# Knowledge, Know-How, Information and Change in Irrigation

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## Abstract

Industry interest in improving water use efficiency has increased greatly in the past few years. To achieve this, growers are seeking more information and practical knowledge about how to improve water management and the relative value of different systems. Extension programs for water management vary across the industry, as does the availability of irrigation consulting services. Interviews of all sectors of the cotton irrigation industry have identified the needs and preferences for accessing and developing knowledge about irrigation.

There is clearly no one option – different people learn in many different ways and a package that combines different approaches is needed. Many consultants are looking to provide irrigation and nutrition services to supplement their business, and have identified a need for training. An extension and services model is being developed to partner public (government and industry extension) and private (consultants) sectors to provide growers with information and advisory services, trials, case studies and training for irrigation management. The Australian Cotton Cooperative Research Centre (Cotton CRC) will develop this with the CRC Irrigation Futures (CRC IF), providing cotton irrigators with greater access to broader irrigation research.

## 1.0 Introduction

Water scarcity combined with increasing awareness of the opportunities to optimise yield through precision irrigation have all led to a growing interest in making changes to maximise the profit from the megalitres of water available. This has been a significant shift in the past two years, and was largely influenced by limited water. It is likely to stay a focus due to both water reform and also the high yields that were obtained by some irrigators with limited water. New approaches, management techniques and economics are clearly a key part of improving water management practices, just as they are with any element of farm management.

Knowledge about irrigation is developed through research, through growers' experiences and through the experiences and trials of consultants and suppliers. Understanding how this knowledge flows through the industry, how growers make decisions about irrigation, how they access information and what influences changes in irrigation management will help the Cotton CRC to better target our research and extension efforts in irrigation.

Until recently, pest management has dominated the focus of management, consulting services and research in the cotton industry. Information about pest management is readily available to growers through a number of avenues including research and extension, consultants, field days, information resources, CottonLOGIC, Area Wide Management groups, seminars and agribusiness. Does this model suit equally well for irrigation? There are a few key differences to be considered: the industry has far fewer researchers working in irrigation; most growers employ a consultant for pest management but few do for irrigation other than scheduling services; there are only a few consultants highly skilled in irrigation in the industry. Also, some of the changes that are needed are substantial decisions that can not all be practically made by trial and development – for example change of irrigation system type. Equipment and skills for measuring irrigation set-ups are specialised, time consuming and often will need to be done on an individual basis for each field.

Understanding these issues, a Cotton CRC research project, funded by the National Program for Sustainable Irrigation, has looked closely at the knowledge patterns and strategies of all industry sectors, specifically in relation to irrigation. From this will be developed strategic approaches to irrigation extension and education in the future. This aims to provide irrigators with the necessary information and services to improve water use efficiency (WUE) and optimise yield and quality.

## 2.0 Approach

Over the 2003-04 summer, 90 interviews were conducted to determine how information about water management is being sourced and used in irrigated cotton and grains. This included predominantly face-to-face, and some telephone interviews of: 39 cotton and grain irrigators; 4 grain irrigators; 30 consultants and irrigation suppliers/designers; 10 members of the cotton extension network; and 7 members of research agencies. Extension staff from cotton, grains and horticulture met to be trained in interview techniques, conduct the initial interviews and debrief on early findings before travelling home to do more interviews.

Interviews and training were done under the guidance of Professor Victor Callan, a specialist in learning organisations in the business sphere. He then analysed the interview reports to prepare a detailed draft report (Callan, Christiansen *et al.* 2004). This was circulated prior to an industry workshop in Moree. This workshop, with representatives of most sectors of the industry, worked through the recommendations in details to advise a future model for irrigation extension.

The project steering committee played a key role in guiding the project and then in assessing and integrating the recommendations to develop an extension model. It should be noted that this study was conducted under a severe drought year where water was the most limiting resource for many.

# 3.0 Findings

## 3.1 Key issues affecting water management

The key issues that affect water management for cotton and grain irrigators were: the availability, continued security and cost of water; Returns per megalitre; Water quality; and Water scheduling.

A number of other issues were frequently mentioned in interviews, including:

- Various ranges in climate and rainfall, and how these influenced decisions on irrigation management and cotton variety;
- Public attitudes about irrigators, and water conservation;
- The use of cheaper ways to monitor more areas using probes;
- The need to better understand and manage waterlogging;
- The relationship between soil types and irrigation choices;
- More understanding of deep drainage & management;
- Ways to increase capacity to store water;
- Ways to minimise labour requirements around the most appropriate choice of irrigation method (NB some have identified potential economic value in increasing labour crews in order to save water);
- Improved tail water reticulation;
- Managing irrigation and soil erosion problems;
- Alternative crops to cotton given changes in water availability and its cost.

Uncertainty about water security was particularly influential in limiting the willingness of irrigators to invest in major changes in their irrigation systems and design until they knew how much water they would have.

There has emerged a very strong focus on $ returns per megalitre. Many growers indicated that they would choose the crop that was most profitable for the water they had available. Currently this was cotton for most irrigators, though most had no commitment to grow cotton if another crop was more profitable per megalitre. In most cases, water has become a greater determinant than land area.

## 3.2 The nature of information, knowledge and knowledge sharing

All sectors believe that the cotton industry is responsive to change, willing to experiment and continually learn, and that growers, consultants and extension officers were very willing to share information and knowledge. Across all sectors, there was the general opinion that the cotton industry was an innovative one. Cotton could be regarded as a knowledge crop.

*"Between us on this farm we read just about everything that's related to the industry, go to events, have trials on-farm and talk with other growers and agronomists. Then we talk about how these ideas fit with our systems and plan what we can do better."*

Driving innovation and the sharing of knowledge is the relative youthfulness of the industry, the good financial returns that have encouraged a willingness to share information, and an acceptance that good information is critical to successful change. New research by Plowman (2004, *Pers. Comm.*) has also identified these as key factors that place cotton as one of the most innovative rural industries in Australia currently. The grower culture is clearly one focussed upon innovation and trail-and-error learning.

Considerable information is available to growers and consultants. A major concern, among growers and consultants, was the need for the information to have been tested and applied to determine its relevance and applicability to specific regions. A number of farmers talked of "giving it the acid test", about "getting a real buzz" from on-farm trials, often "pushing the boundaries" by experimenting with different options and how their own trials and small experiments built up their confidence for larger changes.

### 3.3 Knowledge Pathways

The primary knowledge source for almost all growers was personal experience. The major other "people" sources were consultants, researchers and other growers. The major "resources" were trial data, field days, *Cotton Tales,* grower experiences and case studies. These are detailed in Table 1. Consultants indicated fairly similar preferences.

**Figure 1.** Relative importance of various information sources for irrigation.

| Resource | Most Important | Somewhat Important | Less Important |
|---|---|---|---|
| **People** | Researchers<br>Irrigation consultants<br>Other growers<br>Crop suppliers<br>Crop consultants<br>Other consultants | Farm staff<br>Bankers<br>Water suppliers<br>Other farmers<br>Family<br>Grower groups<br>Extension staff | Resellers<br>Chemical representatives<br>Spray contractors |
| **Resources** | Trial data<br>Field days<br>Cotton Tales*<br>Grower experience<br>Case Studies | Benchmarking<br>Legislation<br>Magazines<br>COTTONpaks^<br>Soil characteristics<br>Soil monitoring<br>Weather bureau<br>Decision support systems | Media<br>World Wide Web<br>Formal courses<br>Cotton conference<br>Knowledge research directory<br>BMP manual |

* ***CottonTales*** *are local, fax out newsletters prepared by the Cotton Industry Development Officer in each region. 1 pager, weekly-fortnightly*

^ ***COTTONpaks*** *are detailed compendiums of information about a given topic eg SOILpak, ENTOpak – a WATERpak is under development.*

Some observations about growers' means of developing their knowledge about irrigation can be made:

1. Growers like a mix of contact.
2. Growers are especially very positive about contact that is one-on-one.
3. A lot of information was seen to be too general and not tested for the climate, soil type and water quality of specific regions. Growers and consultants emphasised the value of greater grower/consultant/extension partnerships to conduct farm trials to deal with local concerns. Growers wanted to see more research being funded for their own region. They wanted region-specific trials rather than the research being done on an experimental farm in a region with quite different conditions.
4. Growers are clearly combining various sets of information over periods of 1 to 2 years to make their decisions.
5. Local papers or cotton-specific media (eg *Cotton Grower* magazine) were seen to be a more significant source of useful information than the larger media (eg *The Land*, newspaper articles). The media and magazines were especially useful to consultants.

6. Many farmers felt that there had been too many courses and too many meetings to transmit information.
7. Growers come together around tangible reasons (eg field trials, demonstration of a new technology).
8. Many consultants, growers, consultants and extension officers believed that there is a real shortage of experienced irrigation consultants, particularly consultants who can merge the agronomic and engineering aspects of water management.
9. Growers judged resellers as being less useful sources of information than consultants.
10. Consultants were by far the major "people" source of information for growers, and consultants also believed that this was the case.
11. Resources like *Cotton Tales*, *COTTONpaks* and magazines needed to shift their focus more towards water management.
12. While benchmarking was identified as a valued resource, growers felt that appropriate benchmarking was a highly complex and difficult task that needed to be managed for them by researchers and public providers. Consultants valued benchmarking as an activity more than did growers.
13. Growers called for short, concise information like in the form of dot-points that was relevant to what they needed at the time and that provided links to other information. Growers indicated that links to other information, including websites, could help growers to access and digest the relevant and trustworthy information from all that is available.

### *Experience*

There was a particularly strong emphasis on own experiences as a key knowledge source. Growers generally liked to try a new technology or practice and see how it went in terms of management, yield and economics.

> *"If my on-farm trial or another in my area is successful, I will possibly put in a field and then see what the results are. Cash flow finally determines if we implement this on a farm scale."*

The experiential learning was also reflected in a desire to know more about how growers had practically implemented a change in irrigation practice, the practical management and economics of that change. Case studies (written or field days) that outlined this experience of other growers were sought after.

### *Consultants*

Growers felt that consultants (irrigation, crop, other) were the dominant source of information. Many other growers shared this grower's point-of-view:

> *"My consultant is a major sounding board. He suggests that I go to field days to see what can be done, and helps me think through the changes. I have irrigation scheduling tools like C-probes to help my day-to-day decisions along with regular visits from my consultant. The consultant works closely with me in planning our crops."*

A consultant reported his relationship with his group of growers as follows:

> *"I have direct day-to-day contact. Because of the water restrictions with growers, we do a review at the start of the season, look at crop types, look at 'what ifs', and I work closely with growers during the season advising on water."*

Consultants tended to have long-term relationships with individual growers built upon a deep understanding of the grower's experience, risk profile, soil and water conditions, as well as high levels of trust based on many years of contact and in making good decisions with those farmers. Consultants were a key resource in terms of bringing into the decision-making framework for growers the experiences of other growers in similar regions and conditions with the same issues. At the same time, growers also emphasised how they worked independently, accessing research findings either directly from researchers by email/telephone/reading reports, or through getting the assistance of other consultants and extension officers.

In relation to irrigation, many growers were actively developing knowledge about irrigation management themselves. One consultant observed:

> *"As consultants, we find that growers are getting more sophisticated with water scheduling, C-probes and continuous recording of soil moisture. Consultants need to keep pace with growers who will lead the way now as they get their own data rather than us. Our task is now to problem-solve and brainstorm with them on the alternatives they might consider to maximise dollar returns per hectare."*

### *Field days*

As grower experience was a core resource, field days that showcased grower experiences were considered valuable. They were seen as a great opportunity for growers to share their experiences, and to hear and most importantly to see what else was possible. There was a clear preference for short (2 hours to half a day), informal field days that focussed on 1 or 2 issues in detail and gave an

opportunity to looks at other growers systems and the application of research. One grower explained the impact of his experiences from a field day as follows:

> *"Here is an example of how a field day changed my mind. After going to a field day and hearing an irrigation consultant, and seeing results, I made some changes almost straight away. I split a field in half, and compared one siphon and two siphons. The whole farm went to two siphons. An improvement of about a bale to half bale has meant I've stayed with the new system."*

Interestingly, some growers who indicated a preference for field days had not attended their recent regional field days. Reasons for this were described as a preference for short field days or farm walks (1-2 hours) that were held nearby and covered only one or two topics. Full day events, drinks and the related social activities were not considered necessary and were too time consuming.

### *Information Resources*

Both growers and consultants made variable comment about the amount of information available. Some felt that there was information overload whilst others felt that more information was needed. There was a high demand from growers for extension services to help by sorting the vast amount of information available to present short, concise, timely, locally relevant summaries *"just the dot-points on 1 page"*. CottonTales were considered to be a good format for this that could have more irrigation content and also provide links to other, trusted sources of information.

There was some call for more readily accessible information about water. WATERpak is currently under development and will meet some of this need.

### *Cotton Conference*

There was a lot of comment by growers about the value of the Cotton Conference held every two years, and many felt this and the proceedings were a great source of information and ideas. At the same time there was some concern about the style of the most recent conference, and its immediate value for growers. A grower explained his concerns:

> *"The cotton conference has been a great source of information. However, I feel that the conference is drifting from research findings, and a different sort of conference strictly focused on research would be useful."*

### *Groups*

Many farmers mentioned the value of grower groups. Several commented that the groups that had been meeting to discuss IPM (eg Area Wide Management groups) were now focussing more on

discussing water management issues. There was a feeling that groups could more purposively address water issues, particularly as some AWM groups had not been active over the past season due to the reduced area of cotton, low pest pressure or other reasons. This was particularly so for those groups that viewed themselves as solely IPM groups.

> *"I see great benefit in getting grower groups together to discuss irrigation methods. We have done this in the past and it has been quite effective. You get a good response from growers because they are the ones who are most interested."*

Another reported:

> *"We are currently doing benchmarking as part of a grower group. It is working quite well. So far 87 paddocks have been benchmarked. Grower groups with more field days, trials and benchmarking linked into them, are a good way to go in getting and applying new information."*

### *Decision Support Tools*

HydroLOGIC had been launched in the season of this study. It was not widely mentioned but some growers did comment that they had seen increasing value in using simulation models to aid their thinking. They referred particularly to the use of crop models to aid in deciding planting area for the water available. Workshops by researchers early in the season using crop models for this purpose were considered very helpful by the few who mentioned them.

There was also interest in climate forecasting tools – particularly if these could be integrated with other water management tools.

## 3.4 What influences decisions?

In addition to the water reform process that is shaping the context within which growers and consultants are making decisions, other factors influence decisions. Personal experience and that of other growers, particularly in the local region, was a prime factor in decision-making. Decisions were made over a period of time of building up ideas. One grower described it as:

> *"My decision-making usually takes about a season or two. I let the idea take shape in my mind, and before discussing it with anyone. I look for evidence from local and international research, using magazines, CDs and the internet. I then discuss this idea with my consultant and agronomist to get their feedback. I might also pick up feedback at growers' meetings, but not always."*

Another talked about his decisions as follows:

*"Our decision-making about planting takes time and preparation. Everything is prepared throughout winter to ensure we could plant everything if water becomes available. Country that came out of fallow was planted solid, and country that had a crop was planted double skip to hedge bets and make the decisions a bit safer. In the end there was no water from the river and we had to rely on bore. This reliance on bore ultimately limited what we could do."*

The driving forces for positive actions to improve water efficiency are:

- evidence of the benefits of a new practice, technology or strategy based on the findings or facts from in-house and outside trials and experimentation on their farm or other farms;
- cutbacks in water availability;
- the drive to continue to gain the best financial return for a farm, and now that pest management was thought to be under control, the focus was upon maximising returns through reducing the management costs per megalitre of water;
- the long-term sustainability of the farm and the soil;
- the support, advice and experience of their consultant agronomist;
- the need to save labour costs associated with irrigation;
- the introduction of neutron probes and other scheduling tools.

The barriers to changing practices are the lack of practical evidence that the changes will actually work on their farms, and the financial and labour costs of introducing new technologies and farming practices.

Whilst information was gathered over a period of time and experiences built up through trials, a key impetus or crisis was a strong driver in actually implementing changes in practices. In reference to the severe water restrictions caused by the drought, a comment was made:

*"We've talked about WUE for 2 years but last season we really had to do something about it."*

### 3.5 Role of public and private service providers

A key observation to make here was that, at least in relation to irrigation, growers themselves are playing a key role in generating information and knowledge, as described above.

Growers saw the research and extension (public) role as being about identifying growers' needs, and to get research completed and communicated back to growers to address their needs about irrigated crops and related issues. Consultants saw the role about commissioning research and communicating it back to the industry, with the implication that the consultant's role was more about identifying

growers' needs than it was for the public provider. Consultants believed that they played a more hands-on role or day-to-day role in working with the grower to decide and to implement the crop and water management strategies for the season. At the same time, growers expected to see a cooperative relationship between consultants and extension. In general, growers and consultants felt that there was a lot of cooperation though the sharing of materials and knowledge between research and extension providers and consultants.

> *"I see the public/industry extension role to be about getting data out and communicating this out to all of us. The private role is to get these messages out to the growers through one-on-one contact. The challenge is that we need to be more confident about the usefulness of the outcomes from research to be convinced that we can use it."*

Another opportunity for cooperation between extension and consultants was in the organisation of benchmarking. Working together, it was felt that public and private providers could drive more opportunities for benchmarking that combined public funds and private sponsorship, with grower groups being central to these benchmarking partnerships. As one consultant commented:

> *"We need to work together by doing field trials on farms, like case studies and benchmarking. By working together, consultants have all of the information, and can exchange with extension staff to write it up and put it out there."*

New and emerging issues were seen to benefit from extension work in developing local understanding, undertaking trials and benchmarking, and communication of findings to raise awareness on an issue. Some growers and extension staff indicated that once "the ball gets rolling" then consultants would provide the services and day-to-day support needed for growers to manage it, driven by both growers and consultants. Depending on the issue, this may take a year or two of extension input to develop the understanding and the capacity in the local industry. The focus of extension tended to be more about the bigger issues facing the industry.

> *"Extension tends to work on the issue until it gets its own legs and then we move on to another issue. We tend to focus upon the bigger picture rather than the nitty gritty that consultants work with. Once an issue gets its own steam than we are able to cut back and move onto other issues, and other information as it becomes available"*

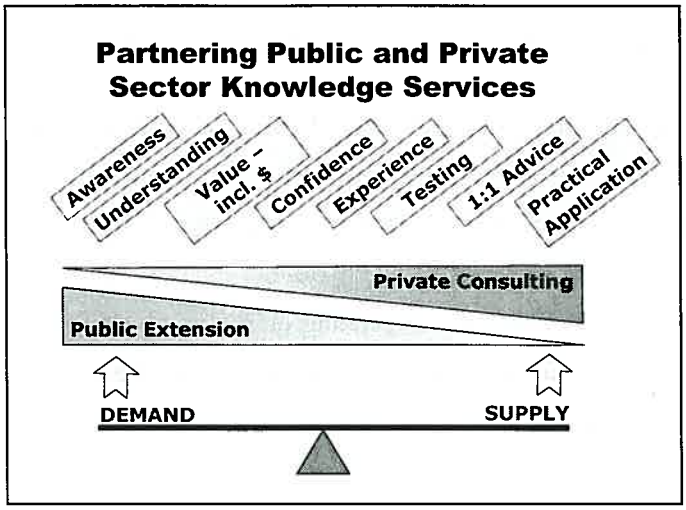
Most consultants have focussed primarily on pest and crop management and have their strongest skills in pest monitoring and management. Due largely to Bollgard®II, consultants are looking for other services that they can provide to maintain the viability of their business. For this reason, many are keen to develop irrigation and nutrition as a part of their consulting service. However, may do not currently have the skills for this and will either recruit the skills or require training to develop

these skills. The Cotton CRC's Cotton Production Course was frequently mentioned as a key way to develop skills and the Cotton CRC would be well placed to deliver irrigation training for consultants.

It is envisaged that there will be a need for several levels of consulting expertise in optimising irrigation – the highly specialised irrigation design engineers such as are currently operating in some regions of the industry complemented by agronomic irrigation consultants. Some growers stressed the need to merge both engineering and agronomic considerations, and believed the agronomic aspects of irrigation management were currently lacking in the industry.

Participants in the stakeholder workshop concluded that "extension" includes both public and private sector services. To ensure that growers have access to skilled consulting services in irrigation, the public and private sectors can work in close partnership to build both the demand for and supply of these services. That is, the research and extension (R&E) sector focuses on raising awareness and demonstrating the value of improved water management practices (Figure 1) and in developing, testing and demonstrating new technologies. Parallel to this is the need to attract specialised irrigation skills to the industry or deliver training to up-skill existing consultants to deliver irrigation services. Both the supply and demand will need to be built in parallel as depicted in Figure 1.

**Figure 1.** Partnering public and private sector services to meet industry needs for optimising irrigation management.




### 3.6 Further research, development and extension needs

Growers, consultants and suppliers identified a long list of issues that they felt required more in-depth research. Common to their lists were water scheduling, production and efficiency figures for different irrigation systems, salinity management, loss of water research and waterlogging.

Several people stressed that WUE is about managing the whole system well – not just making changes to a few small parts of the system. They stressed that optimising yield per megalitre

required careful management of the whole crop and farm as a system. Understanding how to manage WUE in a Bollgard®II crop was one example.

Research needs to be locally tested and demonstrated to be practical. Much information comes from the experience of growers and consultants, and there needs to be a two-way flow with research. There was a clear need for demonstrated benefits of new technologies. Growers in particular were wary of "making change for change sake", particularly where they had seen other growers invest in new equipment such as a lateral move and later abandon this.

> *"If it is not going to give me an extra quarter of a bale or more per hectare, I won't bother. You need to show me the evidence that changes will make a real difference."*

## 4.0 Where to?

The current knowledge pathways in the cotton industry relies very much on growers and consultants developing their experience. Through trial and development growers and consultants are testing new ideas and figuring out how they may apply in their situation. This pattern has worked well for incremental gains in water management and for many other aspects of cotton crop management. There are some obvious challenges with this model where substantial system changes are needed, such as investment in a new irrigation system. Extension strategies are needed that provide some form of experiential learning for these major changes. This may include communication of other grower's experiences or the use of simulation tools.

Any extension package for irrigation management needs to include a variety of mechanisms to suit the varied preferences across the industry. Clear, concise, practical information is needed, backed up with more detailed information, examples of practical application and economic analysis. Both static information and interactive opportunities are needed for all sectors to develop their understanding and to share tacit knowledge. Partnering with private consultants is a key part of the system.

On the recommendation of the steering committee, an irrigation knowledge system is now being developed by the Cotton CRC in partnership with the CRC Irrigation Futures. This project will be funded in part by the National Program for Sustainable Irrigation for the initial 2 years. This will provide a "one-stop shop" for growers, consultants, extension and irrigation suppliers to access information and training about irrigation management. This will include print and internet resources, direct contact with irrigation specialists and researchers, case studies of on-farm experiences and training. Step-wise training modules, to be offered in regional centres, will provide growers and consultants with varying levels and options for training. A system for accrediting skilled irrigation consultants will be investigated together with the Irrigation Association of Australia (IAA) and other relevant groups.

As growers are clearly ready to choose a variety of irrigated crops, it is important that the irrigation management effort is approached as an "irrigation industry" rather than solely the cotton industry. By developing this irrigation knowledge service with CRC Irrigation Futures (CRC IF), the Cotton CRC is taking a lead in developing this "irrigation industry" focus as well as ensuring that the cotton industry has close interaction with the research from CRC IF. This irrigation knowledge model will be developed further and evaluated. If successful, this model may de developed in other regions of Australia by the CRC IF – which will enhance the flow of information about irrigation management and critical issues for irrigation between industries and regions.

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