FAQI

Flower Association of Queensland Inc.

Final Report

South East Queensland Irrigation Futures Program

Sam Plant

Industry Development Officer

Flower Association of Queensland Inc.

May 2009

Final Report SEQ-IF

Researcher Contact Details

Name: Sam Plant
Address: PO Box 327
Cleveland, Queensland
Phone: 07 3824 9579

FAQI Contact Details

Flower Association of Queensland Inc.
PO Box 327
Cleveland, Queensland
Phone: 07 3824 9537
Fax: 07 3286 3094

Email: faqi@flowersqueensland.asn.au
Web: www.flowersqueensland.asn.au

Abbreviations

AHGA	Australian Hydroponic and Greenhouse Association
BWEP	Business Water Efficiency Program
DPI&F	Department of Primary Industries and Fisheries (now part of Department of Employment, Economic Development and Innovation)
FAQI	Flower Association of Queensland Inc.
FMS	Farm management system
IAA	Irrigation Association of Australia
IDO	Industry development officer
IPART	Irrigation performance and recording tool
IPERT	Irrigation pump evaluation recording tool
IPM	Integrated pest management
NCEA	National Centre for Engineering in Agriculture
NRW	Department of Natural Resources and Water (now part of Department of Environment and Resource Management)
OCP	Organic Crop Protectants
R&D	Research and development
RWUE	Rural Water Use Efficiency
SEQ	South East Queensland
SEQ-C	South East Queensland Catchments
SEQ-IF	South East Queensland Irrigation Futures
WUE	Water use efficiency

Table of contents

Industry article
Budgetary and costing information
Report by Samuel Plant: The relationship between previous years rainfall totals and yield of protea 'Pink Ice'
Report by Rachel Poulter and Sam Plant: Investigation of the efficacy of the CalClear water conditioner

List of tables

List of figures

Executive summary

The Queensland Government has committed funds to the South East Queensland Irrigation Futures (SEQ-IF) program to improve the efficiency and off-farm impacts of irrigation in the region. SEQ-IF, which is a rural water-use efficiency project, is a partnership between the Department of Natural Resources and Water (NRW) and the major rural industries engaged in irrigation in the region (Queensland Government, http://www.nrw.qld.gov.au/rwue/seqif.html).

The Flower Association of Queensland Inc. (FAQI) has found the SEQ-IF project to be an excellent initiative, with many water use efficiency (WUE) benefits to the cut flower and foliage industry to date. There is potential for much more work to be done to maximise the return on the government investment and build on the framework established over the last three years. The ultimate aim is to build a dynamic, profitable and sustainable floriculture industry through grower adoption of best irrigation management practices.

Outcomes of the project of particular importance have included the skills and knowledge capability developed by the industry development officers (IDO) and the benefits resulting from the on-farm extension services. FAQI has supported the SEQ-IF and Rural Water Use Efficiency (RWUE(3)) programs with a range of other initiatives, including a research and development program, the collective purchase of irrigation scheduling and other necessary equipment, field demonstrations, irrigation system efficiency assessments, field trials and workshops, extension services and the development of information packages.

As a result of interactions with other IDOs, it became apparent that the flower industry had a lower level of baseline knowledge regarding the water requirements of crops and how to irrigate crops, compared to other industries such as cotton, dairy, sugar and vegetables. It was also noted that the flower industry consisted of two distinct sectors: the native industry and the traditional protected cropping sector. The crops in each of these sectors require very different irrigation management systems.

One of the aims of the project was for FAQI to participate in the farm management system (FMS) program. As a result of this involvement, FAQI made a business decision to not only focus on the irrigation management elements of the FMS, but to develop an FMS model for the cut flower and foliage industry, which will eventually be rolled out nationally and possibly certified. This is an important outcome, since FMS will play a key role in the future development of efficient, sustainable farming systems that responsibly use natural resources. The SEQ-IF elements of the FMS have been trialed throughout the development phase at

SEQ-IF workshops and seminars and updated as required. The irrigation management section of the program has already been adopted by growers, with reports of increased WUE. The complete FMS program has been in the project preparation stage for two years and is due to be launched in 2009.

The project has been highly successful, with many achievements in grower education, improved water management practices and examples of increased WUE. Some of these successes are summarized as follows.

- Multiple trials were instigated to evaluate irrigation equipment of potential benefit to the flower industry. These technologies should reduce the chance of crops being inappropriately watered, avoiding inferior plant growth and water wastage.

- Numerous field days and grower discussions have taken place, to open communications related to irrigation management and develop strong networks to support ongoing system improvements. Overall, 70% of producers and relevant commercial operators have been directly involved in WUE training, demonstrations, incentives and farm activities.

- Fact sheets, e-bulletins, brochures, magazine articles, quarterly updates and website information have all been well received by the growers and have maintained their knowledge of project progress and outcomes. As a result, 90% of industry enterprises in the region have received information about improving WUE.

- Significant WUE improvements have been reported by select growers, and improvements have been made regarding their general knowledge regarding the water use requirements of their crops. For example, two growers reported a reduction in their water use by as much as 50 per cent through the installation of new irrigation equipment and monitoring tools, setting a benchmark for other growers.

- The SEQ-IF module of the FMS program has seen the involvement of 20% of enterprises, and 30% of growers were involved in addressing NRW priority issues.

As a result of the SEQ-IF initiative and the findings of the research, a number of key recommendations can be made, as outlined below.

- Given the extensive rooting system of most of the flower crops investigated in the SEQ-IF project, only about 10 to 20 per cent of the rooting zone is being wetted up by the irrigation system, which is unlikely to generate as much growth response compared to growth

during rainfall periods. Future work should focus on the possibility of generating a growth response by using either under-tree sprinklers or multiple drip lines.

- A few growers have started to recycle all drainage water with the assistance of the Business Water Efficiency Program (BWEP), which was aimed at assisting growers to reduce their reliance on potable water supplies. The potential for water savings is large for this sector of the industry, but the cost and complexity is high, and FAQI needs to assist growers to adopt these kinds of practices in the next phase of the project.

- Compared with irrigation methods used in other industries, the systems of our growers have reasonable uniformity. However, it is believed that over the next 12 to18 months, many more evaluations should be conducted. This will highlight to the growers the need for regular maintenance, and the importance of system monitoring to ensure their irrigations systems are running as well as possible.

- In the ongoing development of the FMS, it is important to continue to engage with industry, NRW groups and additional flower producers. Advocates for the program should be found, to develop momentum in the process and assist in the future adoption of FMS. Further workshops on FMS should be held, including at the native flower conference.

- Working with the growers has also revealed that the problems in greenhouses are 99 per cent water related, through pest infestation, mould, viruses, humidity control and media moisture. Little research has been done in the flower industry in Australia to date into these issues, and these are key areas for future investigation.

- Further collaborative projects have resulted from this project, including the Department of Primary Industries & Fisheries (DPI&F) project *Determining irrigation scheduling for key wildflower crops.* There is also a funding application currently being prepared for the project *Positioning the Queensland cut flower industry to strategically respond to the impact of climate change*.

In summary, the project has provided many valuable outcomes. It has represented much time and effort in the discovery of up-to-date industry information and the training of FAQI staff and flower growers in the use of new relevant technologies. The training in new skills and technologies will provide guaranteed future benefits to the industry. These efforts will be of reduced value if the project finishes in June 2009, since ongoing industry collaboration is required to ensure adoption and to see the project results eventuate into widespread economic and resource savings.

Summary of milestone achievements

Targets	Achievements
90% of industry enterprises in the region to receive information about improving water use efficiency (WUE)	Through SEQ-IF updates every 3 months, the SEQ-IF video, fact sheets created by IDOs, seminars, the industry magazine, regular farm visits and the website, more than 90% of industry enterprises have received information. More visits are planned to disseminate information to more of the smaller growers.
70% of producers and relevant commercial operators to be directly involved in WUE training, demonstrations, incentives and/or on-farm activities	More than 70% of growers have been directly involved through attending soils, water quality and FMS workshops, attending grower seminars such as the Native Flower Seminar, participating in on-farm trials demonstrating monitoring and control equipment, working with IDOs to access BWEP subsidies, participating in on-farm irrigation evaluations and discussions, and receiving monthly e-bulletins and the quarterly magazine.
40% of producers and relevant commercial operators to be directly involved in SEQ-IF activities	Over 40% of producers have been involved in SEQ-IF activities through regular farm visits, attendance at native and traditional flower seminars, involvement in water meter monitoring, attendance at workshops held in a number of SEQ locations, and on-farm measurement of plant growth and crop water usage.
10% improvement in WUE to be achieved	In SEQ, 6 of the larger growers and the industry's biggest water users have reduced their reliance on the municipal supply by more than 40% through recycling, catching rainwater and monitoring leachate from their growing systems. Other growers are continuing to improve their scheduling through on-farm monitoring. It is estimated that more than a 10% improvement in WUE has been achieved by the hydroponic growers. With the native and other in-ground growers, there has been an improvement in WUE by improving scheduling and better understanding of crop water use throughout the soil profile. With improved rainfall, irrigation on native farms has been reduced to fertigation only in many cases, reducing total irritation water applied by more than 10%.
20% of enterprises to participate in farm management system (FMS) program	Work is nearing completion on the development of an FMS program. A checklist has been created and growers have attended 3 workshops specifically on FMS to fine-tune the program. Growers have been surprisingly open to the idea of FMS and see it as a positive step towards sustainability. The 3 FMS workshops were held in Nambour (21 FAQI growers attended), Toowoomba (16 FAQI growers attended) and Cleveland (10 FAQI growers attended). This represents more than 15% of enterprises in SEQ that have participated in the FMS. Further development is being undertaken by the PMSI officer that was appointed 3 months ago. She has met with growers on some of the farm visits and will be attending future water workshops, seminars and meetings to assist growers in implementing the FMS program.
30% of growers to be involved in addressing NRW priority issues	Testing of on-farm irrigation water storage as well as drainage (waste water) monitoring for EC (electrical conductivity), pH, nitrates, phosphates and alkalinity are being carried out on farm visits. Fact sheets have been created on water recycling and disinfestation, scheduling with tensiometers, interpreting water analysis, the effect of water quality on plants, sampling water for quality testing, and water testing services for Qld growers. A trial is being drafted in which we will work with 15 hydroponic growers in SEQ to test their irrigation feed water, drain water and water after disinfestation to give growers and industry a better understanding of nutrient trends within closed systems. This will lead to reduced loss of nutrients into the surrounding environments.

Introduction and background

The Flower Association of Queensland Inc. (FAQI) was formed in 1988 and commenced its role as the peak industry organisation for the Queensland cut flower industry in 1998. FAQI membership includes cut flower growers, grower groups and allied traders (i.e. businesses associated with the cut flower industry, including input supply companies, florists, wholesalers and exporters).

The vision of FAQI is to develop and maintain a sustainable, profitable and efficient flower production and marketing industry, which is commercially focused and works successfully with other stakeholders to expand domestic and export demand for its products. The vision of FAQI is linked to the goals of the Department of Natural Resources and Water (NRW) of enhanced community benefit through sustainable resource management.

The South East Queensland Irrigation Futures (SEQ-IF) initiative was developed with the aim to encourage growers to use strategies to manage water efficiently on-farm and to manage environmental impacts. As part of the SEQ-IF initiative, the Department of Natural Resources and Water (NRW) has been working in partnership with five major irrigation industry groups to deliver the program, including FAQI. The process recognises that industry and government need to work together to improve the use and management of available irrigation water, thereby making Queensland's rural industries more competitive, profitable and environmentally sustainable.

The three-year SEQ-IF program has aimed to help irrigators to meet the challenges of water reform, increasing their ability to compete for water supplies and to achieve sustainable environmental management. To meet this aim, the flower industry has agreed to targets in water-use efficiency improvements through the implementation of better irrigation and water management practices.

The project has involved identifying growers and updating the existing industry database, visiting growers, monitoring irrigation methods and plant measurements, and engaging in on-farm observations. Farm observations have revealed that the industry can achieve further water use efficiencies by using new technology to perform on-site irrigation evaluations, thereby demonstrating to growers the inefficiencies in their current activities and what they need to do to ensure business sustainability and obtain optimal flower stem quality.

Program overview

Project participants

This project was developed by the Flower Association of Queensland Inc. (FAQI) for implementation by the industry development officer (IDO), Sam Plant, with assistance and support from other FAQI staff. Additional support was provided by staff of the Department of Primary Industries and Fisheries (DPI&F).

The on-farm observations and data collection were achieved with the collaboration and assistance of the growers who kindly agreed to participate in the project.

Project activities and methods

Over the course of the last three years, project activities have included updating the grower database, identifying the number of growers in the industry and systematically visiting growers to determine what type of assistance they required to improve their on-farm water efficiencies.

The IDO spent time and resources provided by NRW and FAQI to observe the existing situation in the industry and to gain knowledge in order to move forward in helping growers achieve a better water use efficiency (WUE) for their farms. Throughout the project, equipment was purchased to accommodate both in-ground and traditional irrigation requirements. The irrigation system requirements were more advanced for traditional flowers than for in-ground production.

Industry leaders or 'champions' were identified in both the native industry and traditional protected cropping industries. Enviroscan® equipment was installed to observe crop trends and the depth of irrigation. Changes to farm practices were made as crop water use trends became apparent.

The IDO also spent time researching the international industry and attending seminars for information regarding water efficiency measures for optimal plant growth. Trial results were documented and the industry constantly updated on the findings of the project, via 20 published reports and fact sheets, organised workshops, farm walks and seminars, FAQI e-bulletins, SEQ-IF updates, articles published in the Australian Flower Industry magazine, and information on the FAQI website.

An important part of the project was the education and training of the IDO in the latest knowledge and technology in the field of irrigation management, particularly as new tools

were developed by other stakeholders in the project. This was critical in order to identify the latest and cutting-edge developments in the field, and to determine which tools were of potential application and benefit in the flower industry, both now and in the future.

Key achievements: highlights

Flower grower database

At the beginning of the project in January 2007, the FAQI database contained details for 215 flower growers in South East Queensland (SEQ). One of the initial aims of the project was to locate all the growers in the region, introduce them to the project and update the database.

Over the first 6 to 8 months, 90 per cent of the growers were contacted and the IDO began to build a relationship with them, which was critical for the continued progress of the project. As a result of the drought, the strong dollar impeding exports and an aging demographic amongst flower growers, the true number of active growers in SEQ had dropped from over 200 to around 100. Some new small growers have recently entered the market, so there are likely to be more growers added to the database over the next 12 months. The previous database had people listed who had not grown flowers in more than 15 years, so considerable work was needed to check and update the list. The database shows there is a fairly even split between wildflower growers and greenhouse growers (Table 1), with more than 150 different flower crops grown in total. The total area of production was much higher in the wildflower industry and there was less knowledge of plant water requirements, compared with the more intensive greenhouse industry. As a result of this finding, the FAQI Executive Committee suggested that initial work should focus on assisting the wildflower sector in the initial phase of the contract.

Table 1. Statistics on active flower growers

Type of flower grower	1990s grower database	Current grower database
Wildflower growers (Australian and South African natives)	91	43
Traditional growers (greenhouse, hydroponic and soil-grown crops, including roses and gerberas)	124	53
Total growers in South East Queensland	215	96

Water use data collection

Water meters

It was established early in the project that not much was known about how much water is used by flower growers. Even less was known about the water requirements of particular species, especially for wildflower crops. To address this lack of information, the IDO initiated a number of trials and monitoring projects using funding from NRW.

Water meters were installed at major flower-producing farms to benchmark the amount of water being used annually on some of the major crops. This provided an estimation of the amount of water being used per plant by the growers. This baseline data was essential to show where water was being saved throughout the duration of the project. Forty-three water meters were installed on 27 flower farms. In some cases more than one meter was needed, due to the use of multiple water sources (Table 2).

Monitoring wildflower crops

The native and wildflower industry sector had many gaps in knowledge regarding the water requirements of the crops grown. In order to improve irrigation of these crops, it was important to determine what the growers were doing and what was currently known in relation to irrigation scheduling. There was considerable variation in the irrigation practices being used by growers; some never irrigated, and others irrigated regularly. With the assistance of FAQI, David Hunt from the DPI conducted a literature review to determine what was known and what research had been done on the water requirements for these crops, including the Australian and South African natives. The literature review is presented at the end of this report in the section for supporting documents. The review of the literature confirmed that there was limited information available, and that to assist in improving the WUE for these crops, a number of farm monitoring trials would need to be conducted to determine crop responses to irrigation.

Another way to determine water requirements is to investigate the yield data for a non-irrigated crop over a period of years. Comprehensive harvest records over 14 years were obtained from a ‘Pink Ice’ protea grower whose farm had never been irrigated. By using harvest records and accessing local climate and rainfall records, conclusions were drawn regarding how much rainfall was needed to produce a quality crop for that region and soil type.

Through the SEQ-IF project, instruments were purchased that were appropriate for use in wildflower crops. Using an Enviroscan®, information was obtained on how much water

these crops require and from what depth they can access water. The Enviroscan® gave the researchers and growers an intimate look at the positions from which the plants were extracting water, and how much was being consumed at various stages in crop development. This data was combined with stem growth measurements every two weeks to ascertain when crop growth was taking place, which in turn would indicate the most appropriate times of the year to irrigate for quality flowers in the future.

Wildflower crops were found to require much less irrigation water per plant compared to greenhouse crops, mainly due to regular rainfall events and much different management protocols. With rainfall taken into consideration, approximately 4 to 6 ml/hectare/year is needed for good production. Each protea or NSW christmas bush plant consumes between 3 and 9 ml per day, depending on crop stage and age/size of the plant. Due to the drought, irrigation on wildflower farms was minimal; however, growers would have irrigated much more if the water had been available. Most of these native and wildflower crops are usually grown in soil that has more than a metre of depth, and the plants were found to access that water quite easily. This means they can tolerant longer periods of drought and are less reliant on regular irrigation compared to most crops. In fact, using various irrigation strategies and by taking weekly and sometimes monthly stem growth measurements, it was noted that when growers irrigate, there is minimal response compared to the response to rainfall. This is most likely due to the drip irrigation systems that are used on these farms, often with only one or two drippers per plant. Given the extensive rooting system of most of these crops, only about 10 to 20 per cent of the rooting zone is being wetted up by the irrigation system, which is unlikely to generate as much growth response compared to growth during rainfall periods. As a result of this key finding, it was concluded that future work should focus on the possibility of generating a growth response by using either under-tree sprinklers or multiple drip lines.

Recently an RIRDC project has been initiated to determine the optimum irrigation strategies for two key wildflower crops over the next few seasons. The aim is to map growth and water use of NSW christmas bush and protea ‘Pink Ice’ plants in different regions to better understand when growers should irrigate and how much water to apply.

Monitoring greenhouse crops

Benchmarking total water use in greenhouse crops was an easier process, because the water plants receive in a greenhouse is restricted to irrigation water, as compared to crops grown outside in soil environments which are exposed to rainfall events.

Due to variances in climate, structures, growing media, size of operation, water quality, crop variety and grower practices, water use of roses varied from about 500 ml to

900 ml per plant per day. Gerberas and lilies used a little less at around 300 ml to 500 ml per plant per day. Most hydroponic growers aim for about 30% leachate, but some growers are getting close to 50% and others only 10%. This practice avoids the build-up of excessive salts around the root system. More work needs to be done with growers to understand why there is such variability in practices from one grower to the next. There could be quite a substantial saving in water, nutrients and energy, as well as improved production, if a best practice scenario can be established. There are tools available to assist growers in managing this issue and there are a few growers who have started to adopt this technology.

Hydroponic crops are generally grown in structures and are therefore sheltered from rainfall. Growers irrigate daily, often up to six or seven times a day. Most growers irrigate to a 20-30% leachate factor, which means if they give a plant 1 litre per day, about 200 to 300 ml of water will pass by the root system and go to waste. This water, which is high in nutrient levels, had traditionally been wasted; however, most growers now use this water to irrigate pasture or other soil-grown crops. It was calculated that if this water was completely recycled, the greenhouse flower industry could save about 30 per cent of the water used on farm, not to mention the fertiliser savings.

A few growers have started to recycle all drainage water with the assistance of the Business Water Efficiency Program (BWEP), which was aimed at assisting growers to reduce their reliance on potable water supplies. The reason there has not been a larger uptake of this is due to the complexity and expense of installing the correct equipment, the relatively cheap water available to growers, and the extra management needed to avoid potentially expensive mistakes. The potential for water savings is large for this sector of the industry, but the cost and complexity is high, and FAQI needs to assist growers to adopt these kinds of practices in the next phase of the project.

There are a number of products that claim to treat water and kill pathogens. Growers in Queensland are using a variety of methods including UV (ultra-violet radiation), iodine, ozone, chlorine and chlorine dioxide. There is a big variance in initial set-up and running costs of these technologies, and significant workplace safety issues in some cases. FAQI plans on looking more closely at this subject in the next phase of the project, to develop relevant information for growers on the costs and effectiveness of the different treatments.

Table 2. Statistics on flower growing farms and total water use

Grower location (main crop); hydroponics or soil-grown	Production area (m^2)	Number of plants	Total water used (ML)
Greenhouse/traditional crops			
Sunshine Coast (carnations); hydroponics	**3,150**	**18,000**	**5.773**
Lockyer Valley (roses/gerbera); hydroponics	**6,000**	**35,000**	**5.336**
Lockyer Valley (roses), soil-grown	**1,100**	**6,000**	**1.1**
Sunshine Coast (mixed); soil-grown in shade structure	**80,000**	**n/a**	**1.762**
Sunshine Coast (roses); hydroponics	**3,200**	**16,000**	**5.6**
Toowoomba Range (orchids); hydroponics	**800**	**5,000**	**1.1**
Sunshine Coast (lilies); hydroponics	**15,000**	**n/a**	**7.3**
Ipswich (roses/gerbera); hydroponics	**11,000**	**60,000**	**11**
Redland Shire (mixed); soil-grown	**21,000**	**n/a**	**19**
Sunshine Coast (roses); hydroponics	**2,000**	**16,000**	**4.25**
Beaudesert Region (roses); hydroponics	**2,000**	**16,000**	**4.6**
Wildflower crops (in-ground)			
Toowoomba Range (protea species)	**16,000**	**1,000**	**0.24**
Toowoomba Range (waxflower)	**220,000**	**14,000**	**0.87**
Maleny (NSW christmas bush)	**48,000**	**5,500**	**0.18**
Sunshine Coast (NSW christmas bush, kangaroo paw, leucadendron)	**13,000**	**n/a**	**0.79**
Brisbane Ranges (NSW christmas bush)	**10,000**	**800**	**0.08**
Esk (protea)	**50,000**	**6000**	**0.95**

Determining crop response to irrigation

Monitoring trials

Enviroscan®

To address the lack of information on plant irrigation requirements, Enviroscan® probes were installed for a number of key crops, including *Chamelaucium uncinatum* (geraldton wax), *Stenocarpus* 'Forest Lace', *Protea cynaroides* (king protea), *Protea neriifolia x susannae* 'Pink Ice', *Ceratopetalum gummiferum* (NSW christmas bush) and *Leucospermum* 'Dancer'. Water use and depth of water uptake was monitored with the Enviroscan® moisture probes and by measuring stem growth every two weeks to assess crop response to irrigation and rainfall events. The crops' growth responses to irrigation versus rainfall activity were monitored over a 24-month period.

It was quite surprising to find that there is often very little growth in the established trees from irrigation compared to rainfall events; however, when the plants are young, there was a more predictable response. The crops can access water to a depth of more than a metre, which is probably because they had to evolve to take full advantage of erratic rainfall events in their native environments. Although this is an advantage for survival during times of drought, it is also a disadvantage when trying to manipulate growth through irrigation. Future work should look at increasing the area wetted by the irrigation system so that most of the row is wetted up, in contrast to small wetted areas a metre or so apart. Under-tree sprinklers or multiple drip lines per row with dripper spacings of 30 cm should be investigated.

Phytech

To assist greenhouse flower growers to improve irrigation scheduling, the project had to extend beyond the use of moisture sensors. Two phytomonitoring units from Phytech Israel were purchased, each consisting of sensors to measure a number of parameters. Temperature, humidity, solar radiation, soil moisture and stem diameter growth were all measured and logged every ten minutes, with the aim to look at rose plant growth responses to a number of regular changes. With this information it could be determined if soil moisture levels or climate were limiting factors to stem growth, and the irrigation scheduling could be fine-tuned to maximise stem growth.

Smart controllers

One way to improve WUE is to improve irrigation scheduling. There are often periods throughout the growth of a crop where the crop is under water stress as a result of inadequate scheduling. Scheduling can be improved with the use of tensiometers and

Enviroscan®-type monitoring equipment, which can give growers an indication of when the crop is under stress and therefore ready to be irrigated. The only issue with this method is that if the grower is not there to turn on the irrigation, the crop will start to become stressed immediately, causing reductions in yield, stem length and quality.

Various smart controllers were reviewed in the project, and some were identified that could potentially reduce flower crop stress by implementing and delaying irrigations until required by the plants, if the technology is adopted by industry.

Acclima Closed Loop®

An irrigation controller can be used to automate irrigations. The only issue with most controllers is that they operate based on time, so growers must schedule irrigations based on a time factor or based on the previous day's evaporation numbers, which is not accurate enough for intensive crops. The Acclima Closed Loop® system uses soil moisture sensors, which also monitor soil temperature and soil electrical conductivity (EC) or salts, to initiate or delay irrigations. The system is not the only one available, but it had many unique and useful features. Initially it was tested on oriental lilies in a pine bark growing medium and proved to be a very useful controller. The temperature and moisture readings were extremely accurate; however, the EC values were not. This was due to the relatively poor contact between soil and sensor in the pine bark mix. Nonetheless, the grower much preferred the Acclima controller to the conventional scheduling technique. The data showed the crop media was maintained in an optimum range throughout the growth cycle, whereas the grower-controlled zone had a greater variance in moisture trends from one week to the next.

As most greenhouse crops are not exposed to rainfall events, it was decided after the initial trial on lilies that this technology may be even better suited to soil-grown crops that are exposed to rainfall. The decision was made to install the controller at a new native flower farm north of Brisbane. The system was installed in four irrigation zones for four crops: *Ceratopetalum gummiferum* (NSW christmas bush), dianella, *Banksia plagiocarpa* (Hinchinbrook banksia) and flowering gum.

Over the past six months, the system has been logging and implementing irrigations. However, due to adequate rainfall since installation, the controller has only implemented irrigation a few times. This highlights the benefit of this kind of system, as no water will be wasted by irrigating when it is not needed. The Acclima controller was set up on the farm to showcase this new technology and to enable FAQI to invite growers along to view it in operation.

Leaf-Sen

Another promising controller technology was the Leaf-Sen unit, which was viewed by FAQI representatives in Europe in 2006. The Leaf-Sen unit consists of four leaf sensors which measure the plant's turgidity and initiate irrigations accordingly. The system was found to be quite complicated and required considerable time to set up. It was installed by the researchers on a rose farm for evaluation. The system initiated irrigation fractionally more often compared to the grower's own scheduling, and the crop's response was very positive (Table 3). The system is of potential interest for flower growing, and the Leaf-Sen trials should be extended for evaluation in a hydroponic system.

Table 3. Comparison of Leaf-Sen controller and grower irrigation scheduling for a rose crop

	Leaf-Sen	Grower	SILO ET
Date	**mm**	**mm**	**mm/day**
16 Mar	3.3	7.8	5.2
17 Mar	1.7		4.9
18 Mar	1.9		3.4
19 Mar	1.7		3.4
20 Mar	2.6	7.4	4.4
21 Mar	1.7		4.4
22 Mar	5.2		4.6
23 Mar	3.4		4.5
24 Mar	3.4	8.2	4.8
25 Mar	3.3		4.6
26 Mar	3.1		4.7
27 Mar	1.9	9.7	4.8
28 Mar			4.1
29 Mar	3.7		4.5
30 Mar	1.9	7.4	3.6
31 Mar	3.0		4
1 Apr	1.9		4.2
2 Apr	3.0		1.9

	Leaf-Sen	Grower	SILO ET
3 Apr	4.5	6.2	2.9
4 Apr	2.9		3.5
5 Apr	2.9		3.4
6 Apr	3.8		3.7
7 Apr	3.9	5.0	3
TOTAL	**64.7**	**51.7**	**92.5**
kc	**0.70**	**0.56**	

Figure 1 shows some data from the rose crop moisture monitoring, showing changes throughout the season in the soil moisture readings at depths of 10, 20, 30 and 50 cm. In the early stages, the grower irrigated too much, causing very high moisture trends. Following this, the grower reduced the frequency of irrigations to every three days in line with the IDO's recommendations. Crop growth improved dramatically due to the increase in oxygen in the soil profile. In the third stage, the Leaf-Sen controlller initiated irrigations. Initial crop response to the new irrigation strategy was favourable; however, due to winter conditions, the grower has since gone back to irrigating every three days.

Water quality monitoring

Over the past two years, basic water quality monitoring has been carried out during on-farm visits. This has assisted growers with a monitoring schedule for their water source quality and their drainage (runoff) water quality. During the early stages of the project, water quality on many of the wildflower growers was quite poor, with relatively high EC (salts) readings. This was due to prolonged drought, and the monitoring of the water highlighted the risks of irrigating with water of poor quality. Recently water quality has improved throughout the region due to some good rainfall events, which have diluted the salts in dams and aquifers.

A comprehensive monitoring project has just been initiated by FAQI, which will test the hydroponic growers' source water four times per year. This will include raw water (dam or bore), feed water (with fertilisers added), drainage water, and where applicable, water that has been sterilised (i.e. UV, ozone, chlorination or other methods). This project will improve growers' knowledge of what is happening in their systems throughout the year and will

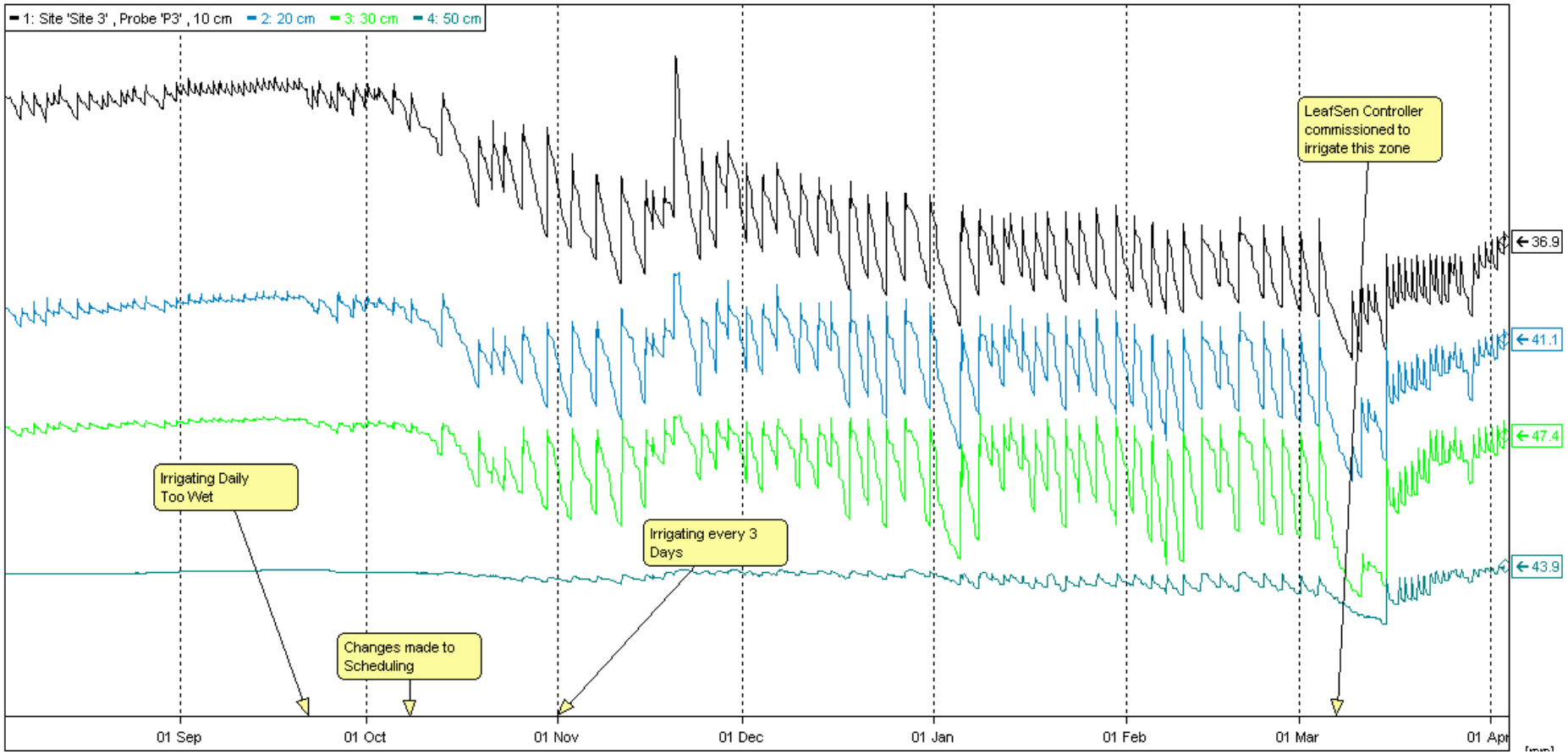

Figure 1. Rose crop moisture monitoring, showing changes throughout season

encourage more regular monitoring and recordkeeping of water quality. Hydroponic growers will be able to save 20 to 50 per cent of their water by recycling. By convincing them of the potential benefits, monitoring the nutrients and water lost from the system and educating them on various recycling options, it is anticipated that they will start to adopt these practices over the next few years.

CalClear trial

Irrigation uniformity is one of the major issues when it comes to improving WUE. Maintenance in drip irrigation systems is one of the major reasons for the decline in uniformity over the life of an irrigation system. There are a number of devices on the market currently which claim to improve calcium absorption in the plant and reduce calcium precipitation in irrigation systems. These systems use magnetic fields or electromagnetic fields to alter the chemistry of the water. They are most applicable to growers who are irrigating from hard bore water, which was the case for many of the growers identified in the project.

FAQI and DPI&F undertook a trial to determine if devices such as these can be used as part of a long-term irrigation maintenance program. Initial results were inconclusive, so the trial is most likely to be kept running for another 6 to 9 months to ensure enough time for the calcium to block drippers on the untreated line.

Irrigation system evaluation and tools for IDOs

IPART (Irrigation Performance and Recording Tool)

Most flower growers in SEQ (95%) use drip irrigation exclusively to irrigate their plants. Drip irrigation is extremely efficient at delivering precise amounts of water to the target. For this reason, the assumption was originally made that most farms were getting very high uniformity in their dripper systems. However, initial irrigation system evaluations made by FAQI highlighted that for various reasons, growers' irrigation systems were not performing as well as expected. This was due to improper pressure, poor irrigation design, inadequate filtration or poor maintenance.

The Queensland Department of Natural Resources and Water commissioned the National Centre for Engineering in Agriculture (NCEA) to develop a web-based system to improve the data entry and collation of in-field irrigation performance evaluation data collected by IDOs. The Irrigation Performance Audit and Reporting Tool (IPART) was developed to assist IDOs in undertaking and reporting on application system performance evaluations.

Since IPART has been available to IDOs, FAQI has performed seven uniformity tests. Compared with irrigation methods used in other industries, the systems of our growers have been found to have reasonable uniformity. However, it is believed that over the next 12 to18 months, many more evaluations should be conducted. This will highlight to the growers the need for regular maintenance and the importance of system monitoring to ensure their irrigation systems are running as efficiently as possible.

IPERT (Irrigation Pump Evaluation Recording Tool)

IPERT has only been available for use by IDOs for a few months, and adequate training to evaluate pumping systems was also lacking for most of the duration of the SEQ-IF program. However, since training was provided by Merv Jessen and Pat Daley, we are confident that over the next 18 months we will have the capacity to evaluate pumping costs and performance of pumps for many of the growers. In the system that we have evaluated to date, major issues were found, and subsequently we recommended a new pump and mains line, reducing pumping costs from $366 per mega litre to about $66 per mega litre. It is clear that a detailed evaluation of their pumping systems will help growers to improve irrigation performance and reduce their business costs. In addition to this, there are major energy savings to be made by choosing the correct pump and by ensuring the system is correctly designed.

Other tools that have been developed by NCEA include:

- EconCalc: Evaluates the costs and uniformity benefits of changing from an old irrigation system (i.e. travelling gun) to newer, more efficient irrigation systems (i.e. drip or centre pivot). It was not found to be very helpful for FAQI, since 95% of growers already use drip irrigation which is the most efficient system.

- IRUSTIC: A tool developed for planning and management purposes to evaluate the amount of water used by various crops in SEQ, incorporating different climates, irrigation systems and soil types. It can be used as a rough irrigation planning guide for industry and growers. It is currently of limited use, but may be of assistance to new growers entering the market.

Farm mapping

ArcGis training and software was provided by SEQ Catchments with the aim of assisting growers with farm planning. It has been of limited use at this stage in the program, due to the small land sizes of many of the flower farms and the poor resolution of the available imagery. As a result, there has been very little to report in regards to mapping.

However, some of the larger growers (farms over two hectares) will be able to benefit from this technology. With the implementation or the farm management system over the next few years, the farm mapping will be an important complementary tool, if better imagery can be obtained to enable the capture of information on smaller farms (less than one hectare).

IDO training

The IDO for FAQI has engaged in relevant training programs in order to be up-to-date on the latest in irrigation technology, as applicable to the flower industry.

Eco Hort: This is the nursery industry's environmental management program, which provided a better understanding of the FMS of another industry. Participation in this course assisted in the planning and implementation of our FMS program.

Water Works: This nursery industry's irritation management program was undertaken to better understand how the nursery industry assists its growers with WUE.

IAA pump/irrigation and hydraulic training: This very informative and productive training initiative was run by Pat Daily and Merv Jessen. The skills derived from this training enabled the IDO to improve irrigation and pumping systems on-farm. The training was held quite late in the project, and most participants felt that more benefit would have been gained if this training could have been provided earlier.

Irrigation Association of Australia (IAA) certified irrigation agronomist: This involved the completion of RPLs to obtain certification.

ArcGIS: Mapping software and GPS training to assist with the FMS part of project

Ultrasonic water meter: Training held by NCEA in the use of an ultrasonic water meter.

IPART: Irrigation performance software training by NCEA.

IPERT: Pump performance software training by NCEA.

Train the trainer: An Australian Institute of Management program designed to assist in the delivery of training modules and workshops.

Pump training: Basic pump training at Nambour DPI&F.

Integrated pest management training from Organic Crop Protectants (OCP): IPM solutions for floriculture crops.

ChemCert training: Chemical application and safety training.

NSW flower seminar in 2007 and 2008: Grower seminars with relevant floriculture education. The IDO presented at this event in 2008 on some of the findings from the SEQ-IF project.

AHGA seminar in Tasmania: Greenhouse and hydroponics seminar with information on irrigation, climate control and water treatments for greenhouse-grown crops.

Further training would be beneficial on best drip management practice and drip irrigation systems, including information on filtration, new and available products, maintenance, trouble shooting and basic design principals.

Workshops

Various workshops were held in the course of the project, with an overall aim to educate growers in irrigation practices and to get the growers interested in the concept of WUE improvement (Table 4).

Table 4. Workshops held during the SEQ-IF project.

Workshop	Topics covered	Location and date	Attendance
Soil quality	Identification of soil textures; how much water soil can hold; how much water is available for crop growth	Nambour: 27 September 2008 Crows Nest: 1 December 2008	Nambour: 11 Crows Nest: 8
Water quality		Nambour: 20 February 2009 Toowoomba: 5 March 2009 Redlands: 19 March 2009	Nambour: 13 Toowoomba: 8 Redlands: 12
Pruning	Pruning; irrigation scheduling	Keith Lumberton's farm, Palmwoods, 13 August 2008	17
Rose and gerbera (Presenter: Wim van der Ende)	Irrigation management; plant maintenance; nutrition and fertigation; climate control; variety selection	Kooralbyn Flowers, Kooralbyn, 24 May 2007	SEQ-IF: 10 RWUE: 2
Rose and gerbera (Presenter: Herman Eijkelboom)	SEQ-IF project; irrigation management; plant maintenance; nutrition and fertigation; climate control; variety selection	Floranda Flowers, Cabarlah, 28 February 2008	SEQ-IF: 16 RWUE: 1

Workshop	Topics covered	Location and date	Attendance
Rose (Presenter: Wim van der Ende)	SEQ-IF project; irrigation management; plant maintenance; nutrition and fertigation; climate control; variety selection	Currey Flowers, Ipswich, 1 October 2008	SEQ-IF: 10 RWUE: 2
Parkland Flowers Hydroponic Field Day	SEQ-IF project; irrigation management; plant maintenance; nutrition and fertigation; climate control; variety selection	Parkland Flowers, Browns Plains, 16 November 2007	SEQ-IF: 21 RWUE: 5

There are also future workshops planned for 2009, as outlined below.

FMS/cost calculator workshop, 13 May 2009, Nambour. The workshop will involve consultation with growers on the new cost calculator developed by FAQI, as well as the FMS checklist developed over the past two years.

Acclima Smart Controller workshop and farm tour, 2 June 2009. This will include information and demonstrations on new soil moisture-based irrigation controllers, with a look into irrigation scheduling by other methods, including tensiometers, Enviroscan®, and via the use of crop water use and climatic data.

LeafSen controller/cost calculator workshop and farm tour, 9 June 2009. New plant-based irrigation controller technology will be investigated, as well as soil moisture monitoring (Enviroscan®), plant growth (Phytech stem sensors), and water meter logging technology. In addition, the growers will be introduced to the new cost calculator developed for the flower industry.

Native flower seminar, date yet to be set, possibly October 2009.

Farm management system (FMS)

The FMS project evolved from the SEQ-IF and RWUE projects. FAQI made the decision to develop a full FMS for cut flower production and this has been achieved through much consultation with industry, NRM catchment organisations and scientific experts. The SEQ-IF elements of the FMS are currently in draft form, and being evaluated by cut flower industry members.

The FMS documents for the cut flower industry have been developed in three parts:

- producer self-assessment tool

- producer score sheet, risk assessment and action planning tool
- producer FMS guidebook.

The SEQ-IF elements of the FMS include:

- farm planning (ArcGIS software and imagery)
- soil management (in-ground growers)
- substrate management (hydroponic growers)
- water and irrigation management (irrigation scheduling techniques)
- nutrient management.

Topics of the FMS include:

- product handling and specifications planning
- pest, weed and disease management
- waste management
- native vegetation, animals and ecosystems
- energy use
- climate change
- harvesting and postharvest
- workplace health and safety
- business management.

Early stages of the FMS consisted of open discussions and consultation with flower growers with reference to other industry FMS programs. A number of workshops were held with growers to gather feedback and identify issues that growers felt were of concern. A basic template was created with an order of priority for the development of the FMS.

In July 2008 the FMS project officer started work for the DPI&F and FAQI. FMS documents were drafted in consultation with industry, DPI&F and NRW organisations. The FMS has been trialled with six producers in SEQ and at two workshops. The producers have completed an FMS checklist and an action plan. A brochure has been developed and has been posted to all FAQI members, and FMS updates are posted on the FAQI website and in the e-bulletin. An article on the FMS has also been written for the Australian Flower Industry Magazine. Two pilot farms have been established in SEQ for use on field days and to demonstrate best practice. The aim is for the final draft FMS to be launched at the Native Flower Seminar later this year.

Key achievements: milestones and targets

The milestones for the project have all been achieved within the appropriate time frames, as documented in the regular milestone reporting. The milestone reports are provided in the section of this report for supporting documents.

Table 5 presents a summary of key features of the project, and shows extensive involvement by the growers throughout the course of the project.

Table 5. Summary of SEQ-IF project activities and grower involvement

SEQ-IF and water use efficiency work	Number of growers involved
Soil Moisture monitoring equipment (including Enviroscan®, tensiometers, Acclima Closed Loop®)	14
Water quality monitoring	32
IPERT (pump evaluation)	1
IPART (irrigation uniformity)	7
Workshops/seminars	126
Financial incentive schemes	7
FAQI magazine	96
FMS promotion (workshops, farm visits)	22
Individual contact and farm visits	81
Mail-outs and emails	96
Number of businesses in SEQ	96 businesses

Milestone variances

At this stage there are no variances against the milestones.

Budget and costs

Documents related to the budget and costs for the project are provided at the end of the report, in the section for supporting documents.

Assessment of effectiveness

The perseverance and dedication of the FAQI team has overcome the initial hesitation by growers to become involved in the project. There is now much enthusiasm in the program and a high awareness of the importance of measuring water use and managing irrigation systems and activities to ensure maximum efficiency. The program has dramatically improved irrigators' awareness of and access to new technologies to improve irrigation management and system performance.

The IDO developed a strong rapport with the growers, and these relationships ensured the effectiveness of the project and will assist in future projects. The project effectively increased the amount of available information on plant water requirements and suitable irrigation management. The effectiveness of the project was proven by the positive feedback from the growers and their interest in being involved in order to improve WUE.

The project was also effective in identifying irrigation technologies that have the potential to improve water management in the industry. Enviroscan®, Phytech, Acclima Closed Loop® and Len-Sen technology were trialled and assessed for their application in flower production. The results of this work will be important to help enterprising growers incorporate suitable new tools into their farming systems.

The FMS work has been effective in attracting grower interest and encouraging discussion. The SEQ-IF elements of the FMS are currently being evaluated by cut flower industry members. The interest from growers has indicated the ongoing effectiveness of the FMS for the future improvement of WUE and the management of water resources.

Information delivery and training were highly successful, with much grower interest and a continual improvement in grower interaction during the course of the project. Grower meetings, workshops and seminars were well attended, and this resulted in a quantitative improvement in water use efficiencies in certain cases. Given that WUE is difficult to define in the short term, it is highly likely that other benefits from the project will be revealed over time as crops mature and as the technologies and processes identified in the project are steadily adopted.

Issues, constraints and lessons

This was a highly successful project, with many useful outcomes and indications of directions for further work. In addition to the successes, a number of issues, constraints and lessons were identified throughout the course of the project, which should be taken into consideration in future projects. These are outlined below.

Issues:

- The FAQI project did not commence until one year after the commencement of the SEQ-IF project. As a result, contracts were delayed, which delayed the ability of the relevant staff to begin collaborating with the participating growers and to take advantage of the original momentum from the launch of SEQ-IF.

- Staff changes, IDO training to update skills and knowledge, and the establishment of project direction with new staff all contributed to a slow start for the project. It was 18 months into the program before FAQI was really able to begin gathering useful data and producing grower materials.

- Initial months were spent gathering foundational information, as the flower industry did not have reliable data available at that time.

- Once the project got into full swing, it soon became apparent that there was far more work to do than was appropriate for a single IDO. Further staffing support was needed to maximise the gains from the project. In addition, as the growers gradually became aware of the WUE and R&D opportunities being offered, they became demanding on the IDO in terms of time and resources.

- The 3-year program was not long enough, and should have been a 4-year program to achieve maximum results in relation to farm water use efficiencies.

- In reality, the RWUE(3) program has only been active for two-and-a-half years, due to the delay in its commencement.

- Although some IDO training was valuable in terms of new skills and software programs, other training was found to be unproductive and not of value to the IDO. It is suggested that a training needs analysis be undertaken at the beginning of future projects, to ensure that training time and resources are efficiently allocated.

Constraints:

- The IDO met all of the milestones developed for the project during the planning phase. However, more could have been achieved if extra time had been available.

- The IDO could have serviced more growers if geographical location was not such an issue. The flower growers are spread throughout SEQ, and consequently it was necessary to spend considerable travel time in servicing outlying growers.

- FAQI has been able to mobilise the Queensland industry to move forward and to feel excited about a prosperous and sustainable industry into the future. We are currently undertaking many R&D projects, with others awaiting funding advice. The program encouraged growers to adopt more efficient water use and environmental practices, resulting in improvements to the business bottom line. Much more can be done in this area, particularly in the area of climate change. However, program time lines are a major constraint to the achievement of further successes.

Lessons:

- The project has proven beyond doubt that the only way the Queensland flower industry can progress is to have extension capabilities available on-farm, through assistance from industry IDOs.

- The IDOs need to identify leaders in the industry and to establish their systems as benchmarks for other growers. Appropriate demonstration farms should be used to showcase significant on-farm improvements, to assist in the flow of information and encourage the adoption of beneficial technologies and processes.

- It has been proven that industry IDOs are skilled at establishing a rapport and achieve more success with growers, as compared to government extension officers.

- Industry organisations could achieve much more with available monies and grants than government, through the ability to leverage funds. Real R&D results have resulted from collaborative partnerships through leveraged funds.

- Due to on-farm IDO extension work, R&D projects have been identified by growers and aligned to industry needs before funding applications have been submitted. Previously, R&D activities have been identified by government.

In summary, it has been established that, in comparison to government processes:

- industry can undertake productive extension work;
- industry is better able to leverage grant money for R&D purposes;
- industry is better able to understand what growers want from R&D and have the capacity to work with growers through on-farm trials, resulting in the growers taking ownership of the trial if they are involved in the activities; and
- industry is more efficient at budgeting funds, as there are less government overheads.

Supporting documents

SEQ-IF brochure

Literature review by David Hunt: Optimum irrigation scheduling techniques for key wildflower crops: do they exist?

Milestone reports from the SEQ-IF program

SEQ-IF quarterly updates

Fact sheets and industry reports

Industry article

Budgetary and costing information

Report by Samuel Plant: The relationship between previous years rainfall totals and yield of protea ‘Pink Ice’

Report by Rachel Poulter and Sam Plant: Investigation of the efficacy of the CalClear water conditioner