact, communication and networking among the stakeholders in the irrigation sector	A national network needs to be established to enable easy and efficient communication among all key bodies.
Lack of effective model for workplace assessment and recognition of prior learning	Skills gained in the workplace need to be recognised. Workplace assessors should assess knowledge in the workplace. The system needs to be based on a regional network.
Lack of national register of education and training courses available	A register of training courses, course materials and providers needs to be established on a national basis. Such a register needs to be publicly available (eg. Internet).
Lack of cohesiveness and correlation between competencies, curriculum, training and certification	A mapping exercise needs to be undertaken so that the connection among 'competency standards', 'curriculum' and 'certification' can be established and become clear to those undertaking training.
Lack of education provider representation on the NIEC board; resulting in gaps between industry and education providers	That education providers (from all levels of eduction) be represented on the NIEC board.
Inequitable lack of extension, research and development in the northern and western Australia areas of the country	From a national perspective, separation between tropical and sub-tropical regions and the temperate regions would be a reasonable division. Due to geographic isolation, Western needs separate consideration.
Lack of articulation among various courses	Collate all available courses and place them as part of an overall, Australia-wide, aims oriented education system. Courses need to be complementary.
Lack of education in the features of the recently introduced Water Reform Package.	Implement an education program to convince people this is the most desirable direction to take.
Lack of education in marketing	Input more irrigation based subjects into already established marketing or economics based courses. An agribusiness course is to be established at CSU and this would be a good course in which to include irrigation marketing.
Lack of adoption of aspects of education and training programs from other industries, such as the construction industry, and lack of recognition of prior learning from other industries – lack of cross-industry collaboration.	Adopt a flexible education and training program whereby the irrigation sector is open to adopt aspects of programs from other industries. A mapping exercise may have to be performed to discern what is available and relevant for adoption.
Basic competencies for irrigation have been developed. These need to be more clearly defined for specific occupations, for example, greenkeepers, landscape architects and gardeners.	Addition of occupation-specific modules that can be attached to the more generic competency standards so that individual relevance is improved.
Lack of volume of public vocational education and training availability to the industry.	Establish program of workplace assessment and recognition of prior learning that can then be encompassed into the initial stages of public vocational education and training.

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Appendix

General Recommendations from Other Studies

Graf, Meacham & Meyer (1996) have listed a number of recommendations for the implementation of irrigation education at the university level (it must be noted that this study was completed from the Charles Sturt University perspective):

1. There should be a common core to irrigation education at the tertiary level, with topics offered at various levels within a spiral curriculum.
2. Courses should be delivered in a way that provides effective access for clients, that is, modularised programs with credit accumulation delivered at a distance or through local centres.
3. The 'unimportant' topics should be considered for exclusion from the core program.
4. The 'important' topics should be given considerable attention within the core program.
5. Areas of perceived incompetence in areas not regarded as unimportant require special consideration within the core program.
6. The responses from the whole respondent group should form the basis of course planning, with this data complemented by the specialist knowledge of the course designers.
7. Further surveys on demand should be carried out in the States with apparent high proportional interest in further studies in the field, if irrigation courses from Charles Sturt University are to be offered nationally.
8. Notwithstanding recommendation 7, the needs of potential clients who are very remote from the university should be considered in the design of irrigation courses.
9. Marketing of irrigation courses should target all States with identified high demand.
10. New courses should be developed as a continuation of existing levels of education as part of a potential life-long learning path.
11. Courses should be marketed towards potential clients with a wide range of potential experience, and course design should take cognisance of the varied backgrounds of potential students.
12. The interest shown by respondents from many occupational roles should guide marketing strategies.
13. In marketing new courses, particular attention should be paid to the needs of equipment designers, merchandisers and installers.
14. The same levels of courses should be offered in all States.
15. Short courses should be developed in areas of perceived demand, with completion of short courses leading to an accumulation of credits towards a formal qualification.
16. Irrigation courses should be modular, allowing accumulation of credits up to the award of masters (coursework).
17. Topics of interest through short courses should be developed and offered to practitioners holding different work roles in the irrigation industry. Any credits for such courses should be cumulative, leading towards formal awards.
18. Opportunities for postgraduate places in irrigation studies at Charles Sturt University should be targeted at personnel in the research and research support function in the industry.
19. Undergraduate and postgraduate award courses in irrigation should be offered through the distance education mode of study in all States.
20. Courses should be offered at local centres in New South Wales and Victoria, possibly using TAFE facilities.
21. Full-time internal courses should not normally be considered as an option for mature students of the type surveyed. This mode of delivery should largely be restricted to school leavers, if a market can be identified.

22. Irrigation courses should be offered through distance education to all potential students, regardless of their workplace roles (Graf, Meacham & Meyer, 1996).

Kilpatrick (1997) has identified 10 features of effective training which should be incorporated into all training programs and which should encourage participation in training. The features are:

1. Interactive training, with opportunities for discussion and interaction with both fellow participants and 'experts'.
2. Relevant topics, applicable to target group's situation.
3. Credible facilitators/instructors and materials.
4. Groups of people who regard each other as similar, and are comfortable with each other.
5. Reduction or removal of barriers such as child care and travel.
6. Sessions, times and venues to suit target group's work and personal lives.
7. Short sessions.
8. Value for money.
9. Programs that can be taken in manageable chunks.
10. Marketing through associations, community groups and organisations.