South-East Queensland Irrigation Futures
Research and Development Support

Annual Report

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Executive Summary

The South-East Queensland Irrigation Futures (SEQIF) Research and Development Support (RADS) project was funded by the Queensland Department of Environment and Resource Management (DERM) over three years to provide research and technical support to the SEQIF Industry Development Officers (IDOs) and SEQ Catchment staff. The key objectives were to:

- provide research and development outcomes that will underpin a 10% improvement in water use efficiency by 2009 for SEQIF,
- provide the basis for changes in on-farm water management practices and/or take-up of more water efficient equipment and operations through Research and Development (R&D),
- assist in the uptake of farm management systems through better definition of best management practices and efficiency targets, and
- assist grower involvement in SEQIF by providing up to date research for SEQIF stakeholders by conducting research at a local level while having access to the broader research framework of the CRC for Irrigation Futures (CRCIF) at a national level.

The RADS team worked closely with IDOs on more than 16 trial sites throughout SEQ conducting crop water use efficiency and benchmarking studies, crop vigour and EM38 surveys, pressurised irrigation monitoring system (PIMS) testing, monitoring root zone salinity accumulation and nutrient fluxes and developing and supporting a range of monitoring tools that facilitated the objectives. The monitoring tools to improve water use efficiency included:
PIMS, Data Signature Logger (Smart water metering), continuous logging tensiometers, soil solute monitoring tools, and weight based irrigation scheduling devices.

Optimising performance and managing infield variability was conducted using vegetative index sensors (Greenseekers(R)) and electromagnetic (EM38) soil surveys for Dairy, Turf and Horticultural industries. This constituted a considerable amount of activity in spatial variability in irrigated production, utilising NDVI to monitor turf production and quality. Data signature logging continually provided useful insights into the operation of sophisticated and simplistic irrigation systems in the floral and horticultural industries. Whilst the use of PIMS in Turf and Dairy implemented significant changes to irrigation infrastructure and irrigation management thought processes. Significant advancements were made in irrigation scheduling and management in the nursery industry under the development of weight based crop water use monitoring. However the research trial to evaluate root zone management under lettuce production was a major undertaking by RADS in 2008/09, the full draft report is under review by the our clients prior to dissemination.

Mentoring and training has been an ongoing activity for RADS, although in this last year training and training support was less than in previous years because the demand was reduced. However, mentoring remained active and at the forefront of RADS support as it had been in previous years. Mentoring included; a) Provision of instrumentation advice and field support for installation, maintenance and data acquisition. b) Provision of guidance on strategic data collection and benchmark reporting over project life. c) The incorporation of spatial variability data in to GIS mapping systems. In a similar vein RADS continued discussions on weight based irrigation scheduling development and implementation of collaborative research with DEEDI. Mentoring support often extended to general liaising and coordinating in regard to performance evaluation, software and tools with industry consultants such as Daley Water Services. The various tools and activities have highlighted significant issues with irrigation machines and

practices which through mentoring and training have enhanced the IDOs research and extension capacity.

All research data are reported in the attached Annexes to this document. Also in keeping with the reporting requirements a series if information sheets have been developed and published on the SEQIF website to highlight the tools available to the IDO's which support their extension work in SEQ.

All outputs whether reported here or not have been delivered to the IDO's for their inclusion in their activities or for discussion with their clients. There have also been a number of opportunities to present the outcomes and activities to industry and catchment stakeholders one of the most important being the RADS activity presentation at Annual Research Forum for the CRCIF. It aroused considerable interest in the delivery model and the instrumentation developed by RADS.

Development of Year 2009/13 RADS plan

Following ratification by the IDOs, the plan was forwarded to DERM for final comment and clarification. Following some points of clarification and detailed discussion with IDO's and Board Members, the following was established as broad outline of continuing R&D.

Dairy.

To provide R&D with PIMS, sensor/instrument support, and more importantly continue to evaluate spatial variability and irrigation deficits with the EM38 (scheduling and irrigation performance).

Nursery

To apply significant effort into establishing an interface between the weight-based scheduling (WBS) tool (data logger, etc) and on-farm irrigation controllers commonly used (e.g. Hunter, Rainbird, etc) within nursery production.

Horticulture

To provide R&D with PIMS, sensor/instrument support, and more importantly continue to evaluate spatial variability and irrigation deficits with the EM38. Focusing on CWU, root zone management and climate change mitigation

Turf

SEQIF RADS would continue to provide R&D with PIMS, sensor/instrument support and more importantly continue to research spatial variably and irrigation deficits with the EM38 and turf quality indicators with the NDVI.

Flowers

Continuation to provide R&D with PIMS, Smart water metering (DSL) and sensor/instrument support. Assist in developing Drip/Micro Irrigation Maintenance Workshops. Integration of drainage monitoring tools, develop indoor crop water use measuring and introduce EM38 surveying to in-ground production systems.

Contents

1. Introduction

The South-East Queensland Irrigation Futures (SEQIF) Research and Development Support (RADS) project has been funded by the Queensland Department of Environment and Resource management three years to provide research and technical support to the SEQIF Industry Development Officers and SEQ Catchment staff. The key objectives are to:

- provide research and development outcomes that will underpin a 10% improvement in water use efficiency by 2009 for SEQIF;
- provide the basis for changes in on-farm water management practices and/or take-up of more water efficient equipment and operations through Research and Development (R&D);
- assist in the uptake of farm management systems through better definition of best management practices and efficiency targets; and
- assist grower involvement in SEQIF by providing up to date research for SEQIF stakeholders by conducting research at a local level while having access to the broader research framework of the CRC for Irrigation Futures at a national level.

This annual report provides an update of work conducted over the second 12 months of the project within each of the activity areas identified in Schedule 2 of the project contract.

SCHEDULE 2 *(of Project Contract)*

No	Description	Commencement	Completion
2	Support IDO's in establishment of and maintenance of irrigation trial sites in SEQ in accordance with their Industry programs, the R&D priorities identified above and this Project's Terms of Reference. • Trial sites identified • Field data collection, collation and analysis • Technologies and management practices for improved irrigation practice developed trialled and evaluated.	1 July 2008	30 June 2009 30 September 2008 30 April 2009 30 June 2009
3	Technical and scientific support and mentoring to Industry and Catchment groups • Training in irrigation performance and efficiency • Guidance on improved irrigation technologies and practices. • Support for developing best management practice and reduction targets. • Field day and workshop support	1 July 2008	30 June 2009 30 June 2009 30 June 2009 30 June 2009
4	Reporting, Extension and Adoption • Collation and packaging of data and results • Preparation of Case Studies • Presentations to Industry and Catchment Stakeholders • Project Reporting	1 July 2008	30 June 2009
5	Project Reporting – YEAR 3 Progress Report Project review & preparation for future activities Annual and Final Report		 31 December 2008 30 March 2009 30 June 2009

2. Establish and maintain irrigation research trial sites in SEQ in accordance with the R&D priorities identified above and this project's terms of reference.

2.1. Research trial sites identified

The RADS team have been closely working with IDOs on a series of trial sites, some of which were used to gather complimentary research data to their current activities and others were used for standalone research and development of monitoring equipment. The sites are listed by industry below.

Turf

Cabarlah Park Turf Farm at Kingsthorpe

- CWUE and benchmarking studies.
- NDVI Survey
- EM38 Survey

Turf Biz at Lowood

- NDVI Survey
- EM38 Survey

GrassCo at Lowood

- NDVI
- EM38

Australian Lawn Concepts Canungra

- PIMS
- NDVI Survey
- EM38 Survey

Caboolture Turf, Caboolture

- Continuous logging tensiometers

Four farms used are still using the FAO56 ET_0 SMS service from Irrigateway server at CSIRO Griffith for the CRC IF, and after a visit from the service provider further farmers 6 farmers are required to evaluate the service.

Nursery Industry

Toowoomba City Council Nursery

- Weight based irrigation scheduling (Load Cell)

Redlands Bay DPI research Station

- Weight based irrigation scheduling (Load Cell)

Five nurseries used the FAO56 ET_0 SMS service from Irrigateway server at CSIRO Griffith for the CRC IF.

Flower Industry

Lockyer Cut Flowers – Grantham

- Smart water meter

Derek's Flowers - Grantham

- Smart water meter

Horticulture Industry

Story Fresh – Cambooya

- Root zone salinity accumulation Nutrient fluxes in Lettuce production

Black Boy Ridge Orchards - Grantham

- PIMS – Irrigation performance
- Smart water meter

Three horticultural industry sites used the FAO56 ET_0 SMS service from Irrigateway server at CSIRO, Griffith for the CRC IF.

Dairy & Fodder Industry

Yarrow's Farm – Harrisville

- Micro Meteorological Station (ECv)

Roderick's farm – Harrisville

- Spatial Variability (NDVI and EM38)

QDO research Station Mutdapilly

- Spatial Variability (NDVI and EM38)

Rihane - Innisplain

- Spatial Variability (NDVI and EM38)
- PIMS – Irrigation performance

Smiths Farm - Nobby

- PIMS – Irrigation performance

2.2. Equipment needs identified and installations complete

2.2.1 Monitoring tools to improve water use efficiency

Pressurised Irrigation Monitoring System (PIMS). PIMS Generation 2 was completed and launched with delivery if 4 units. Testing ad support has continued across the three industries using the device. Software development has continued with production of the PIMS interface.

Data Signature Logger. Two logger/modem one from CRCIF and one from the NCEA has been configured to send data to the CRC IF web site through a new collaborative arrangement between CRCIF and SEQIF. Farmer response was impressive in that one set up his own system.

Voltage stabilisers for continuous logging of GT3 Jetfill Tensiometer Transducer. Continued to advise and support logging tensiometers at a Caboolture turf farm and Growcom's unit, designed and constructed by SEQIF RADS Team.

Soil salinity monitoring tools. Continued to develop methodology and associated tools with the SWE under other crops. Developing multiple data strand approach with ET, tensiometers, nitrate sampling and farmer data.

Load cell devices: QDPI at Redlands conducted intensive comparative trials on the device with continual support and advice from NCEA.

2.2.2. Optimising performance and managing infield variability

NDVI. Evaluation and acquisition of vegetation index (NDVI) sensors for measuring crop variability have been enhanced to gather multiple forms of indices such as soil adjusted vegetation index (SAVI). Mapping and data manipulation has been improved to enhance output and provide relevant information to the users. Serial interface unit has been designed and developed to capture and collate data from the 4 NDVI sensors and the GPS directly to a computer using a single timestamp. Sensor platform has been highly modified to conduct data acquisition in all crops in all terrains utilising an Ag Bike.

EM38. The electromagnetic survey of horticulture, turf and dairy farms has continued to identify subsoil and root zone constraints. A trailer system has been developed to acquire data from all terrains and surface conditions. Data is acquired concurrently with NDVI. Data analysis and mapping techniques have been developed concurrently to enhance the IDO end product.

2.3. Field data collection, collation and analysis

2.3.1. Weight based irrigation scheduling

In conjunction with Toowoomba regional Council, NGIQ and QDEEDI the weight based irrigation scheduling device has undergone extensive comparative testing. The report compiled by QDEEDI is at with NGIQ.

2.3.2. Spatial variability in irrigated production

- The EM38 has been used extensively in the turf and dairy industries to identify variation in soil type and constraints to production in the root zone and subsoil. The data is analysed and presented as GIS layers that the IDOs then combine with existing farm plans/maps. In most cases the maps are discussed with the farmer in relation to field history, cropping practices and irrigation uniformity. Examples of which are at Annex 7.
- The NDVI surveys are used in much the same way as EM38 in that, maps are constructed from survey data of crop vigour which is related to nutrient status, water stress etc. These maps are then related to other on-farm measurements, such as irrigation uniformity collected concurrently by the IDOs. These overlays of metadata have highlighted to the producers areas of water logging, water stress, compaction, soil changes and nutrient status. Examples of the data are shown in Annex 8.

2.3.3. Utilising NDVI to monitor turf production and quality

The trial at Cabarlah Park Turf by QTPA and NCEA was incomplete due to pump breakdowns. Preliminary results are shown in a fact sheet at Annex 8.

2.3.4. Data signature logger

The analysis continues to provide useful insights into the operation of sophisticated and simplistic irrigation systems. The analytical methodology at moderately high resolution was significant hydraulic inconsistencies. The fact sheets at Annex 9 and reporting data at Annex 3 show examples.

2.3.5. Crop water use

- EM38.

EM surveys have been used to demonstrate crop water use under LM irrigators and the spatial variability of subsequent irrigations.

- Weight based crop water use.

The study at Redlands compared daily ET, times and gravimetric data with observed daily plant weight loss (water consumption) and also investigated other irrigation water losses.

2.3.6. Pressurised Irrigation Monitoring System (PIMS)

The PIMS has been run on a number of irrigation units following its launch. The results from Turf, Dairy and Horticulture, have been analysed by industry consultants Daley Water services prior to presentation to the farmer. The impact on infrastructure has been significant. Examples of the data and results are given in Annex 4 and 5.

2.3.7. Field evaluation of root zone salinity

The six month in-field trial was conducted on a Lettuce farm at Cambooya. The report and data has been delivered to the Growcom prior to dissemination and discussion with the farmer. The full report will be allocated to Annex 13 on approval of the farmer and Growcom.

2.3.8. Continuously logging tensiometer

The RADS team has built and delivered other devices for use in the horticulture industry providing support and maintenance. An example of the data output is given in Annex 10.

2.4. Technologies and management practices for improved irrigation practice developed, trialled and evaluated

2.4.1. Macros

A suite of Excel spreadsheet macros have been developed to clean, collate and present output from an array of devices used by RADS in support of the IDOs. The raw output from Eddy Co-variance, NDVI, PIMS, Dynasonic flow meters, Data Signature logger and enviroscan moisture probes is often voluminous, contains spurious data, not in the correct format, and needs mathematical processing. The Macros perform all these functions in a fraction of the time normally required for manual operations. The ET model Watersched was also modified to enhance useability for all IDO's should they choose to utilise the software. Other software such as IPART, IPERT have had significant input from the RADS team during its development and testing phases. PIMS post processing software has been developed to provide analytical and graphing tools.

2.4.2 GIS Mapping of spatial variability

NDVI, EM38 and PIMS data has been processed with ARC GIS mapping software so that IDOs can apply these surface map layers to existing farm plans and cadastral maps. Presentation of crop vigour, subsoil constraints and irrigation performance in terms of spatial variability has provided the IDOs with a very powerful extension tool. Examples of the maps provided to the IDOS are at Annexes 4, 5 and 7. Considerable modification of the data logging components have been undertaken to capture the various signals outputted from the NDVI EM38 and DGPS units. The data acquisition and sensor platform was expensive and took considerable time to develop, but SEQIF RADS has significant capacity to provide the crop and field survey service to SEQIF IDOs.

2.4.3 Monitoring Tool Fact Sheets

A series if information sheets have been developed to highlight the tools available to the IDO's which support their extension work in SEQ. The tools are detailed on the web site: http://www.seq.irrigationfutures.org.au/news.asp?catID=39

- **Measuring ET with an Eddy Covariance (ECv) Station**

Eddy covariance measures the net ecosystem flux of carbon dioxide water vapour and other gases from vegetated areas and water bodies. It can be used for many different purposes eg. the direct measurement of evapotranspiration for contrasting cropping on soils of differing texture, water holding capacity and nutrient status.

- **EM38 — Assessing soil spatial variability**

Designed to be particularly useful for agricultural surveys in mapping soil type and quantifying salinity and soil moisture levels. EM38 can cover large areas and it provides depths of exploration of 1.5m and 0.75m. EM38 surveys of soil parameters in order to interpret yield maps and crop production in a spatial context is becoming increasingly popular.

- **SMART Water Metering Data Signature Logger (DSL)**

Farm irrigation schemes often consist of complex hydraulic delivery networks and obtaining detailed water use can be expensive and technically difficult. 'Smart' technology can be coupled with a meter to measure water use and provide information that can lead to improved irrigation practice and efficiency.

- **Normalised Difference Vegetation Index (NDVI) - Measuring crop performance**

NDVI technology is becoming common place in conducting on-farm trials and determining farming input recommendations. It assists in fine-tuning your knowledge of variability within fields and the contrasts that exist among management histories.
Greenseeker® ground-based optical sensor contains its own red and near-infrared (NIR) light source, allowing measurements to be taken at any time, day or night. NDVI is a common measurement of plant health or vigour because chlorophyll in plants absorbs red light as a source of energy. Simplistically healthier plants (more chlorophyll) will absorb more red and reflect more NIR, and consequently have a higher NDVI. Using Greenseekers®, researchers, agronomists and farmers can map crop health.

- **The Wireless Pressurised Irrigation Monitoring System (PIMS)**

PIMS is a versatile tool kit which caters to irrigation consultants conducting irrigation performance assessments. Continuous irrigation system monitoring with the PIMS adds value to performance assessment by providing data on irrigation parameters across the complete irrigation cycle, which is essential if the pump performs variable duties during that cycle.
PIMS remotely monitors: Pump suction and storage or bore water level simultaneously and multiple pressure points. Additional sensors to monitor water quality, fuel consumption and global

position of the mobile irrigator can be added to the system. Further optional customisations (eg 3G Modem) are also possible.

- **Portable Transit Time Flow Meter — Series TXFP: Field Zeroing**

The factsheet at Annex 12 provides instructions for manually zeroing a portable transit time flow meter. The meter must be manually zeroed once the meter is properly configured and the transducers are mounted on the pipe.

- **Continuously Logging Jetfill Tensiometers**

Providing a plant root view of soil water status a tensiometer senses the suction required to extract water from the soil. As the soil dries, water in a closed tube is drawn out through a ceramic tip, which creates a vacuum in the tube.
The first 4 channel continuous logging jet fill tensiometer were designed, constructed and delivered to Growcom as part of the ongoing supply of water saving technology by the RADS program. The unit was supplied at a significantly reduced cost compared to that of the proprietary system. Fact sheet is at Annex 10.

3. Provide mentoring to industry IDOs in establishment and operation of industry trials.

3.1. Guidance on improved irrigation technologies and practices

3.1.1. Training

Training in delivery of soil water and scheduling workshop to growers
RADS attended a Growcom soil workshop for support and delivery training on farm at Fernvale. The training in workshop techniques and delivery was given under grower workshop conditions. RADS and IDOs delivered instrumentation and remote sensing introductory training at the AusHS conference on the Gold Coast.

3.1.2. Mentoring

Turf
Provision of instrumentation advice and field support for installation, maintenance and data acquisition. Provision of guidance on strategic data collection and benchmark reporting over project life and the incorporation of spatial variability data in to GIS mapping systems. Consultation on centre pivot specifications for ALC Canungra and other travellers in the Brisbane valley and north Brisbane. Support and advice at QTPA board meetings to the IDO in discussing RADS output and QTPA IDO milestones and outputs.

Nursery
Continued significant discussions on weight based irrigation scheduling to implement collaborative research with DPI and NCEA. Workshopped possible applications for the WBS developed the instrumentation to conduct an intensive trial in 08/09 at QDPI.

Flowers
Extensive advice and support has been given on various instrumentation, more notably the DSL and Leaf Sen. Close working relationship was built between IDO and growers in the Lockyer valley developing and applying instrumentation to Rose production systems.

Horticulture
General liaising with regard to performance evaluation, on water balance, IPART, PIMS, Soil water extractors have formed a minor role. However in conjunction with Daley water services we have built capacity in the on-farm irrigation performance assessment utilising PIMS especially at Black Boy Ridge Orchards. Long term trials at BBR have introduced 3 consecutive Growcom IDOs to instrumentation, data acquisition, analysis and diagnostics.

Dairy
Collaborative work in 2008/09 has built capacity and confidence amongst IDOs, NCEA and QDO consultants. The various tools and activities have highlighted significant issues with irrigation machines and practices which have enhanced their research and extension capacity.

3.2. Promote consistent protocols for water use assessment and performance benchmarking across industries

3.2.1. Program

The SEQ IF RADS team is providing support across the industries in SEQ. The team provides updates and direction in the IDO forums and the SEQ catchments group. The SEQIF program includes:

- The evaluation of development software and negotiation for the standardisation of infield reporting sheets across the industries. The process developed the field evaluation package, which has ultimately led to the development and advancement of IPART and IPERT and various other software tools, graphic user interfaces (GUI) and ready reckoners.
- Instrumentation selection and evaluation has continued throughout 08/09 by both design and construction within NCEA and evaluation of 'off the shelf' components.
- Automated weight based scheduling system has proven to be a better system for scheduling irrigation.
- Measuring performance in the horticulture and flower industries with hydraulic signatures from smart water metering is highly developed. The collaboration between CRCIF, SEQIF, and Growcom has made significant inroads into water use diagnostics from high resolution monitoring of basic water meters.

3.3. Provide support for developing best management practice and reduction targets

- PIMS was launched and delivered to the industry's in 08/09 and has been widely used in assessing performance and diagnoses of irrigation machines especially in Dairy, Turf. The system has highlighted significant issues with both new and old installations.
- Assessment of irrigation spatial variability in Dairy, Fodder and Turf industries has demonstrated that it is very prevalent, even on high performance machines..
- Hydraulic signatures have provided significant impetus to change and selection/design of irrigation components especially in effective filtration and solenoid operations in horticultural and floriculture systems.
- Development of inexpensive continuous monitoring devices for soil water potential.
- Development of mapping skills to visualise spatial variably in relation to BMP.
- Provision of software to interpret data sets that are relevant to farmer needs, skill level and extension requirements.
- Provision of salinity and nutrient data for horticultural research.

3.4. Provide field day and workshop support regarding research outputs

- Soil water and scheduling workshops. In conjunction with Water for Profit Fernvale, the RADS team provided training and delivery support.
- RADS provided PIMS training to all IDOs at USQ.
- Delivery of instrumentation and remote sensing at AusHS on the Gold Coast.
- Delivery of instrumentation and RADS services, Gatton Irrigation Showcase (QDEEDI).
- PIMS launch to QDERM and Industry.

4. Reporting, Extension and Adoption

All research data are reported in the attached Annexes to this document. Examples of various outputs are also reported in the annexes. All outputs whether reported here or not have been delivered to the IDO's for their inclusion in their activities or for discussion with their clients. The following is a summary of all research and outputs.

4.1. Collation and packaging of research data and outputs

Report on root zone salinity and nutrient loss on lettuce is allocated to Annex 13, and will be inserted after review by the clients.

4.2. Preparation of case studies based on research outputs

Monitoring tool fact sheets are located on the SEQIF web site and are listed in Annexes 4-12:
http://www.seq.irrigationfutures.org.au/news.asp?catID=39

4.3. Presentation of research outputs to industry and catchment stakeholders

- Activity reports to SEQ IDO, SEQ catchments, and SEQIF stakeholder meetings by Prof Steve Raine, Mr Erik Schmidt and Dr Jack McHugh.
- PIMS performance to Daley water services for turf, horticulture and Dairy IDOs
- Data signature logger performance and results presented to FAQI and Growcom IDO.
- Delivery of root zone salinity and nutrient loss report to Horticultural IDOs.
- PIMS launch and output presentation.

4.3.1. Presentations at conferences and publications

- RADS activity presentation at Annual Research Forum CRCIF.

5. Development of Year 2009/13 R&D plan

This section outlines the specific work identified by the IDOs to be undertaken by the RADS team during SEQIF 2.

5.1. Review and update of current irrigation research activities in and relevant to SEQ IF

A review was conducted on the progress of all activities in preparation for the SEQ IF board meeting on 23 June 09. The plan was tabled at the previous SEQIF steering committee meeting and attendees were asked to comment. The proposed activities were then discussed by telephone and emails with individual IDOs.

5.2. Confirmation of R&D priorities/activities for year 2009/13 in consultation with stakeholders

Following ratification by the IDOs, the plan was forwarded to DERM for final comment and clarification with the steering committee and stakeholders. Following some points of clarification and detailed discussion with IDO's and Board members the following was established as broad outline of continuing R&D.

5.3. Specific stakeholder prioritised RADS program activities:

5.3.1. Dairy

To provide R&D with PIMS, sensor/instrument support, and more importantly continue to evaluate spatial variability and irrigation deficits with the EM38 (scheduling and irrigation performance).
Specific tasks:

- On selected irrigated pastures and crops, survey (EM38) soil moistures pre and post irrigation to determine spatial variability of irrigation application.
- Utilising full stops, EC and G bugs to determine impact of variable DU on application and irrigated depth (Integrate tensiometers and/or G-bugs, and EC(full stops) into PIMS for five strand approach, see below).)
- Determine crop water use and deficits (possible constraints to crop vigour)
- Integrate water quality sensors for effluent ponds into PIMS
- Map impact of effluent irrigation on soil and crop with EM38 and NDVI.

5.3.2. Nursery

NGIQ provided preliminary endorsement for RADS to apply significant effort into establishing an interface between the weight-based scheduling (WBS) tool (data logger, etc) and on-farm irrigation controllers commonly used (e.g. Hunter, Rainbird, etc) within nursery production.
Specific tasks:

- Incorporate WBS in to existing irrigation controllers (includes algorithms to trigger events).
- Develop graphical user interface (GUI) for WBS (precursor to controller integration)
- Develop weight based instrumentation to demonstrate media degradation and plant available water. (IDO demonstration tool with load cells and GUI)
- Determine crop water use and crop factors for indicator species, based on local and SILO ET (SMS)

5.3.3. Horticulture

SEQIF RADS suggested continuing to provide R&D with PIMS, smart water meter, sensor/instrument support, and software provision and support.
Specific tasks:

- On selected irrigated crops survey soil moistures pre and post irrigation to determine spatial variability of irrigation application.
- Determine crop water use and deficits (possible constraints to crop vigour)

- Revision of solute monitoring tools and methodology by inclusion of concurrent sampling/data collation; (eg five strands of irrigation data approach)
    - The knowledge of the irrigator based on their accumulated experience
    - Potential crop water use (ET)
    - Soil water status monitoring (logging tensiometers/bugs)
    - Depth of wetting front using wetting front detectors (WFD) and
    - Electrical conductivity of the solute wetting front (logging EC in WFD).
- Demonstrate proof of concept of conservation agriculture (CA) potato production (zero till, mulch covered) to achieve reduction in inputs (water conservation and energy).

5.3.4. Turf

SEQIF RADS would continue to provide R&D with PIMS, sensor/instrument support and more importantly continue to research spatial variably and irrigation deficits with the EM38 and turf quality indicators with the NDVI.
Specific tasks:

- Survey soil moistures pre and post irrigation to determine spatial variability of irrigation application.
- Determine crop water use and deficits (possible constraints to crop vigour)
- Map crop vigour with NDVI and determine relationship to crop quality
- Adapt existing ready reckoners (cost benefit and economic analysis related to inefficiencies) to turf

5.3.5. Flowers

Continuation to provide R&D with PIMS, Smart water metering (DSL) and sensor/instrument support. Assist in Developing Drip/Micro Irrigation Maintenance Workshops.
Specific tasks:

- Assistance in collating "Nutrient Monitoring Trial" data to determine how much nutrient is being used up in different stages in hydroponics. Assist in calculating a $ value of the total nutrients left in drain water, look at how much nutrient is being consumed by the plants, and look at the loss of nutrients when using dis-infestation practices, this would provide awareness of the costs of not recycling.
- Evaluate methods to determine drainage volume/rates from hydroponic systems.
- Develop a method to integrate weight based irrigation monitoring in protected environments.
- Develop EM38 survey methodology in tree crops for crop water use and spatial variability of irrigation application.

List of Annexes

Annex

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South-East Queensland Irrigation Futures

Research and Development Support

Quarterly Report - Liaison with Industries

September 2008

NCEA Publication 1002008/7

National Centre for Engineering in Agriculture
University of Southern Queensland
Toowoomba

This quarterly report is produced in accordance with Item 9 of the Project Terms of reference - Identification of liaison with industries. It does not include details on any of the research and development support activities undertaken by this project.

The following tables capture the majority of liaison activity undertaken by the key members of the RADS team for the period June – September 2008.

Table 1 is a compilation of phone, email and in-person communications with the industries.

Tables 2-6 summarise email activity between the project leader, IDOs, stakeholders, colleagues and suppliers intimately involved in SEQIF activities. Note that these tables are not exhaustive, in that some activities have not been captured due to their incidental nature or inadvertently omitted. The email activity between the other RADS team members (McKeering, Eberhard, Raine etc to IDOs, Stakeholders and others, have not been included due to the counterproductive nature of compiling a complete and exhaustive list of contact, communication and liaison activities generally conducted by email.

Table 7 is a list of emails related to instrumentation issues.

Table 8 is a list of some of the in-field activities that have been undertaken. This table does not include the pre and post activities associated with the field work or the in-field work undertaken with the flower industry crop water use sites.

Table 1. Communication activities for liaison between members of the SEQIF supported industries for June to mid September 2008.

Date	Communication Method	Initiated by:	With:	Total Activity Time	Purpose
5-Jun	Phone	Jack McHugh	Sam Plant	15-30 min	Discuss installation of logger from David Pezzaniti
5-Jun	Phone	Jack McHugh	Scott Wallace	1-15 min	Tensiometer interface configuration
5-Jun	Email	Jochen Eberhard	Dan Corfe	1-15 min	send final ArcGIS map of NDVI assessment at GrassCo
5-Jun	Email	Jochen Eberhard	Scott Wallace	1-15 min	arranged delivery of PIMS for George Russell in Tully
6-Jun	Phone	Geoff McGlashan	Jack McHugh	15-30 min	Fix ET SMS service
6-Jun	Phone	Jack McHugh	Scott Wallace	1-15 min	Spoke to George Russel in Tully re PIMS delivery
11-Jun	Email	Jochen Eberhard	Sam Plant	30-45 min	internet search and suggestions on purchasing a solarimeter
12-Jun	Phone	Sam Plant	Jochen Eberhard	15-30 min	clarifying some details of David Pezzaniti's new logger/modem system
12-Jun	Email	Jochen Eberhard	Emily Litzow	45-60 min	maps of EM39 and NDVI for Tredegar Park paddock
13-Jun	Email	Jochen Eberhard	Dan Corfe	15-30 min	sent results from PIMS testing at Australian Lawn Concepts (centre pivot)
16-Jun	Phone	Dan Corfe	Jochen Eberhard	1-15 min	arrange a second visit at GrassCo for NDVI and EM38 mapping
17-Jun	Phone	Dan Corfe	Jochen Eberhard	1-15 min	GrassCo visit not before next week
17-Jun	Email	Dan Corfe	Jochen Eberhard	1-15 min	Dan arranged visit for ALC in Canungra for the next day
19-Jun	Email	Emily Litzow	Jochen Eberhard	15-30 min	reply on data that had been sent to her a week ago
20-Jun	In-person	Jochen Eberhard	Sam Plant	3-4 hr	met at growers place in Lockyer valley to discuss DSL results
25-Jun	Email	Jochen Eberhard	Dan Corfe	15-30 min	indicate results for ALC in Canungra, elaborated on ideas like precision irrigation and yield mapping
25-Jun	Phone	Jack McHugh	Scott Wallace	1-15 min	Re loggers, PIMS and tensiometers
26-Jun	In-person	Jack McHugh	Scott Wallace	30-45 min	Delivered tensiometers
26-Jun	In-person	Jochen Eberhard	Dan Corfe	15-30 min	EM38 & NDVI methodology & results, future sites, commercial turf grading
27-Jun	Phone	Jack McHugh	Dan Corfe		which farmers were using ET SMS
27-Jun	Phone	Duncan McGregor	Jack McHugh	1-15 min	Irrigation scheduling workshop and need for soil water table (PAWC)
30-Jun	Email	Loretta McKeering	Dan Corfe	1-15 min	sent copy of Ben Muller's final thesis report & RADS summary (factsheet)
30-Jun	Email	Jochen Eberhard	Scott Wallace		more details on Ed Windley's lateral move, discussed cause of pressure loss in system
1-Jul	Phone	Jack McHugh	Sam Plant	15-30 min	modem logger site, collaboration with leaf sensor work and new sensors for PIMS in hydroponic area?
2-Jul	Email	Jochen Eberhard	Dan Corfe		sent results of EM38/NDVI survey of ALC, Canungra
3-Jul	Phone	Dan Corfe	Jochen Eberhard		talked about results for ALC, Canungra. Mentioned turf grading and precision irrigation
7-Jul	Phone	Jack McHugh	Sam Plant	1-15 min	Discussed monitoring of crop water use in hydroponic situations
7-Jul	Phone	Scott Wallace	Jack McHugh	1-15 min	Discussed black boy ridge DSL and to pressure monitoring
10-Jul	Phone	Dan Corfe	Steve Raine	30-45 min	irrigation performance evaluation issues

Date	Communication Method	Initiated by:	With:	Total Activity Time	Purpose
16-Jul	Phone	Geoff McGlashan	Steve Raine	1-15 min	Smart Science for Innovation in Horticultural Enterprises conference details
16-Jul	In-person	Other Horti	Steve Raine	1.5-2.0 hr	Smart Science for Innovation in Horticultural Enterprises conference presentation requirements
16-Jul	In-person	Steve Raine	Scott Wallace	45-60 min	RADS activities in horticulture - nutrient trial planning/PIMS deployment
16-Jul	Phone	Sam Plant	Steve Raine	1-15 min	Arranging access to dendrometers for Rose trial in Lockyer valley
18-Jul	In-person	Jochen Eberhard	Sam Plant	1.5-2.0 hr	Follow up on planned drainage trial
21-Jul	Email	Jochen Eberhard	Sam Plant	30-45 min	further elaborating on the discussion we had a few days ago about the problems a grower has with his greenhouse irrigation system
22-Jul	In-person	Other Horti	Jack McHugh	9-10 hr	Support workshop to Horticulture conference Gold Coast
22-Jul	In-person	Other Horti	Steve Raine	9-10 hr	Support workshop to Horticulture conference Gold Coast
23-Jul	Phone	Other Dairy	Steve Raine	15-30 min	Justin Schultz (EA Systems) Assistance with Lucerne irrigation performance evaluation for QDO
25-Jul	Email	Jochen Eberhard	Sam Plant	45-60 min	discussing greenhouse climate control and hydroponics drainage trial
30-Jul	email	Dan Corfe	Jochen Eberhard	15-30 min	detailing what might be needed to correlate NDVI with turf quality at GrassCo
1-Aug	Email	Steve Raine	Emily Litzow	30-45 min	Irrigation performance evaluation data in IPART
4-Aug	Email	Jochen Eberhard	Sam Plant	15-30 min	follow up on greenhouse climate control discussion we had last Friday
4-Aug	In-person	Loretta McKeering	Ben Muller	1-15 min	organising site visit to Story Farms
7-Aug	In-person	Ben Muller	Loretta McKeering	1.0-1.5 hr	combined site visit to discuss trial at Story Fresh
11-Aug	Phone	Jochen Eberhard	Sam Plant	1-15 min	discussed technical problems with some of his equipment
14-Aug	Email	Jochen Eberhard	Dan Corfe	15-30 min	further elaborated on how to relate NDVI with turf quality
21-Aug	In-person	Dan Corfe	Jochen Eberhard	1.5-2.0 hr	talked about NDVI trial at Cabarlah Park to relate NDVI to turf quality
27-Aug	Phone	Jack McHugh	David Hunt	1-15 min	Arrangements for open day
29-Aug	Phone	Jack McHugh	John McDonald	1-15 min	progress of Load Cells
29-Aug	Phone	Jack McHugh	Other Turf	15-30 min	Advised CSIRO SMS team of events for following week at turf Farm
3-Sep	Email	Loretta McKeering	Ben Muller	1-15 min	update on Story Fresh trial
4-Sep	email	Jochen Eberhard	Emily Litzow	1-15 min	update on EM38 and requested new sites
5-Sep	In-person	Jochen Eberhard	Dan Corfe	8-9 hr	met with Nicolas Car on two turf farms discussing SMS-ET service
8-Sep	Phone	Jack McHugh	John McDonald	1-15 min	progress of Load Cells
12-Sep	Phone	Jack McHugh	Ben Muller	1-15 min	Advised PIMS is ready for deployment
15-Sep	Email	Jochen Eberhard	Emily Litzow	1-15 min	asked for a few sites to use the EM38 and potentially the NDVI
16-Sep	Phone	Jochen Eberhard	Dan Corfe	1-15 min	arranged with him to contact Turfbiz and Cabarlah Turf Farm to start EM38 and NDVI trials in October
17-Sep	email	Jochen Eberhard	Sam Plant	1-15 min	updated him on DSL and drainage trial
17-Sep	Phone	Dan Corfe	Jochen Eberhard	1-15 min	arranged NDVI and EM38 survey at Turfbiz for 7th of October

Date	Communication Method	Initiated by:	With:	Total Activity Time	Purpose
17-Sep	Phone	Jack McHugh	David Hunt	1-15 min	Advised status of load cells and arranged delivery and requirements
18-Sep	In-person	Loretta McKeering	Ben Muller	3-4 hr	Delivery of PIMS to Growcom, set up and test at Story Fresh
18-Sep	Email	Loretta McKeering	Ben Muller	1-15 min	provide contact details
18-Sep	Email	Loretta McKeering	Ben Muller	1-15 min	provide contact details
19-Sep	In-person	Ben Muller	Loretta McKeering	1-15 min	collection of remaining PIMS gear and discussion on its use
22-Sep	In-person	Ben Muller	Loretta McKeering	15-30 min	discussion on how to analyse PIMS data & further PIMS2 issues
22-Sep	Email	Loretta McKeering	Ben Muller	1.0-1.5 hr	Emails & phone calls regarding PIMS2 equipment list, conversion equations for sensors, direct download of end node data, text file errors, aerial strengths
22-Sep	Email	Other NRW/SEQC	Steve Raine	15-30 min	Jinaraj - data from Mary Valley dairy water use
23-Sep	In-person	Loretta McKeering	Scott Wallace	1-15 min	return PIMS2 equipment for debugging
25-Sep	In-person	Loretta McKeering	Ben Muller	1-15 min	borrow hand auger for Story Fresh trial
26-Sep	Email	Loretta McKeering	Dan Corfe	1-15 min	RADS update
26-Sep	Email	Loretta McKeering	Sam Plant	1-15 min	RADS update
26-Sep	Email	Loretta McKeering	John McDonald	1-15 min	progress of Load Cells
29-Sep	Email	Dan Corfe	Loretta McKeering	30-45 min	general update + discussion on EM38 units and characteristics
30-Sep	Phone	Ben Muller	Loretta McKeering	1-15 min	arrange return of PIMS2 & hand auger

Table 2. Emails sent to stakeholders in relation to SEQIF RADS activities.

Industry	To Name	Subject	From Name
All	Steven Rees;Troy Symes	FW: Solution for Pressure Monitoring	Allen (Jack) McHugh
All	Steven Rees;Troy Symes	FW: Solution for Pressure Monitoring	Allen (Jack) McHugh
All	Troy Symes	EDAC e-farm solutions - cellular-monitoring	Allen (Jack) McHugh
All	Troy Symes	FW: PIMS Coordinator Decal	Allen (Jack) McHugh
All	Troy Symes	RE: Lables for Generics - PIMS	Allen (Jack) McHugh
All	Loretta McKeering;Jochen Eberhard	FW: gis training reminder	Allen (Jack) McHugh
All	'program@tmslaser.com.au'	PIMS Node Mounting Plate	Allen (Jack) McHugh
All	Gavin Brink	RE: PIMS Coordinator Decal	Allen (Jack) McHugh
All	'Geoff McGlashan';'Merv Jessen'	IDO training	Allen (Jack) McHugh
All	'Grodecki Andrew'	RE: CIRM SEQ Peri-urban R&D - Technical Prioritisation Workshop	Allen (Jack) McHugh
All	'Gus Brown'	RE: PIMS Node Mounting Plate	Allen (Jack) McHugh
Dairy	'Litzow, Emily'	RE: Farm at Harrisville	Allen (Jack) McHugh
Dairy	'yash.dang@nrm.qld.gov.au'	SSC and soil test kit	Allen (Jack) McHugh
Dairy	Jochen Eberhard	EM38 usefulness	Allen (Jack) McHugh
Dairy	Erik Schmidt	Tow bar for the rodeo	Allen (Jack) McHugh
Flowers	'duncan@flowersqueensland.asn.au'	FW: Soils Workshop	Allen (Jack) McHugh
Flowers	'David Pezzaniti'	RE: Data Signature Logger (DSL) promo leaflet	Allen (Jack) McHugh
Flowers	'David Pezzaniti'	RE: Logger/modem	Allen (Jack) McHugh
Flowers	'David Pezzaniti'	RE: Logger/modem	Allen (Jack) McHugh
Flowers	'David Pezzaniti'	RE: Logger/modem	Allen (Jack) McHugh
Flowers	'David Pezzaniti'	RE: Logger/modem	Allen (Jack) McHugh
Flowers	'David Pezzaniti'	RE: Logger/modem	Allen (Jack) McHugh
Flowers	'David Pezzaniti'	RE: Logger/modem	Allen (Jack) McHugh
Flowers	'David Pezzaniti'	RE: Logger/modem	Allen (Jack) McHugh

Industry	To Name	Subject	From Name
Flowers	'David Pezzaniti'	RE: Logger/modem	Allen (Jack) McHugh
Growcom	'Ben Muller'	turf fact sheet	Allen (Jack) McHugh
Growcom	'Ben Muller'	RE: IPART	Allen (Jack) McHugh
Growcom	'Ben Muller'	RE: Soils Workshop	Allen (Jack) McHugh
Growcom	'Scott Wallace'	Logger/modem for remote condition monitoring and reporting	Allen (Jack) McHugh
Growcom	Jochen Eberhard	FW: PIMS for NQ	Allen (Jack) McHugh
Growcom	Loretta McKeering	Ben Muller’s contact	Allen (Jack) McHugh
Growcom	Loretta McKeering	FW: Papers	Allen (Jack) McHugh
Growcom	Loretta McKeering	FW: Soil water extractors	Allen (Jack) McHugh
Growcom	Loretta McKeering	Laboratory Evaluation of the Horiba Cardy Nitrate Meter	Allen (Jack) McHugh
Growcom	Nishant Pradhan	testing for Nitrate in water samples	Allen (Jack) McHugh
Internal	Steven Raine	FW: SILO SMS costs	Allen (Jack) McHugh
Internal	Steven Raine	RE: RADS Project report	Allen (Jack) McHugh
Internal	Steven Raine	RE: RADS Project report	Allen (Jack) McHugh
Internal	Steven Raine	RE: RADS Project report	Allen (Jack) McHugh
Internal	Steven Raine	RE: RADS Project report	Allen (Jack) McHugh
Internal	Amjed Hussain	RE: seqif annual report	Allen (Jack) McHugh
Internal	Amjed Hussain	seqif annual report	Allen (Jack) McHugh
Internal	Loretta McKeering	RE: Information Sheets	Allen (Jack) McHugh
Internal	Erik Schmidt	FW: Factsheets/Information Sheets	Allen (Jack) McHugh
Internal	Erik Schmidt	FW: PIMS Node Mounting Plate	Allen (Jack) McHugh
Nursery	'tti@ttloadcells.com'	FW: Information Request: temperature compensation	Allen (Jack) McHugh
Nursery	'tti@ttloadcells.com'	Information Request: temperature compensation	Allen (Jack) McHugh
Nursery		Accepted: FW: Australian Horticulture Conference - Water workshop discussion	Allen (Jack) McHugh
Nursery	Erik Schmidt	FW: Weight Based Scheduling Project	Allen (Jack) McHugh
Turf	'jerry.spencer@etpturf.com.au'	ETP Query	Allen (Jack) McHugh
Turf	Jochen Eberhard	RE: NDVI	Allen (Jack) McHugh
Turf	Jochen Eberhard;Loretta McKeering	FW: Tami Mills EM38 report	Allen (Jack) McHugh
Turf	Loretta McKeering	RE: Turf factsheet	Allen (Jack) McHugh
Turf	Loretta McKeering;Jochen Eberhard	em38 paper	Allen (Jack) McHugh
Turf	'mark.silburn@nrm.qld.gov.au'	Data interpretation EM38	Allen (Jack) McHugh
Turf	'Nicholas.Car@csiro.au'	RE: Moving forward	Allen (Jack) McHugh
Turf	Guangnan Chen	FW: NIRS components	Allen (Jack) McHugh

Table 3. Emails with Flower industry - June to Sept 2008

FromName	ToName	Subject
Sam IDO water SEQ-IF	Allen (Jack) McHugh	missed call
Sam IDO water SEQ-IF	Allen (Jack) McHugh	Phytech battery/solar panel
Sam IDO water SEQ-IF	Allen (Jack) McHugh	phytech sensors
Sam IDO water SEQ-IF	Allen (Jack) McHugh	Lockyer
Sam IDO water SEQ-IF	Allen (Jack) McHugh	rain gauge idea
Sam IDO water SEQ-IF	Jochen Eberhard	RE: Derek's rose house
Sam IDO water SEQ-IF	Jochen Eberhard	RE: Derek's rose house
Sam IDO water SEQ-IF	'David Pezzaniti';Allen (Jack) McHugh	RE: Logger/modem

Table 4. Emails with Horticultural industry - June to Sept 2008

FromName	ToName	Subject
Ben Muller	Loretta McKeering;Allen (Jack) McHugh	Story contact details
Amjed Hussain	Allen (Jack) McHugh	Papers
Henderson, Craig W	Steven Raine;Allen (Jack) McHugh;Scott Wallace;Sam Plant	AuSHS Conference workshop - Understanding and managing water in horticultural cropping
Scott Wallace	Allen (Jack) McHugh;david.ingham@dfat.gov.au	FW: Letter From Australian Department of Agriculture, Fisheries and Forestry [SEC=IN-CONFIDENCE:COMMERCIAL]
Scott Wallace	Allen (Jack) McHugh	FW: Plant Sap Nitrate Meter
Henderson, Craig W	Steven Raine;Allen (Jack) McHugh;Scott Wallace;Sam Plant;Limpus, Sarah	AuSHS Conference workshop - Understanding and managing water in horticultural cropping

Table 5. Emails with Nursery industry – June to Sept 2008

FromName	ToName	Subject
John McDonald	Allen (Jack) McHugh	RE: Weight Based Scheduling Trial
John McDonald	Allen (Jack) McHugh	Weight Based Scheduling Trial
John McDonald	Allen (Jack) McHugh	RE: Weight Based Scheduling
John McDonald	Allen (Jack) McHugh	Weight Based Scheduling
Steve Hart	admin@gladlandflowers.com.au;admin@taravalley.com;adaroo@bluemaxx.com.au;anza@bigpond.com;austpark@bigpond.com;anthony@plantsofnoosa.com.au;Alex Jakimoff;Allen (Jack) McHugh;brisbanefoliage@bigpond.com.au;blackallrange@bigpond.com;birdwood1@optusnet.com.a	Redlands Research Station SPRINKLER open day
John McDonald	Allen (Jack) McHugh	Weight Based Scheduling
John McDonald	Hunt, David;Holborn, Shane;Allen (Jack) McHugh	Weight Based Scheduling Project

Table 6. Emails with Turf industry – June to Sept 2008

FromName	ToName	Subject
Dan Corfe	Allen (Jack) McHugh	RE: Friday nick carr
Dan Corfe	Nicholas.Car@csiro.au;Allen (Jack) McHugh	RE: Brizzie Visit
Nicholas.Car@csiro.au	Allen (Jack) McHugh;ido@qtpa.com.au	Brizzie Visit
Dan Corfe	Jochen Eberhard	RE: GrassCo
Dan Corfe	Jochen Eberhard	RE: GrassCo

Table 7. Emails related to instrumentation issues – June to Sept 2008

	FromName	ToName	Subject
All	Tony Luxford	Allen (Jack) McHugh	Quote #00016482; From Wiring Looms Aust Pty Ltd
All	Troy Symes	Allen (Jack) McHugh;Loretta McKeering;Steven Rees	Additions to technical note to program boot loader and application code for PIMS2.
All	Troy Symes	Steven Rees;Allen (Jack) McHugh	Instructions for Program Boot loader - PIMS2
All	Lidya Agustina	Allen (Jack) McHugh	RE: IPERTt
All	Tim Sheehan	Allen (Jack) McHugh	Thank you for Friday
All	Tim Sheehan	Allen (Jack) McHugh	Re: Online Enquiry
All	Mandy Jansz	'Mandy Jansz'	BIOLAB: New Solutions from GE That Make a Difference!
Flowers	David Pezzaniti	Allen (Jack) McHugh	RE: Logger/modem

Flowers	David Pezzaniti	Allen (Jack) McHugh	RE: Logger/modem
Flowers	David Pezzaniti	Allen (Jack) McHugh	RE: Logger/modem
Flowers	David Pezzaniti	Sam IDO water SEQ-IF;Allen (Jack) McHugh	RE: Logger/modem
Growcom	Merv Jessen	Allen (Jack) McHugh	G Harris Pump Calculator
Growcom	Troy Symes	Erik Schmidt	FW: Modman enquiry
Growcom	Troy Symes	Allen (Jack) McHugh	FW: Artwork Approval for file: USQ1010(c).pdf
Growcom	J. Matthew Pryor	Craig Baillie	Re: Demonstration
Growcom	Henry Bettle	Allen (Jack) McHugh	RE: Solution for Pressure Monitoring
Growcom	Henry Bettle	Allen (Jack) McHugh	Solution for Pressure Monitoring
Growcom	Troy Symes	Allen (Jack) McHugh;Steven Rees;Erik Schmidt	FW: Reid Industrial
Growcom	Gus Brown	Allen (Jack) McHugh	RE: PIMS Node Mounting Plate
Growcom	Gavin Brink	Allen (Jack) McHugh	PIMS Node Mounting Plate
Nursery	Troy Symes	Allen (Jack) McHugh;Loretta McKeering	Latest test data for load cells
Nursery	Troy Symes	Allen (Jack) McHugh	FW: Shipment from Digi-Key Corporation
Nursery	Troy Symes	Allen (Jack) McHugh	FW: Your Digi-Key order has been received.
Nursery	Troy Symes	Rabi Misra	RE: Load cell related info
Turf	Nicholas.Car@csiro.au	Allen (Jack) McHugh	Friday
Turf	Nicholas.Car@csiro.au	ido@qtpa.com.au	Invitation to turf growers
Turf	Nicholas.Car@csiro.au	ido@qtpa.com.au	RE: Brizzie Visit
Turf	Jerry Spencer	Allen (Jack) McHugh	NDVI
Turf	Jerry Spencer	Allen (Jack) McHugh	RE: ETP Query

Table 8. In-field liaison activities with partner industries – June to Sept 2008

Date	Personnel	Industry	Purpose
18 June	Jochen Eberhard & Loretta McKeering	Turf	NDVI & EM38 survey (ALC)
24-25 June	Loretta McKeering	Nursery	In-field load cell testing (TCC Nursery)
26 June	Jochen Eberhard & Loretta McKeering	Turf	NDVI & EM38 survey (GrassCo & ALC)
14 July	Jochen Eberhard & Loretta McKeering	Dairy	NDVI & EM38 survey (Mutdapilly RS)
6 August	Jochen Eberhard & Loretta McKeering	Turf	NDVI & EM38 survey (GrassCo)
7 August	Jack McHugh, Jochen Eberhard & Loretta McKeering	Horticulture	Nutrient trial site selection (Story Fresh)
8 August	Jochen Eberhard & Loretta McKeering	Turf	NDVI & EM38 survey (GrassCo)
25-26 August	Jochen Eberhard & Loretta McKeering	Horticulture	EM38 survey, soil sampling & weather station setup at nutrient trial site (Story Fresh)
29 August	Jochen Eberhard & Loretta McKeering	Horticulture	Soil sampling at nutrient trial site (Story Fresh)
11 September	Jochen Eberhard	Horticulture	Catch can measurements at nutrient trial site (Story Fresh)
26 September	Loretta McKeering	Horticulture	Install two replicates of enviroscans, catch cans and suction probes at nutrient trial site (Story Fresh)
27-30 September	Loretta McKeering	Horticulture	Data collection at nutrient trial site (Story Fresh)

South-East Queensland Irrigation Futures

Research and Development Support

Progress Report

December 2008

NCEA Publication 1002008/8

National Centre for Engineering in Agriculture
University of Southern Queensland
Toowoomba

1. Introduction

The South-East Queensland Irrigation Futures (SEQIF) Research and Development Support (RADS) project has been funded by the Queensland Department of Natural Resources and Water initially for two years to provide research and technical support to the SEQIF Industry Development Officers and SEQ Catchment staff. The key objectives are to:
provide research and development outcomes that will underpin a 10% improvement in water use efficiency by 2009 for SEQIF;
provide the basis for changes in on-farm water management practices and/or take-up of more water efficient equipment and operations through Research and Development (R&D);
assist in the uptake of farm management systems through better definition of best management practices and efficiency targets; and
assist grower involvement in SEQIF by providing up to date research for SEQIF stakeholders by conducting research at a local level while having access to the broader research framework of the CRC for Irrigation Futures at a national level.

1.2. *Activities as per Schedule 2*

This progress report provides an update of work conducted over the 6 months July – Dec 08 within each of the activity areas identified in an extract of Schedule 2 of the project contract.

SCHEDULE 2 *(of Project Contract)*

Note: The schedule Nos 1, 2 & 3 refer to the heading Nos 2, 3 & 4 of the following report

No	Description	Commencement	Completion
1.	Support IDO's in establishment of and maintenance of irrigation trial sites in SEQ in accordance with their Industry programs, the R&D priorities identified above and this Project's Terms of Reference. • Trial sites identified • Field data collection, collation and analysis • Technologies and management practices for improved irrigation practice developed trialled and evaluated.	1 July 2008	30 June 2009 30 September 2008 30 April 2009 30 June 2009
2.	Technical and scientific support and mentoring to Industry and Catchment groups • Training in irrigation performance and efficiency • Guidance on improved irrigation technologies and practices. • Support for developing best management practice and reduction targets. • Field day and workshop support	1 July 2008	30 June 2009 30 June 2009 30 June 2009 30 June 2009
3.	Reporting, Extension and Adoption • Collation and packaging of data and results • Preparation of Case Studies • Presentations to Industry and Catchment Stakeholders • Project Reporting	1 July 2008	30 June 2009
4.	Project Reporting – YEAR 3 Progress Report Project review & preparation for future activities Annual and Final Report		 31 December 2008 30 March 2009 30 June 2009

1.3 Summary of specific stakeholder prioritised RADS program activities

Horticulture – Root zone salinity and nutrient issues. Season one trial at Cambooya is complete, with the second season of measurements underway. Data analysis of the soil water extraction samples under lettuce production is currently being conducted.
Soil workshop support was provided to Growcom at Fernvale. A data signature logger (DSL) is providing high resolution flow rate data from an orchard near Helidon to the WWW which the farmer and IDO can access at any time to discuss irrigation performance.
Turf – Spatial variability. NDVI and EM38 surveys of a number of trial sites have provided maps and information to the IDOs and farmers that directly relate to irrigation performance and crop management practices.
Flowers – Leaf sensors and Data Signature Logger. Imported Leaf sensors have been assessed at the NCEA and have been found to functioning normally. A second DSL has been constructed and is ready for deployment to FAQI.
Dairy - Spatial variability. NDVI and EM38 surveys of a number of trial sites have provided maps and information to the IDOs and farmers. Collation with existing maps (soil and Salinity) have provided information for change in management practices
Nursery – Scheduling tools. Extensive testing of load cells under laboratory and field conditions has yielded a pot plant weighing system that demonstrates significant promise for scheduling irrigation events in protected environments.
All Industries – Instruments. PIMS was delivered to IDOs following considerable laboratory and field testing. IDOs and other interested parties attended an introductory brief on the operation and components of the system. Continuous logging tensiometers were delivered to Growcom. Web enabled DSLs have been constructed and delivered to the clients (Growcom and FAQI). Workshop support has been provided and general support has been delivered as per the communication tables listed at the end of this report.

2. Supporting IDOs in establishment and maintenance of irrigation research trial sites in SEQ in accordance with the R&D priorities identified above and this project's terms of reference.

2.1 Trial sites identified

2.1.1 Turf

2.1.1.1. Australian Lawn Concepts at Beaudesert was used for EM38 and NDVI Surveys

2.1.1.2. GrassCo and TurfBiz at Lowood were assessed for spatial variability with EM38 and NDVI.

2.1.1.3. Cabarlah Park has been intensively surveyed to establish relationship between quality and NDVI.

2.1.1.4. Some farms are still using the FAO56 ET_0 SMS service from Irrigateway server at CSIRO Griffith for the CRC IF. Stakeholder meetings in 2008 between the stakeholders hoped to establish 10 farms to participate in an extended trial, currently there are 4 farmers in the group.

1.2.2. Nursery Industry

Redlands DPI has been selected for longer term trial to test the weight based scheduling system. TCC nursery has been used for preliminary field assessment of load cells.

2.1.2. Flower Industry
Two sites at Grantham, Lockyer Cut Flowers and Derek's Roses have been established for the Data signature Logger. Further sites have been identified for the New Year to continue this work.

2.1.4. Horticulture Industry
2.1.4.1. Nutrient trials on lettuce production utilising SEQIF soil water extractors have been completed at Story Fresh Cambooya. A second season at this site is currently underway.
2.1.4.2. Blackboy Ridge Orchards at Helidon have been used to further assess the DSL and the web based data analyses.

2.1.5. Dairy & Fodder Industry
Sites at Kalbar, Mutdapilly, Harrisville and Innisplain have been established. Considerable numbers of EM38 and NDVI surveys have been conducted to assess variability in production and soils.

2.2. Field data collection, collation and analysis

2.3.1. Nursery
Weight based irrigation scheduling has been assessed utilising a various load cells. Load cell performance is dependent on manufacturing quality control. To that end, a suitable product has finally been found at a reasonable cost. Extensive static testing under controlled laboratory conditions is complete. Field testing at Toowoomba City Council Nursery has yielded expected data sets, which can be used to identify changes in plant pot weight that could trigger irrigation events.

2.3.2. Turf
The trials at Cabarlah Park Turf, Turfbiz, GrassCo and ALC are continuing. The IDO and farmers have been presented with a range of mapped outputs from NDVI and EM38 to consider in relation to their corresponding irrigation performance data and management practices.

2.3.3. FAQI
Imported leaf sensors have been assessed for correct operation at the NCEA and found to be functioning normally. A second data signature logger has been built and is ready for deployment to gather hydraulic signatures for analyses of irrigation performance. Previous signatures have been reviewed as farmers come to understand the technology.

2.3.4. Horticulture
The initial salinity accumulation and nutrient use lettuce farm trial at Cambooya was completed, but the data is yet to be analysed. The second trail is underway with an expected finish date in March.
Hydraulic data signatures gathered from Black Boy Ridge Orchards near Helidon, are available on the web site to the farmer and Growcom for daily and weekly water consumption and flow rates. Analyses/discussion between the IDO and farmer is ongoing.
PIMS was trialled on a pivot irrigation system at Clifton. The data is in the hands of Growcom.

2.3.5. Dairy
EM38 and NDVI surveys have been conducted in the Fassifern Valley. The outputs have been mapped into ArcGIS, collated (layered) with other maps (soil) and presented to the researchers and IDOs for their use.

2.3. Technologies and management practices for improved irrigation practice developed, trialled and evaluated

2.4.1. Spatial Variability
Extensive use of EM38 and NDVI surveys has been conducted in Turf and Horticultural industries to compare mapped variability with irrigation performance and crop quality.

2.4.2. PIMS
The PIMS system has been extensively developed in to a second generation management and assessment tool to evaluate irrigation performance. Four units have been built and delivered to the IDOs for deployment in their industries.

2.4.3. Data Signature Loggers
Second generation logger modems designed by the CRCIF have been duplicated at the NCEA and deployed to Growcom. Data is streamed to an ftp site at 30 minute intervals so that the farmer and IDO can easily access data for analyses and discussion of the system performance.

2.4.4. IPART
The tool is live on the web and is currently in full use by the majority of IDOs in SEQ and also in broad use in the cotton and grains industry of southern Queensland and Northern NSW. The Sugar Industry in southern and central areas of Queensland is also a registered user. The SEQIF RADS team have been providing technical support and upgrades to the tool as the users reported.

2.4.5. Load cells for weight based irrigation scheduling
Higher quality load cells, compared to the initial purchase, have been procured and are currently under field testing. They are showing great promise as a scheduling tool. The original load cells failed to perform to specifications even after considerable noise filtering and temperature compensation was applied to the devices over an extended period.

2.4.6. Other instrumentation and technology.

2.4.6.1. Continuous monitoring tensiometers
The GT3 Jetfill tensiometers vacuum transducers with voltage regulators ordered by Growcom are reported to be performing well.

3. Technical and scientific support and mentoring to Industry and Catchment groups

3.2. Training in irrigation performance and efficiency

Training
Preliminary introduction to PIMS: its components and use.
Introduction to remote sensing instrumentation and techniques at the AuSHS Conference Workshop.

3.3. Guidance on improved irrigation technologies and practices

Mentoring

Turf

Provision of crop vigour maps and EM38 soil condition maps to support and advise on irrigation performance management.

Flowers

Advice on hydraulic data signatures and interpretation. Advice on the performance of leaf sensors and runoff measurement.

Horticulture

General liaising IPART, PIMS, DSL and nutrient sampling instrumentation. Simple brief on plant based sensors and provision of literature.

Nursery

Discussion on weight based load cell requirements, use of outputs and interpretation of data to trigger irrigation systems. Briefed TCC nursery manger on irrigation system performance and efficiency, based on preliminary load cell data.

3.2. Providing support for developing best management practice and reduction targets has continued by:

a) Final development, testing and delivery of Generation 2 PIMS tool kit that is capable of near to real time display of performance and remote monitoring and download.
b) Assessment of irrigation spatial variability in the vegetable and turf industries.
c) Evaluation of hydraulic signatures as an irrigation performance monitoring tool.
d) Development of a weight based scheduling device for the nursery industry.

3.2.1. Providing field day and workshop support regarding research outputs

Support was provided to Growcom Soils workshop at Fernvale.

4. Reporting, Extension and Adoption

4.1. Collation and packaging of research data and outputs

The team has continued this output through:

a) Data Signature logging: Flow pattern analysis and recognition for improved irrigation efficiency and practices. Analysis presented to IDOs for discussion with farmers.
b) Preliminary crop water use in protected environments with weight based scheduling.
c) Promulgation on SEQIF web site information sheets on monitoring tools developed and available for use from the SEQIF team and NCEA. Include; PIMS, DSL, NDVI, EM38, ECv, tensiometer regulator.
d) Spatial variability of NDVI and EM38 mapping to the turf and Dairy industries.
e) Developed macros and software to facilitate data collation and analyses.

4.2. Preparation of case studies based on research outputs

No new case studies have been published during the six months covered by this report.

4.3. Presentation of research outputs to industry and catchment stakeholders

Activity reports to SEQ IDO, SEQ catchments, and SEQIF stakeholder meetings by Prof Steve Raine, Mr Erik Schmidt and Dr Jack McHugh.

5. SEQIF RADS Progress Report – Liaison with Industries

This quarterly report is produced in accordance with Item 9 of the Project Terms of reference - Identification of liaison with industries. It does not include details on any of the research and development support activities undertaken by this project.

The following tables capture the majority of liaison activity undertaken by the key members of the RADS team for the period October – December 2008.

Table 1 is a compilation of phone, email and in-person communications with the industries.

Tables 2-7 summarise email activity between the project leader, IDOs, stakeholders, colleagues and suppliers intimately involved in SEQIF activities. Note that these tables are not exhaustive, in that some activities have not been captured due to their incidental nature or inadvertently omitted. The email activity between the other RADS team members (McKeering, Eberhard, Raine etc to IDOs, Stakeholders and others, have not been included due to the counterproductive nature of compiling a complete and exhaustive list of contact, communication and liaison activities generally conducted by email.

Table 8 is a list of emails related to instrumentation issues.

Table 9 is a list of some of the in-field activities that have been undertaken. This table does not include the pre and post activities associated with the field work or the in-field work undertaken with the flower and horticulture industries sites.

Table 1. Communication activities by phone, email and in-person for liaison between members of the SEQIF supported industries for Oct to Dec 2008.

Date	Method	Initiated by:	With:	Total Activity Time	Purpose
1-Oct	In-person	Loretta McKeering	Ben Muller	1-15 min	return of PIMS2 to Growcom + discussion on use
6-Oct	Phone	Dan Corfe	Loretta McKeering	1-15 min	organise TurfBiz EM38 & NDVI trip
6-Oct	Email	Loretta McKeering	Ben Muller	1-15 min	PIMS2 & Story Fresh trial update
8-Oct	Email	Loretta McKeering	Ben Muller	1-15 min	PIMS2 update & downloaded data file
9-Oct	In-person	Scott Wallace	Steve Raine	1.5-2.0 hr	SEQIF program planning, soils workshop gear
13-Oct	Email	Jochen Eberhard	Ben Muller	1-15 min	arrange date for installation of Modem-Flow meter-logger at Blackboy Ridge, Gatton
16-Oct	Email	Jochen Eberhard	Dan Corfe	1-15 min	update on TurfBiz and Cabarlah Park
16-Oct	Email	Jochen Eberhard	Emily Litzow	1-15 min	request for new sites for EM38/NDVI surveys in the next couple weeks
17-Oct	Email	Loretta McKeering	Ben Muller	1-15 min	enquire about PIMS2 data collected (he hasn't done anything)
21-Oct	In-person	John McDonald	Steve Raine	2-3 hr	Benchmarking improvements due to SEQIF program activities
29-Oct	Email	Loretta McKeering	Ben Muller	1-15 min	enquire about PIMS2 data collected
30-Oct	Phone	Steve Raine	Sam Plant	15-30 min	performance evaluations and IPART data entry
30-Oct	Phone	Scott Wallace	Steve Raine	1-15 min	Micro sprinkler performance irrigation data entry
30-Oct	Phone	Sam Plant	Loretta McKeering	1-15 min	IPART issues
2-Nov	Phone	Ross Warren	Jack McHugh	1-15 min	New site at Innisplain for EM38 survey
3-Nov	Phone	Sam Plant	Loretta McKeering	1-15 min	IPART issues
3-Nov	Phone	Ben Muller	Loretta McKeering	1-15 min	Story Fresh DU tests, PIMS2 data, next PIMS site (Blackboy Ridge)
3-Nov	Email	Justin Clarke	Steve Raine	1-15 min	Micro sprinkler performance irrigation data entry
4-Nov	Phone	Jack McHugh	Ben Muller	1-15 min	PIMS at BB Ridge set up next week, IPART, and DSL data
7-Nov	In-person	Dan Corfe	Jochen Eberhard	2-3 hr	Visiting Cabarlah Park Turf to discuss NDVI-turf quality trial with grower
19-Nov	Phone	Ben Muller	Loretta McKeering	1-15 min	Request PIMS delivery
20-Nov	In-person	Justin Clarke	Loretta McKeering	1-15 min	Picking up PIMS unit
20-Nov	Email	Jochen Eberhard	Dan Corfe		15-30 min
1-Dec	In-person	Jack McHugh	Other NRW/SEQC	45-60 min	PIMS Intro and hand over to all IDOS and SEQC personnel
3-Dec	Phone	Ross Warren	Jack McHugh	1-15 min	Requesting the use of Beaudesert site - left message
3-Dec	Phone	Jack McHugh	Ross Warren		1-15 min
10-Dec	Phone	Dan Corfe	Loretta McKeering	1.5-2.0 hr	numerous phone calls assisting with setting up PIMS
13-Dec	Phone	Scott Wallace	Jack McHugh	1-15 min	Message regarding PIMS modifications
15-Dec	Phone	Sam Plant	Jack McHugh	1-15 min	Discussed sites for DSL and Leaf sensors
16-Dec	Phone	Ben Muller	Loretta McKeering	1-15 min	discussion/request to have PIMS coordinator fitted into a pelican box
17-Dec	Phone	Sam Plant	Jack McHugh	1-15 min	Discussion about protea data issues
17-Dec	Phone	Jack McHugh	Scott Wallace	1-15 min	DSL web page
17-Dec	In-person	Jack McHugh	Steve Hart	15-30 min	Discussed Load cell output with TCC manager and NGIQ IDO
18-Dec	Phone	Jack McHugh	Sam Plant	30-45 min	4 phone calls related to Leaf sen and DSL sites

Date	Method	Initiated by:	With:	Total Activity Time	Purpose
18-Dec	Phone	Jack McHugh	Other Dairy	1-15 min	Pat Daley arranged meeting and site for PIMS at Clifton Dairy farm with
19-Dec	In-person	Jack McHugh	Steve Hart	15-30 min	Discussed load cells at TCC with nursery manager
19-Dec	Phone	Jack McHugh	Other Nursery	1-15 min	Discussion of twin pot with Mal Hunter

Table 2. Emails sent to various stakeholders in relation to SEQIF RADS activities.

Industry	To Name	Subject	From Name
All	Dan Corfe; 'Sam IDO water SEQ-IF'; Scott Wallace; 'Ross Warren	PIMS delivery, training and demo	Allen (Jack) McHugh
All	'Geoff McGlashan'; Ben Muller; Dan Corfe; Duncan McGregor; John Miller; Merv Jessen; 'Ross Warren; Sam Plant; Scott Wallace; Steve Capeness; Steve Hart; Karen Murday ; 'Pat Daley (pmja2@bigpond.com)'	PIMS Launch	Allen (Jack) McHugh
Dairy	'Mark.Callow@dpi.qld.gov.au'	RE: response from Mark Callow, Dairy industry	Allen (Jack) McHugh
Dairy	'Warren, Ross G'	EM survey	Allen (Jack) McHugh
DPI&F	'Pendergast, Lance'	RE: Cannot edit recommendations in IPART	Allen (Jack) McHugh
FAQI	'David Pezzaniti'	RE: logger modem	Allen (Jack) McHugh
FAQI	'David Pezzaniti'	logger modem	Allen (Jack) McHugh
FAQI	'David Pezzaniti'	web page for Logger/modem	Allen (Jack) McHugh
FAQI	'David Pezzaniti'	RE: Costing for new signature logger	Allen (Jack) McHugh
FAQI	'David Pezzaniti'	RE: Signature Logger	Allen (Jack) McHugh
FAQI	'Sam IDO water SEQ-IF'	site for logger modem	Allen (Jack) McHugh
FAQI	'Sam IDO water SEQ-IF'	RE: Drip workshop	Allen (Jack) McHugh
FAQI	'Sam IDO water SEQ-IF'	Drip workshop	Allen (Jack) McHugh
Horticulture	'Limpus, Sarah'	Plant based sensors	Allen (Jack) McHugh
Horticulture	'Scott Wallace'	FW: logger modem	Allen (Jack) McHugh
Horticulture	'Scott Wallace'	RE: PIMS	Allen (Jack) McHugh
Horticulture	'Scott Wallace'	FW: Option for Growcom Soil Suction Logger etc.	Allen (Jack) McHugh
Horticulture	'Scott Wallace'; 'Ben Muller'	PIMS	Allen (Jack) McHugh
Internal	'Armando Apan'	RE: Handheld spectrometer	Allen (Jack) McHugh
Internal	Craig Baillie	PIMS photos	Allen (Jack) McHugh
Internal	Craig Baillie	FW: PIMS Launch	Allen (Jack) McHugh
Internal	Erik Schmidt	RE: NCEA Board Meeting	Allen (Jack) McHugh
Internal	Erik Schmidt; Steven Raine; Craig Baillie	RE: PIMS	Allen (Jack) McHugh
Internal	Jochen Eberhard	FW: PIMS	Allen (Jack) McHugh
Internal	Jochen Eberhard	RE: General update	Allen (Jack) McHugh
Internal	Jochen Eberhard	FW: logger modem	Allen (Jack) McHugh
Internal	Loretta McKeering	more to what troy has sent	Allen (Jack) McHugh
Internal	Loretta McKeering	RE: PIMS	Allen (Jack) McHugh
Internal	Loretta McKeering	RE: PIMS manual - battery packs	Allen (Jack) McHugh
Internal	Loretta McKeering	FW: Cannot edit recommendations in IPART	Allen (Jack) McHugh

Industry	To Name	Subject	From Name
Internal	Loretta McKeering	FW: Cannot edit recommendations in IPART	Allen (Jack) McHugh
Internal	Sharlene Gordon	RE: PIMS	Allen (Jack) McHugh
Internal	Sharlene Gordon	RE: ET Master class, 03 04 Nov	Allen (Jack) McHugh
Internal	Yvonne Hallaran	RE: Voice Message from Yvonne Hallaran (5498)	Allen (Jack) McHugh
Internal	Yvonne Hallaran	RE: Voice Message from Yvonne Hallaran (5498)	Allen (Jack) McHugh
Internal	Yvonne Hallaran	3G SIM card Request	Allen (Jack) McHugh
NRW	'Christiansen Col'	RE: IRES workshop	Allen (Jack) McHugh
NRW	Christiansen, Col @ NRW	PIMS Training and demo	Allen (Jack) McHugh
Nursery	Loretta McKeering	FW: Regarding lysimeter data in glass house	Allen (Jack) McHugh
Nursery	Sue Sutherland	purchase of load cells	Allen (Jack) McHugh
Nursery	'John McDonald'	RE: Weight Based Scheduling	Allen (Jack) McHugh
Nursery	'John McDonald'	RE: Weight Based Scheduling	Allen (Jack) McHugh
Nursery	'John McDonald'	RE: Weight Based Scheduling	Allen (Jack) McHugh
Nursery	'John McDonald'	RE: Weight Based Scheduling	Allen (Jack) McHugh
Nursery	Jyotiprakash Padhi	RE: Regarding lysimeter data in glass house	Allen (Jack) McHugh
Nursery	Jyotiprakash Padhi	RE: Regarding lysimeter data in glass house	Allen (Jack) McHugh
Nursery	'regional'	RE: Quote for PT1000-5kg 10M0005A000XXX	Allen (Jack) McHugh
Nursery	'regional@pt-global.com'	Quote for PT1000-5kg 10M0005A000XXX	Allen (Jack) McHugh
Turf	Jochen Eberhard	next week	Allen (Jack) McHugh
Turf	Jochen Eberhard	RE: Cabarlah Park Turf	Allen (Jack) McHugh
UQ	'Ben Boughton'	RE: Greenseeker	Allen (Jack) McHugh
UQ	'Ben Boughton'	RE: Greenseeker	Allen (Jack) McHugh

Table 3. Emails with Flower industry - Oct to Dec 2008

From Name	To Name	Subject
Sam IDO water SEQ-IF	Allen (Jack) McHugh	RE: site for logger modem
Sam IDO water SEQ-IF	Allen (Jack) McHugh	RE: Drip workshop
Sam IDO water SEQ-IF	'Murday Karen'; 'Merv Jessen'	RE: irrigation maintenance for Drip
Sam IDO water SEQ-IF	Jochen Eberhard	Leaf Sen
Sam IDO water SEQ-IF	'Merv Jessen'	irrigation maintenance for Drip
Sam IDO water SEQ-IF	Allen (Jack) McHugh	RE: site for logger modem
Sam IDO water SEQ-IF	Allen (Jack) McHugh	RE: Drip workshop
Sam IDO water SEQ-IF	'Murday Karen'; 'Merv Jessen'	RE: irrigation maintenance for Drip

Table 4. Emails with Horticultural industry - Oct to Dec 2008

From Name	To Name	Subject
Scott Wallace	Allen (Jack) McHugh; Ben Muller	RE: PIMS

Table 5. Emails with Nursery industry – Oct to Dec 2008

From Name	To Name	Subject
John McDonald	Allen (Jack) McHugh	RE: Weight Based Scheduling

John McDonald	Allen (Jack) McHugh	RE: Weight Based Scheduling
John McDonald	Allen (Jack) McHugh	RE: Weight Based Scheduling
John McDonald	Allen (Jack) McHugh	Weight Based Scheduling
John McDonald	Allen (Jack) McHugh	RE: Weight Based Scheduling
John McDonald	Allen (Jack) McHugh	Weight Based Scheduling
John McDonald	Allen (Jack) McHugh	RE: Weight Based Scheduling

Table 6. Emails with Turf industry – Oct to Dec 2008

From Name	To Name	Subject
Dan Corfe	Allen (Jack) McHugh	RE: Friday Nick Carr
Dan Corfe	Nicholas.Car@csiro.au;Allen (Jack) McHugh	RE: Brizzie Visit
Nicholas.Car@csiro.au	Allen (Jack) McHugh;ido@qtpa.com.au	Brizzie Visit
Dan Corfe	Jochen Eberhard	RE: GrassCo
Dan Corfe	Jochen Eberhard	RE: GrassCo

Table 7. Emails with SEQC/NRW – Oct to Dec 2008

From Name	To Name	Subject
Christiansen Col	Allen (Jack) McHugh	IRES workshop
Christiansen Col	Abdalla Barham; Adam Knapp; Anne Chamberlain; Anne Currey; Barry Stone; Brad Hussey; Brett Anderson; Craig Henderson; David Hunt; Dixon Ken; Donohue Ed; Gardner Ted; Gunawardena Thusitha; Haller Amy; Helen Fairweather; Jamie O'Brien; Jeffery Mark; Jensen	RWUE update 52
Pendergast, Lance	Allen (Jack) McHugh	RE: Cannot edit recommendations in IPART
Christiansen Col	Abdalla Barham; Adam Knapp; Anne Chamberlain; Anne Currey; Barry Stone; Brad Hussey; Brett Anderson; Craig Henderson; David Hunt; Dixon Ken; Donohue Ed; Gardner Ted; Gunawardena Thusitha; Haller Amy; Helen Fairweather; Jamie O'Brien; Jeffery Mark; Jensen	RWUE 3 Update No 51
Christiansen Col	Adam Knapp; Anderson Brett; Anne Chamberlain; Anne Currey; Bagdon Tad; Barham Abdalla; Brad Hussey; Craig Henderson; David Hunt; Dixon Ken; Donohue Ed; Gardner Ted; Gunawardena Thusitha; Haller Amy; Helen Fairweather; Jamie O'Brien; Jeffery Mark; Jensen G	RWUE update No 50

Table 8. Emails related to instrumentation issues – Oct to Dec 2008

Industry	From Name	To Name	Subject
All	Troy Symes	Allen (Jack) McHugh; Loretta McKeering; Steven Rees	Notes for today's changes to PIMS.
All	Troy Symes	Allen (Jack) McHugh; Steven Rees; Loretta McKeering	Most recent changes to the PIMS system
All	Troy Symes	Allen (Jack) McHugh; Loretta McKeering	FW: Series 810 vent filters enquiry from Australia

All	Troy Symes	Loretta McKeering; Allen (Jack) McHugh	Changes for PIMS manual - not urgent, but should be done for the next version of the manual.
All	Troy Symes	Allen (Jack) McHugh; Loretta McKeering	FW: Sales contact from AIC website
All	Troy Symes	Loretta McKeering; Allen (Jack) McHugh	Changes to PIMS Generic code by TS.
FAQI	David Pezzaniti	Erik Schmidt; Rick Darroch	RE: Costing for new signature logger
FAQI	Troy Symes	'David Pezzaniti'; Allen (Jack) McHugh; Jochen Eberhard	NCEA Sig Logger 2
FAQI	Troy Symes	Allen (Jack) McHugh; Jochen Eberhard	Meter inputs for Signature Logger
FAQI	Troy Symes	'Paul Kamel'; Steven Rees; Steven Raine; Allen (Jack) McHugh	16 bit ZigBee data logger
FAQI	David Pezzaniti	Allen (Jack) McHugh	RE: Costing for new signature logger
FAQI	David Pezzaniti	Allen (Jack) McHugh	RE: logger modem
FAQI	David Pezzaniti	Allen (Jack) McHugh	RE: Costing for new signature logger
FAQI	David Pezzaniti	Allen (Jack) McHugh	RE: Logger/modem
Horticulture	Troy Symes	Allen (Jack) McHugh	Option for Growcom Soil Suction Logger etc.
Nursery	Jyotiprakash Padhi	Allen (Jack) McHugh	Voltage output data from load cells
Nursery	Jyotiprakash Padhi	Allen (Jack) McHugh	RE: Regarding lysimeter data in glass house
Nursery	Jyotiprakash Padhi	Allen (Jack) McHugh	Regarding lysimeter data in glass house
Nursery	regional	Allen (Jack) McHugh	RE: Quote for PT1000-5kg 10M0005A000XXX
Nursery	regional	Allen (Jack) McHugh	RE: Quote for PT1000-5kg 10M0005A000XXX

Table 9. In-field liaison activities with partner industries –Oct to Dec 2008

Date	**Personnel**	**Industry**	**Purpose**
9-Jul	Jack McHugh	Horticulture	Soils Workshop Fernvale
21-Jul	Jack McHugh & Steve Raine	Horticulture	AuSHS Conference Workshop
11-Aug	Jochen Eberhard & Loretta McKeering	Horticulture	Site assessment Story Fresh
29-Aug	Jochen Eberhard & Loretta McKeering	Horticulture	Soil sampling at nutrient trial site (Story Fresh)
12- Nov	Jochen Eberhard & Loretta McKeering	Horticulture	Enviroscan problems, checking weather station
5-Dec	Jochen Eberhard & Loretta McKeering	Horticulture	Assisting Student
8-Dec	Jochen Eberhard & Loretta McKeering	Horticulture	Assisting Student
9-Dec	Jochen Eberhard & Loretta McKeering	Horticulture	extracting of Enviroscan probes and weather station
14-Nov	Jochen Eberhard	Turf	NDVI survey of trial sites
21-Nov	Jochen Eberhard	Turf	NDVI survey of trial sites
24-Nov	Jochen Eberhard	Turf	NDVI & EM38 survey of trial sites
28-Nov	Jochen Eberhard	Turf	NDVI survey of trial sites
05-Dec	Jochen Eberhard	Turf	NDVI survey of trial sites
15-Dec	Jochen Eberhard	Turf	NDVI survey of trial sites
18-Dec	Jochen Eberhard	Dairy	NDVI & EM38 survey of trial sites
20-Nov	Jochen Eberhard	FAQI	Leaf Sensors

South-East Queensland Irrigation Futures

Research and Development Support

Quarterly Report

March 2009

NCEA Publication 1002008/9

National Centre for Engineering in Agriculture
University of Southern Queensland
Toowoomba

1. Introduction

The South-East Queensland Irrigation Futures (SEQIF) Research and Development Support (RADS) project has been funded by the Queensland Department of Natural Resources and Water initially for two years to provide research and technical support to the SEQIF Industry Development Officers and SEQ Catchment staff. The key objectives are to:
provide research and development outcomes that will underpin a 10% improvement in water use efficiency by 2009 for SEQIF;
provide the basis for changes in on-farm water management practices and/or take-up of more water efficient equipment and operations through Research and Development (R&D);
assist in the uptake of farm management systems through better definition of best management practices and efficiency targets; and
assist grower involvement in SEQIF by providing up to date research for SEQIF stakeholders by conducting research at a local level while having access to the broader research framework of the CRC for Irrigation Futures at a national level.

1.1. *Activities as per Schedule 2*

This progress report provides an update of work conducted over the 6 months July – Dec 08 within each of the activity areas identified in an extract of Schedule 2 of the project contract.

SCHEDULE 2 *(of Project Contract)*

Note: The schedule Nos 1, 2 & 3 refer to the heading Nos 2, 3 & 4 of the following report

No	Description	Commencement	Completion
5.	Support IDO's in establishment of and maintenance of irrigation trial sites in SEQ in accordance with their Industry programs, the R&D priorities identified above and this Project's Terms of Reference. • Trial sites identified • Field data collection, collation and analysis • Technologies and management practices for improved irrigation practice developed trialled and evaluated.	1 July 2008	30 June 2009 30 September 2008 30 April 2009 30 June 2009
6.	Technical and scientific support and mentoring to Industry and Catchment groups • Training in irrigation performance and efficiency • Guidance on improved irrigation technologies and practices. • Support for developing best management practice and reduction targets. • Field day and workshop support	1 July 2008	30 June 2009 30 June 2009 30 June 2009 30 June 2009
7.	Reporting, Extension and Adoption • Collation and packaging of data and results • Preparation of Case Studies • Presentations to Industry and Catchment Stakeholders • Project Reporting	1 July 2008	30 June 2009
8.	Project Reporting – YEAR 3 Progress Report Project review & preparation for future activities Annual and Final Report		31 December 2008 30 March 2009 30 June 2009

1.2. Summary of specific stakeholder prioritised RADS program activities

1.2.2. Horticulture – Root zone salinity and nutrient issues. Season two trial at Cambooya is complete. Data analysis of the soil water extraction samples under lettuce production is currently being conducted. Soil samples are being analysed . Reports form season one and two are being complied and a Engineering Student is conducting salinity modelling work on the second season data.

A data signature logger (DSL) is continuing providing high resolution flow rate data from an orchard near Helidon to the WWW which the farmer and IDO can access at any time to discuss irrigation performance. Automatic software recognition of flow data is being developed.

1.2.3. Turf – Spatial variability. NDVI and EM38 surveys of a number of trial sites have provided maps and information to the IDOs and farmers that directly relate to irrigation performance (spatial variability and PIMS assessments) and crop management practices that impact on turf quality.

1.2.4. Flowers – Leaf sensors and Data Signature Logger. Leaf sensors have been deployed at Grantham to assess performance and understand scheduling requirements. A second DSL has been deployed to FAQI and has been used at Grantham with enthusiastic response from the farmer.

1.2.5. Dairy - Spatial variability. NDVI and EM38 surveys of a number of trial sites have provided maps and information to the IDOs and farmers. Collation with existing maps (soil and Salinity) has provided information for change in management practices. The Em38 is providing very useful data on irrigation spatial variability in combination with PIMS irrigation performance assessments.

1.2.6. Nursery – Scheduling tools. A weight based irrigation scheduling tool has been delivered to DPI Redlands to assess its performance against common scheduling techniques.

1.2.7. All Industries – Instruments. PIMS was launched on farm with a practical demonstration. Data collection platform was also displayed. General technical and instrumentation support has been delivered to Turf and FAQI IDOs in particular and Growcom to a lesser extent.

2. Supporting IDOs in establishment and maintenance of irrigation research trial sites in SEQ in accordance with the R&D priorities identified above and this project's terms of reference.

2.2 Trial sites identified

2.2.1. Turf

- Australian Lawn Concepts at Beaudesert was used for final PIMS assessments and case study development.
- GrassCo and TurfBiz at Lowood were assessed for spatial variability with EM38 and NDVI and PIMS assessment of travelling Gun.
- Cabarlah Park has been intensively surveyed to establish relationship between quality and NDVI.
- Some farms are still using the FAO56 ET_0 SMS service from Irrigateway server at CSIRO Griffith for the CRCIF, currently there are 4 farmers in the group.

2.2.2. Nursery Industry

Redlands DPI has been conducting a longer term trial to test the weight based scheduling system. TCC nursery has been used for preliminary field assessment of load cells.

2.2.3. Flower Industry

Two sites at Grantham, Lockyer Cut Flowers and Derek's Roses have been established for the Data signature Logger and Leaf Sen. PIMS assessment was conducted at a Crowsnest wax flower farm.

2.2.4. Horticulture Industry

- Two nutrient and salinity trials on lettuce production utilising SEQIF soil water extractors have been completed at Story Fresh, Cambooya.
- Blackboy Ridge Orchards at Helidon is continuing assessment of the DSL, web based data analyses and automated analyses software development.

2.2.5. Dairy & Fodder Industry

Sites at Innisplain and Nobby have been established. EM38 surveys have been conducted to assess variability in production and soils. PIMS performance assessments have also been conducted.

2.3. Field data collection, collation and analysis

2.3.1. Nursery

Field testing at Toowoomba City Council Nursery has yielded expected data sets, which were used to identify changes in plant pot weight that could trigger irrigation events. Data is currently been collected at Redlands DPI under trial conditions.

2.3.2. Turf

The trials at Cabarlah Park Turf, Turfbiz, GrassCo and ALC are continuing. The IDO and farmers have been presented with a range of mapped outputs from NDVI, EM38 and PIMS to consider in relation to their corresponding irrigation performance data and management practices.

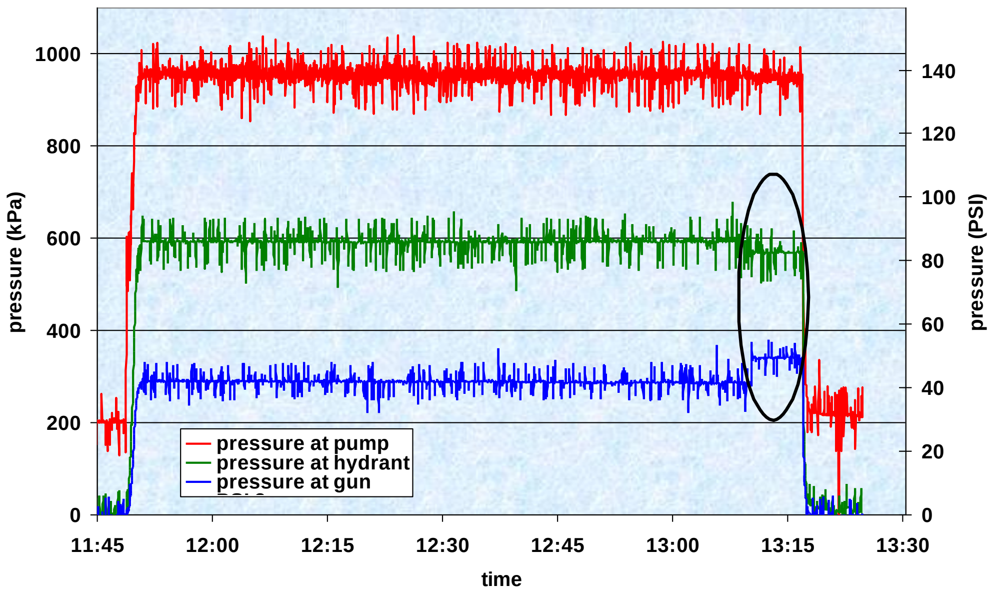


Figure 1: Pressures in a hard hose irrigator including the shut-down phase (black circle)

Since the introduction of the PIMS to the IDOs interest in utilising this technology even for standard pump tests has been growing thus demand for support in the field has increased.
The data collected with the PIMS detects and visualizes characteristics of specific irrigation systems that otherwise would go unrecognised. The change in pressure when a hard hose irrigation gun is pulled up at the kart becomes obvious in Figure 1 (black circled area). Utilising the PIMS on a travelling gun equipped with a GPS provides a full understanding of system performance in relation to topography and field position.

The trial at Cabarlah Park to establish a useful correlation between NDVI measurements and final turf quality has been continued and with the new platform configuration (**Figure 2**) it will be easier to collect the data. So far the experience is that the turf maintenance (mowing) has a major effect on what the NDVI system measures. Consecutive data sets produce dramatic visualisations of grass cover and quality (colour) but it is yet not clear if NDVI measurements can be used to support a turf growth/quality model.

Figure 2: NDVI and EM38 mounted on an Ag-bike

Utilizing the EM38 in a solid set turf irrigation system (pop-up sprinklers) to determine spatial variability of irrigation performance hasn’t been very successful so far primarily because the required accuracy for geo-referencing the data are much higher than that required centre pivots or travelling guns. A specific methodology is under development to collect and map high quality EM38 data.

PIMS – ALC
In March 2008 the PIMS unit was used to measure the pressure at the end of the main centre pivot at Australian Lawn Concepts, Canungra. The pressure transducer was located at an outlet of the overhead line near the last tower and logged for approximately two-thirds of an irrigation cycle. This analysis found that the pressure was inadequate when the end of the pivot was considerably elevated (eg when it was on top of the ridge). Pressures of less than 1 bar (14.5 psi) were measured for over half of the full irrigation circle and pressures of less than 0.7 bar (10 psi) were measured over one-quarter of the area logged. Since then the grower has installed a variable speed drive pump, so in March 2009 another analysis was undertaken using a PIMS unit to compare the results and see if the variable speed drive pump was delivering enough pressure throughout the irrigation cycle. This time the pressure transducer was installed immediately above the pressure regulator above the first nozzle after the end tower. The difference in elevation between the previous and current transducer locations would result in an approximately 0.2 bar (2.5-3 psi) increase in

pressure, although friction and minor losses would reduce this increase. Results of the 2009 analysis are shown in Figure 3.

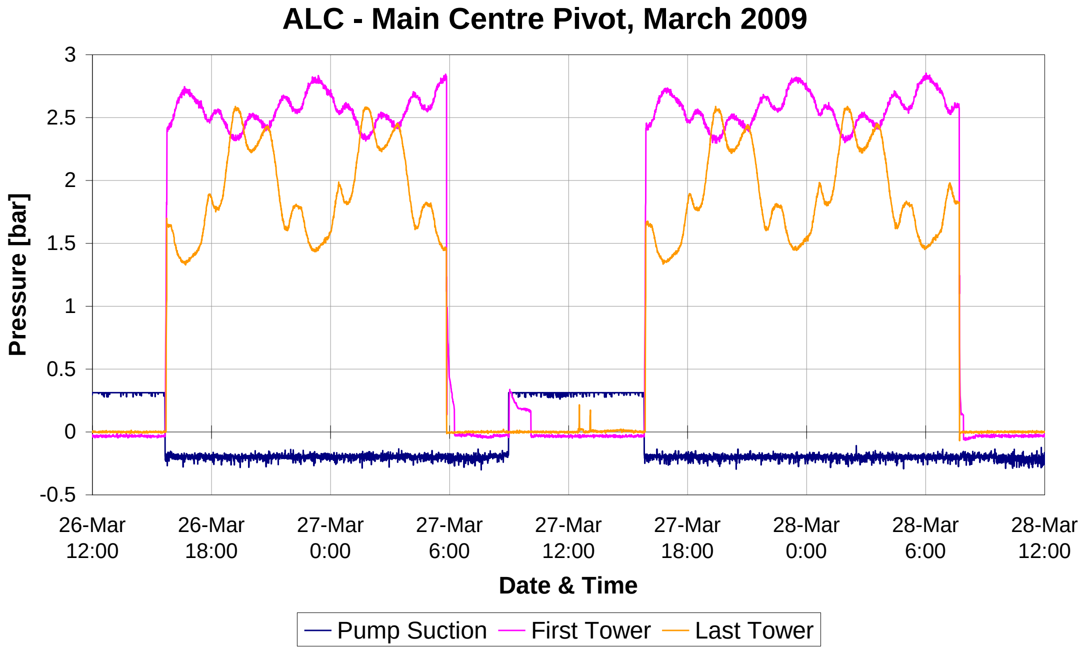


Figure 3: PIMS output from pivot irrigator at ALC Canungra

Figure 3 shows that the pressure has been increased satisfactorily. Pressure at the end tower now remains above 1.35 bar (20 psi) throughout the irrigation event. Assuming that the pressure regulators are set at 15 psi, sufficient pressure is reaching the end of the pivot to operate the regulators. The graph shows that there is still considerable variation in pressure at the end of the pivot, therefore some energy savings might be possible by adjusting the pump speed to reduce the higher pressures. The regions of higher pressure near the end of the pivot do however coincide with regions of lower pressure near the centre of the pivot, therefore it is likely that the pump speed has already been reduced and it may not be practical to further reduce this.

2.3.3. FAQI.

A strong collaboration with the Queensland Flower Association has been developed in the last few months based on evaluation of new and emerging technologies. Imported leaf sensors have been assessed at Grantham. A second data signature logger is also deployed nearby to gather hydraulic signatures for analyses of irrigation performance.

The automated high frequency logging of the water flow meter identical to that in the horticulture industry has been tested and utilised in a greenhouse for roses. The web-based data processing and presentation made the grower aware of problems he had with his irrigation system (sticky solenoids, Figure 4) and generally raised his interest in continuously measuring his irrigation activity (he bought himself a flow meter logger).

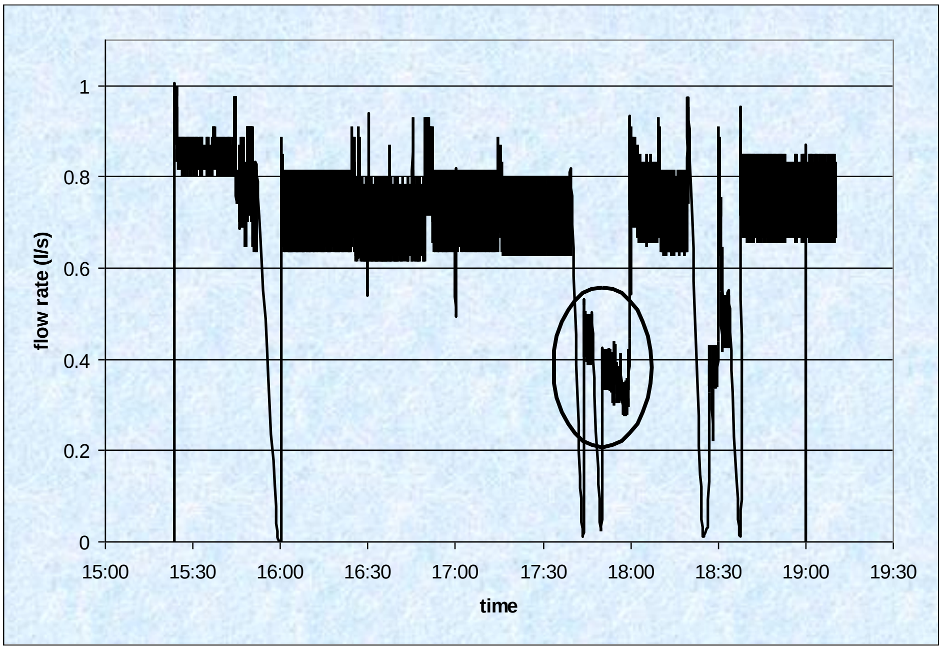


Figure 4. Flow-rates for different irrigation bays and associated problems with sticky solenoids (black circled area)

The logging of the flow meter was also an essential tool to evaluate the leaf based irrigation controller that used changes in leaf turgor pressure to schedule irrigations. Because this system was developed specifically for hydroponic applications, testing it in a soil based cropping system would have been very difficult without the information of the logged flow meter.
Figure 5 shows the diurnal changes in leaf thickness measure by the controller. The immediate dramatic jumps in thickness are caused by moving the sensors to new leaves.
Frequent visits to the trial site have been essential to build and maintain support to the grower. In concert with the IDO, RADS has displayed and discussed the collected data with the farmer.

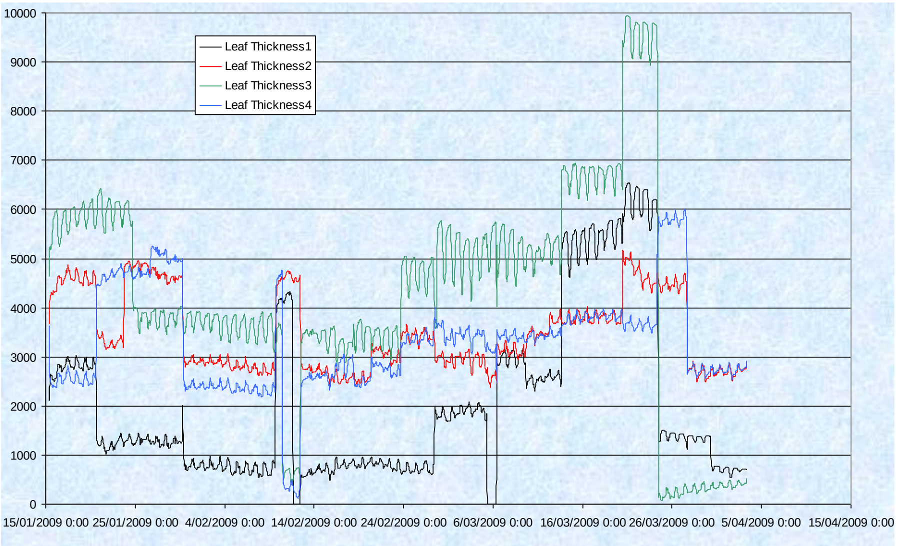


Figure 5. Example for diurnal changes of the thickness of leafs (sudden large changes indicate that the sensors has been moved to another leaf)

It would appear that this system could be used to establish kc values (crop factors) for indoor crops and open nurseries, because it is plant based and relatively independent of irrigation systems, shading/shelter structures and growing media. E.g. One out of five irrigation bays has been managed by the leaf based irrigation controller (Leafsen) while the other have been irrigated by the grower (best practise). **Table 1** shows the irrigation activity of a three week period in relation to calculated ET (SILO) for the region.

Table 1: daily irrigation records and comparison with SILO ET and calculated kc values

Date	Leafsen Mm	Grower mm	SILO ET 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
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	

The data can be used to calculate a kc value for any crop stage assuming that this irrigation controller tries to maintain a well watered crop. Utilizing this approach to establish kc values in indoor/nursery crops could be very cost effective.

PIMS has been employed to support a pump test at a wax flower farm and again the results have been very enlightening for all the participants. Due to field topography the water is pumped uphill and gravity fed to the dripper lines. Thus it took 45 minutes to reach the end of the drip line while barely attaining the minimum pressure requirements (Figure 6). This data is proved very useful for the IDOs in gaining a better comprehension of individual irrigation systems and improve their consultative activities, let alone being graphically indicative of the inadequacies of the installed system.

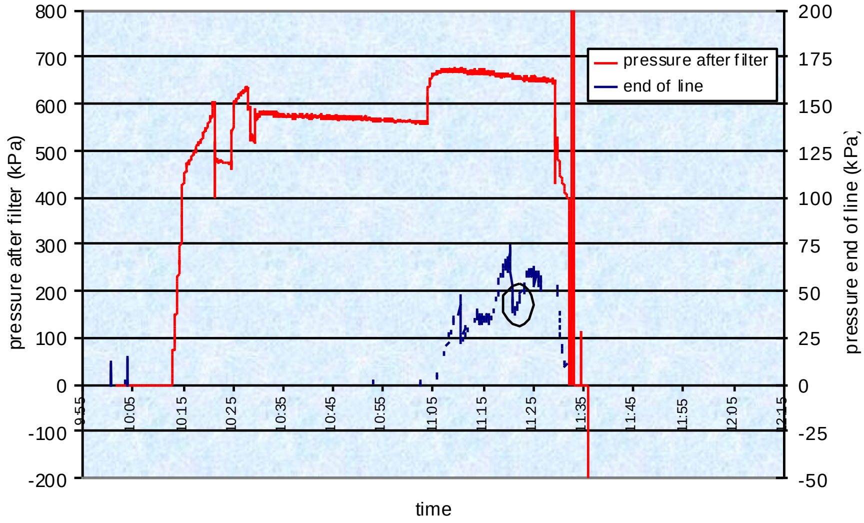


Figure 61. Pressure after the pump/filter and at the end of the drip line

2.3.4. Horticulture

The second nutrient and salinity trial at Cambooya was completed in mid March, although the laboratory soil analysis is still continuing. Data analysis of the soil water extraction samples under lettuce production is currently being conducted. Compiled results from the soil water samples extracted using SEQIF suction cups are shown in the figures 7 and 8.

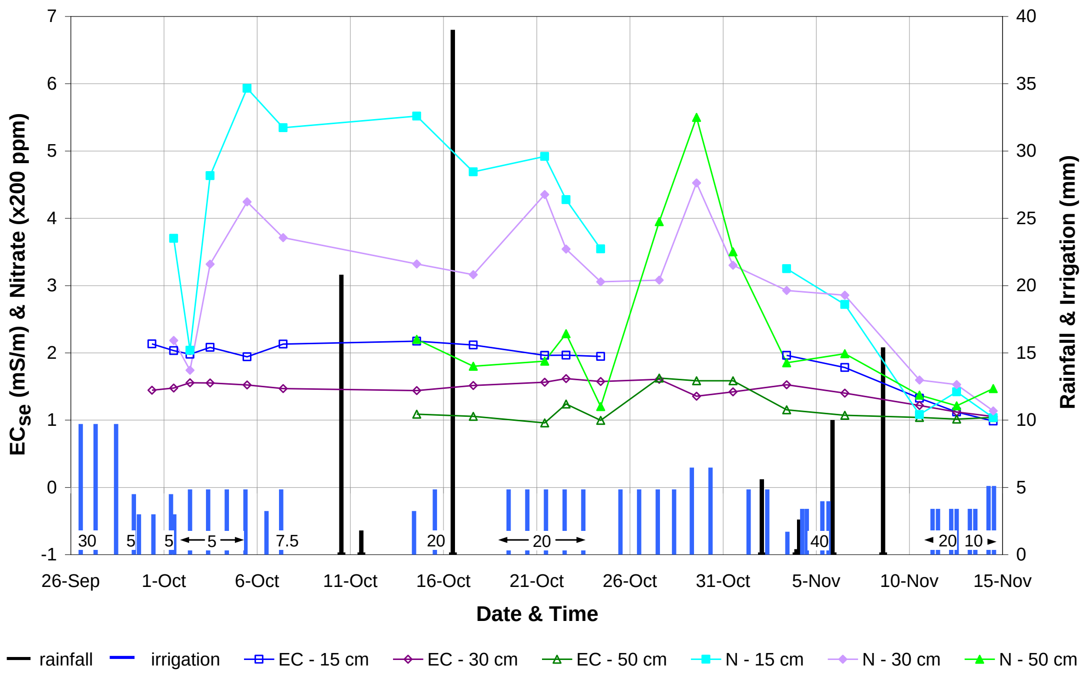


Figure 7. Electrical conductivity and nitrate at defined depths during the early season trial.

Season one shows no salinity accumulation and continual availability of Nitrogen. There is not enough information to suggest loss of N to deep drainage.

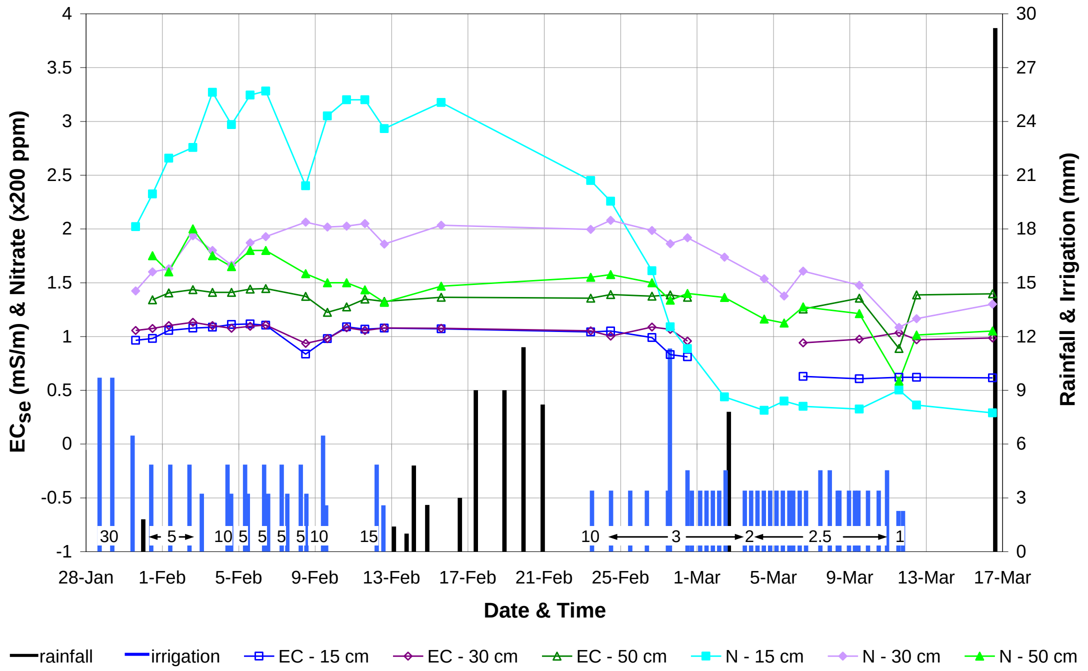


Figure 8. Electrical conductivity and nitrate at defined depths during the late season trial.

The second season (Figure 8) provided us with even fewer answers to the question of N utilisation or fate. The continual dosing of N is probably masking any sampling differences.
Note that there are a number of influencing factors that affect the results displayed in these graphs and further information is required in order to fully understand the cause and effect relationships. These influencing factors include differences in the distance from the suction cups to the drip tape emitters, distance to the plant row, soil water potential, dosing regime and the type of suction cups used. More comprehensive details (including methodology and all results) will be provided in the annual report.

Work with the high frequency flow meter logging was continued at an orchard near Gatton (Figure 9). In collaboration with a CRC IF funded project at the University of South Australia the web based data collection, processing and presentation was further developed (Figure 10).

Figure 9. High frequency flow meter logging at an orchard near Gatton

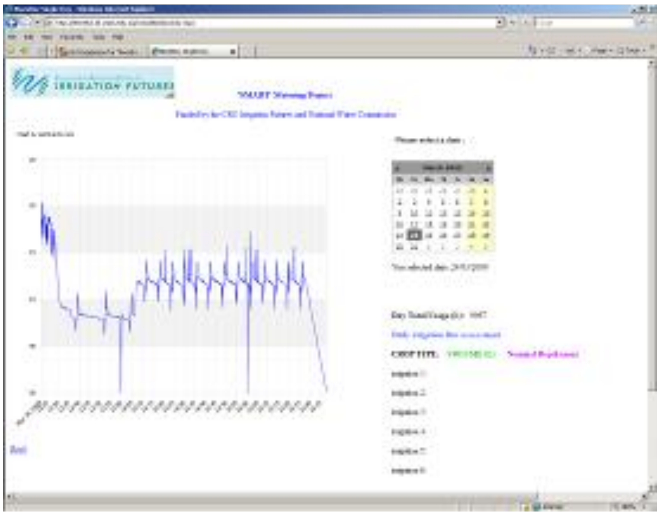


Figure 10: Web based presentation for flow meter data

Further collation of the collected data provides an excellent starting point to evaluate the irrigation management practice of the grower. Figure 11 shows the calculated application depth and application rate for individual irrigation blocks. The data displays obvious differences and variance in application providing considerable discussion on applied volumes of water to each tree (Figure 12).

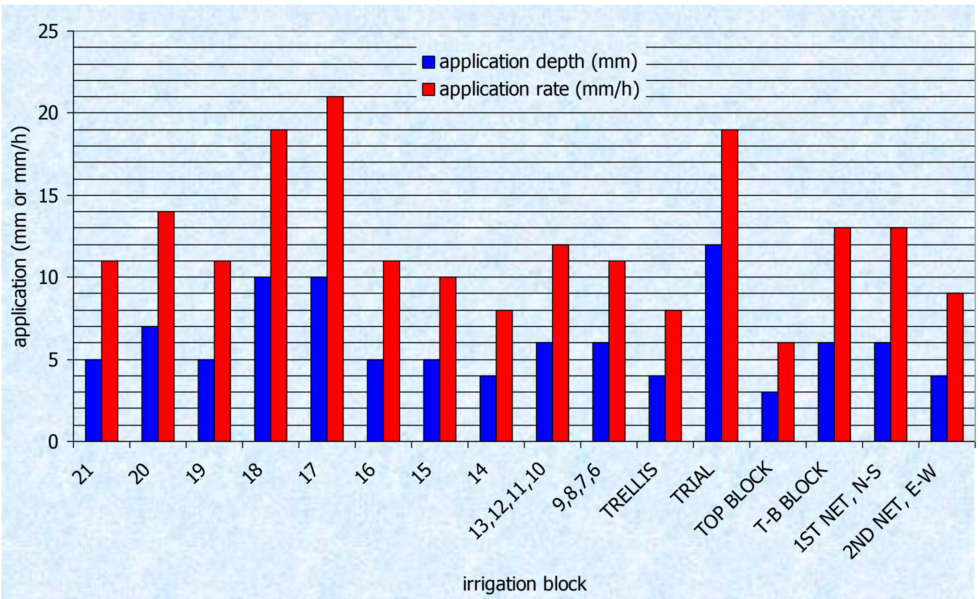


Figure 11. Application depth and rate for all irrigated blocks

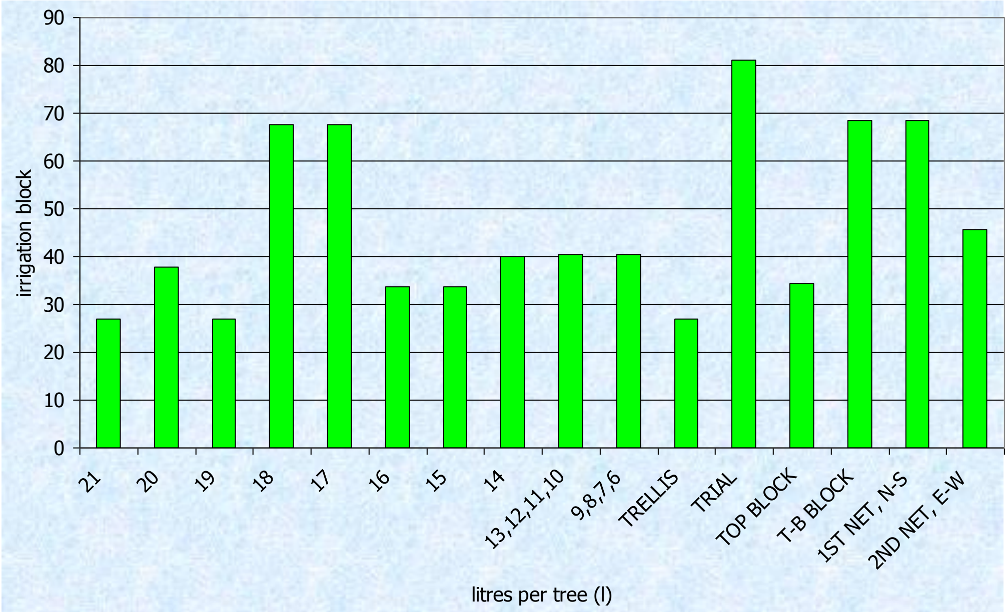


Figure 12. Variability of irrigated volume applied per tree (y axis) in the various blocks (x axis)

The high frequency logging of the flow meter not only provides information about the irrigation management practice but also about the irrigation system performance. Figure 13 shows that the system runs at different flow rates, which are achieved primarily by utilizing a variable speed pump. The critical aspect revealed by this graph is the frequency of automatic back-flushing of the filter system, which has a dramatic effect on the flow rate and consequently affects the pressure in the system and thus influencing the sprinkler/dripper performance. The grower was unaware that the system was basically back-flushing permanently at flow rates of 15 l/sec or above. Based on these findings it was also strongly suggested to use the PIMS to check for possible pressure variation in individual irrigation blocks.

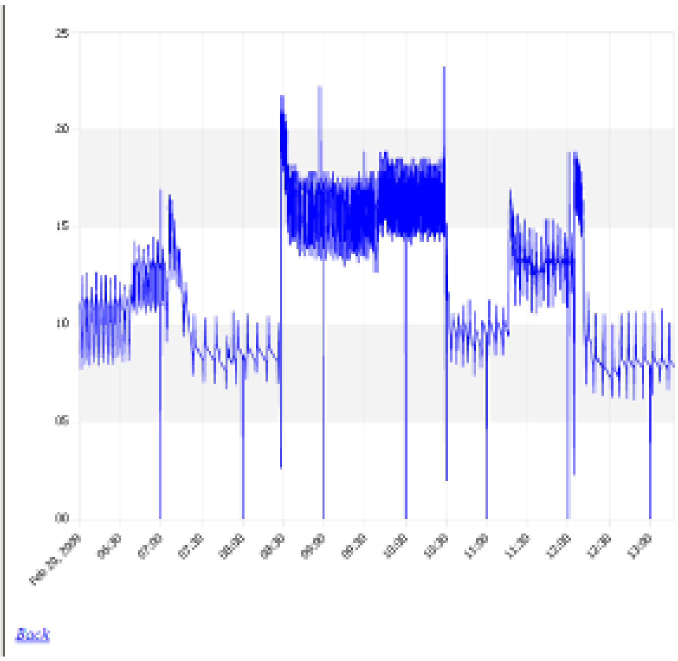


Figure 13. Variance of flow rates when irrigating different blocks

2.3.5. Dairy

EM38 and NDVI surveys have been conducted in the Fassifern Valley and Beaudesert areas. The outputs have been mapped into ArcGIS, collated (layered) with other maps (soil, irrigation pressure) and presented to the researchers and IDOs for their interpretive use.
Data collection on dairy and forage farms with the NDVI and EM38 technology was an ongoing process while the processing of the data takes considerable time.
Measuring the apparent electrical conductivity (EM38) of the soil proved to be highly beneficial. Figure 14 shows a survey of grazing land (marked as such) and a paddock irrigated with a Lateral Move irrigator. Blue indicates high soil moisture content with brown reflecting low soil moisture which appears indicative of water loss from storages.

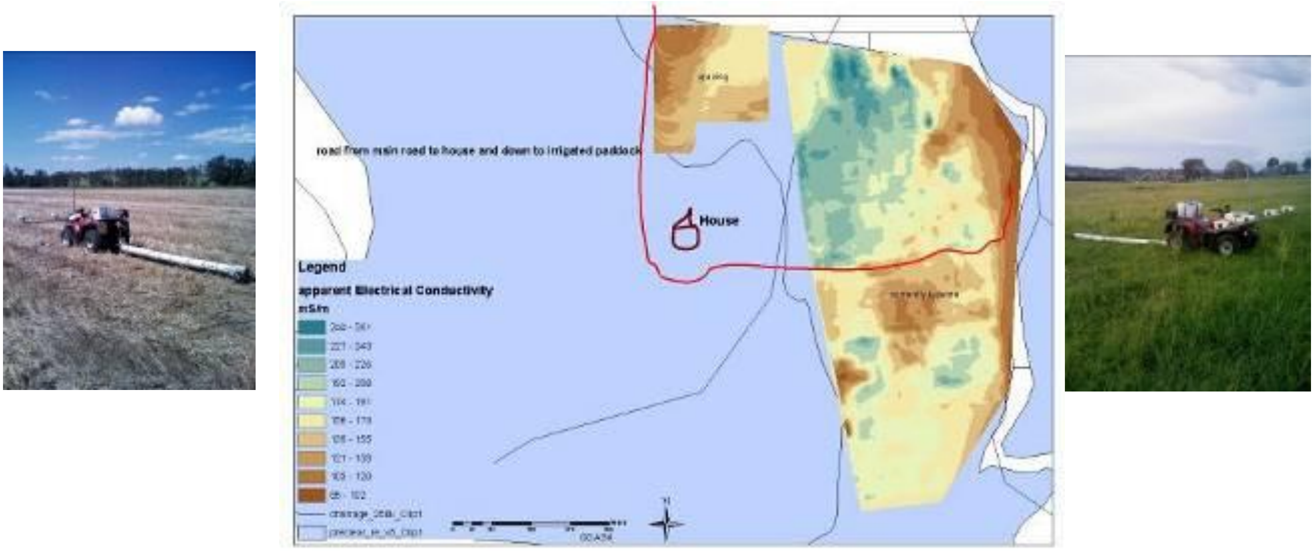


Figure 24. Apparent electrical conductivity (EM38) under Lateral Move irrigator and grazing pastures collected by quad mounted sensor platform.

The smaller pictures in figure 14 show the configuration of the NDVI and EM38 for a field survey where RADS relied mostly on farmer equipment and consequently setup was time consuming and dependant on what type of vehicle was available. Modifications to the sensor platform were trialled to improve this situation and finally an Ag-bike (pictured previously) offered the greatest flexibility. In the last few months our ability to conduct frequent surveys with minimal crop damage has increased dramatically.
Surveying the top horizon of the soil (0-50cm) with the EM38 reveals the spatial effect of an irrigation event on soil moisture. Taking concurrent soil samples during the survey and determining the absolute moisture content of these samples provides the opportunity to develop a relationship between the relative EM38 measurements and the actual soil moisture content (work developed by USQ and DERM). This is demonstrated in Figure 15 with classes of readily available soil moisture before and after irrigation of a Lucerne crop under a lateral move on sloping country.

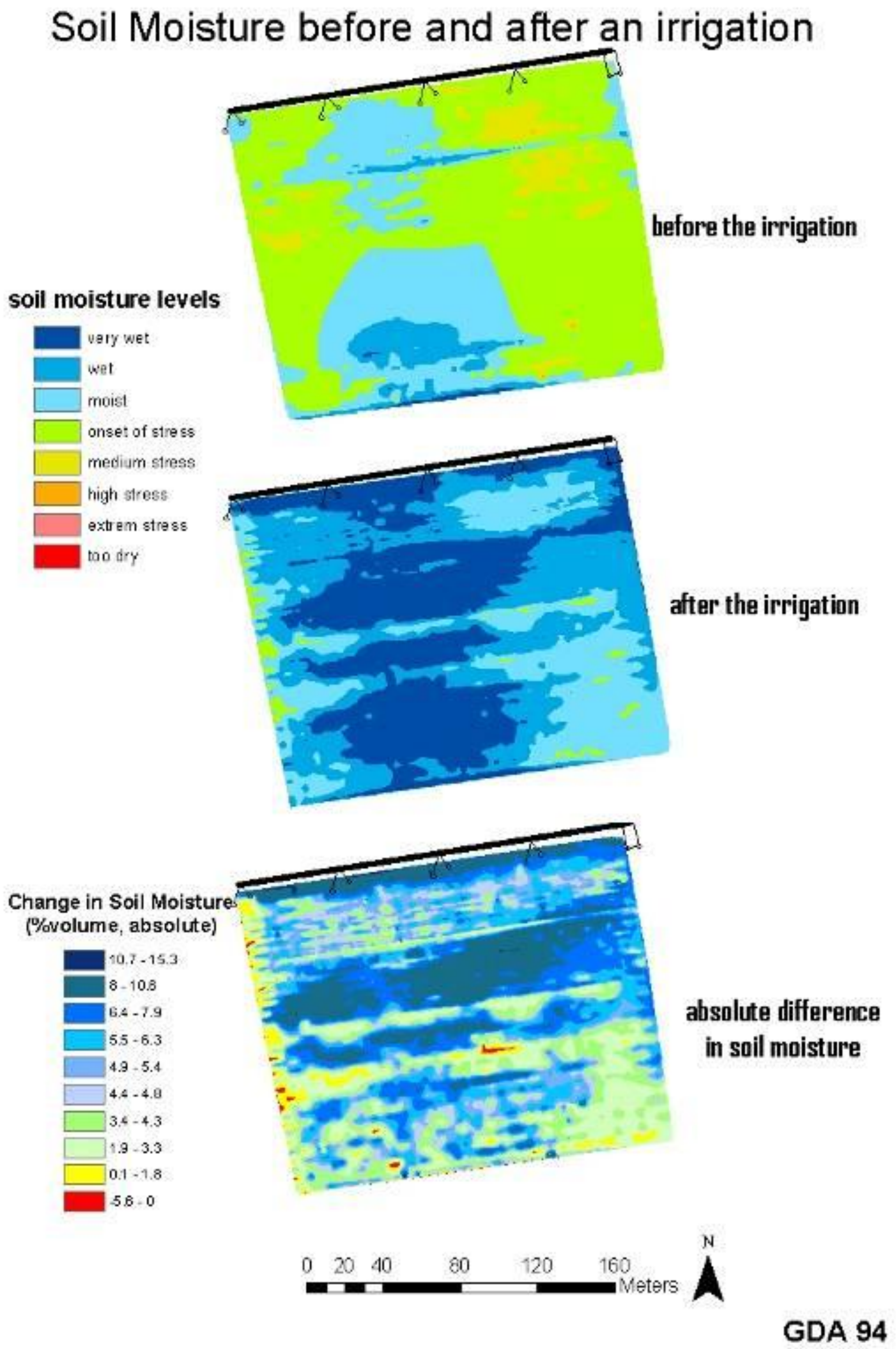


Figure 15. The change in soil moisture following an irrigation event

A few more surveys should be done on the same field to establish if the linear structures in the difference map (difference between soil moisture before and after the irrigation) can be related to the way the irrigation machine operates. If this relationship could be established the EM38 technology would be a very convenient way of rapidly measuring soil moisture deficit and the performance (distribution uniformity) of an irrigation system over the entire working area. This is significant because establishing the true spatial variability of an irrigation system with catch cans is basically impossible. These past few months has led to the combination of EM38 data with Geo-

referenced PIMS data to provide a complete duty cycle data set on the performance and spatial variability of a given irrigation system.
As indicated above PIMS was also tested on the same irrigator. One node was placed in the pump house, measuring pump pressure above ground and water level in the bore. A second node measured the pressure at the cart and a third node captured the pressure at the far end of the lateral. The data was transmitted to the central unit (coordinator) in two minute intervals and later downloaded. Figure 16 shows the immediate drawdown of the bore and the significant pressure loss from the pump to the irrigator. Unfortunately heavy rain terminated the irrigation event prematurely so data from the sloping country and other hydrants could not be captured.

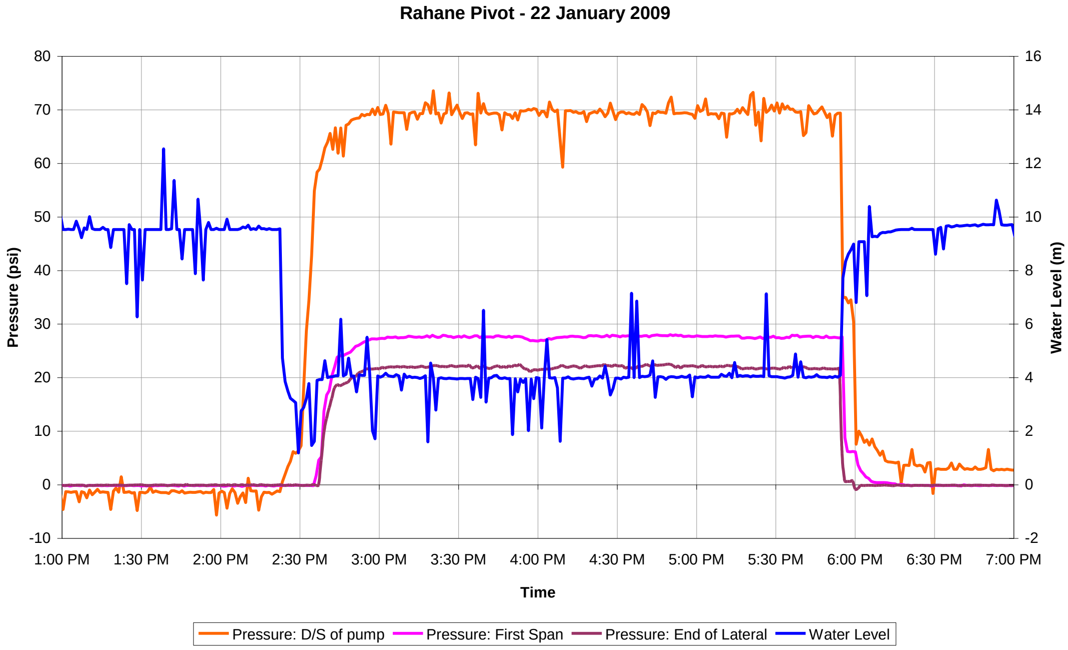


Figure 16. PIMS data for shortened irrigation, displaying bore water level and various pressures across the system.

Consultants and farmers are quite impressed with this kind of graph, where the pressure losses become so obvious and the relationship of pressures within the irrigation system is demonstrated. Completed combination data sets (PIMS + EM38) will be available as soon as weather and field conditions permit and are likely to be very impressive and revealing of irrigator performance.

2.4. Technologies and management practices for improved irrigation practice developed, trialled and evaluated

2.4.1. Spatial Variability

Extensive use of EM38 and NDVI surveys has been conducted in Turf, Dairy and Horticultural industries to compare mapped variability with irrigation performance and crop quality as seen above.

2.4.2. PIMS.

The PIMS system has been extensively developed in to a second generation management and assessment tool to evaluate irrigation performance and are heavily utilised in all but the nursery industry. Geo-referencing capability from Generation 1 PIMS is now integrated into Generation 2 PIMS.

2.4.3. Data Signature Loggers.

Second generation logger modems designed by the CRCIF have been duplicated at the NCEA and deployed to Growcom and FAQI. Data is streamed to an ftp site at 30 minute intervals so that the farmer and IDO can easily access data for analyses and discussion of the system performance. The FAQI farmer (Derek's Rose Farm) became so dependent on the information that he purchased his own logger to monitor his system.

2.4.4. Load cells for weight based irrigation scheduling.

The pot plant weighing system (WBS) is currently under trial at Redland Bay DPI Nursery facility.

2.4.5. Other instrumentation and technology.

Due to considerable refinements in the last few months on how the NDVI and EM38 data is collected, changes and additions have been made to the post-processing macros and the on-board data integration software.

3. Technical and scientific support and mentoring to Industry and Catchment groups.

3.1. Training in irrigation performance and efficiency

Training

PIMS Launch:
On farm demonstration of PIMS static display and irrigator mounted units at Innisplain attended by DERM, SEQC and all IDOs.

3.2. Guidance on improved irrigation technologies and practices

Mentoring

3.2.1. Turf

Continued provision of crop vigour maps and EM38 soil condition maps to support and advise on irrigation performance management. PIMS support for travelling gun assessments.

3.2.2. Flowers

Continued advice on hydraulic data signatures and interpretation. Technical support, installation and monitoring of the performance of leaf sensors. PIMS support and training at Wax flower farm.

3.2.3. Horticulture

General liaising PIMS, DSL and nutrient sampling instrumentation.

3.2.4. Nursery

Interpretation of data to trigger irrigation systems and utilisation of weight based scheduling device.

3.3 Providing support for developing best management practice and reduction targets has continued by:

- PIMS support and provision of customised research unit.
- Assessment of irrigation spatial variability in the pasture and turf industries.
- Evaluation of hydraulic signatures as an irrigation performance monitoring tool.
- Development of a weight based scheduling device for the nursery industry.

3.4 Providing field day and workshop support regarding research outputs

PIMS launch and field demonstration of its use was delivered at Innisplain near Beaudesert.

4. Reporting, Extension and Adoption

4.1 Collation and packaging of research data and outputs

The team has continued this output through:

a) Data Signature logging: Flow pattern analysis and recognition for improved irrigation efficiency and practices. Analysis presented to IDOs for discussion with farmers.
b) Delivery of Leafsen data for irrigation scheduling.
c) Updated SEQIF web site promulgations on monitoring tools developed and available for use from the SEQIF team and NCEA. Include; PIMS, DSL, NDVI, EM38.
d) Delivery of irrigation spatial variability mapping to the Turf and Dairy industries.
e) Modified existing macros and software to facilitate data collation and analyses.

4.2. Preparation of case studies based on research outputs

Case studies under development for ALC turf, and Rahane pasture production,

4.3. Presentation of research outputs to industry and catchment stakeholders

PIMS data and utilisation at Rahane PIMS launch.
Presentation of Turf quality NDVI trial at Turf Growers board meeting at Cabarlah Park.

5. RADS activity review 2009-11

RADS has had preliminary discussions with the IDOs as to areas of activity for the next round of the support program. The responses received were brief and need to be developed more. However the theme tends to be continuation of the current work, mostly on a task orientated basis.

5.1. Dairy

To provide R&D with PIMS, sensor/instrument support, and more importantly continue to research spatial variably and irrigation deficits with the EM38 (scheduling and irrigator performance).

5.2. Flowers

The FAQI had not provided a clear direction for future activities at the time of writing this report. However RADS suggested a continuation to provide R&D with PIMS, Smart water metering (DSL) and sensor/instrument support. Obviously RADS has expertise in other areas and would like the opportunity to discuss any priority research tasks that are under consideration by FAQI.

5.3. Turf

The QTPA IDO had not provided a written response to RADS email raised from a telephone discussion on future activities. The following describes the main points of the discussion. SEQIF RADS would continue to provide R&D with PIMS, sensor/instrument support and more importantly continue to research spatial variably and irrigation deficits with the EM38 and turf quality indicators with the NDVI. Also as QTPA IDO indicated on the phone there is a need to investigate and develop software and tools that provide cost/benefits related to inefficiencies in irrigation systems. Adaption of some existing ready reckoners and software to Turf could be investigated. This last season RADS undertook to determine yield response with the NDVI sensors without a great deal of success, in the coming season that research could be tightened up, refined and re focused to also include cost benefit analysis. This would tie-in with spatial variability and fertiliser applications.

5.4. Nursery

NGIQ provided preliminary endorsement for RADS to apply significant effort into establishing an interface between the WBS tool (data logger, etc) and on-farm irrigation controllers commonly used (e.g. Hunter, Rainbird, etc) within nursery production. This effort is contingent on the results of the current trials of the WBS at Redlands. RADS also considered that the WBS and LeafSen technology could be utilised in determining crop factors for indicator crops in protected environments.

5.5. Horticulture

Growcom had not provided a clear direction for future activities at the time of writing this report as RADS, DPI Gatton and Growcom had not determined a mutual meeting time to discuss research direction a priorities.

SEQIF RADS suggested continuing to provide R&D with PIMS, smart water meter, sensor/instrument support, and more importantly continue to study solute management. Our past 2 of 3 trials had not provided definitive answers to the question of salinity accumulation and Nutrient loss. Soil water extractor methodology (solute monitoring) needs to be revised and inclusion of concurrent sampling/data collation (5 strand approach) is crucial in understanding solute movement/responses.

Research on irrigation spatial variably and irrigation deficit measurement on a field scale with the EM38 are well advanced in other industries. Our mapping and surveying product has been extremely useful in providing turf, cotton and pasture producers with spatial knowledge to improve irrigation and farm efficiencies, which is a significant improvement on the point determination of spatial variability conducted in horticulture previously.

SEQ Irrigation Futures R&D Support

Dairy and Fodder Production

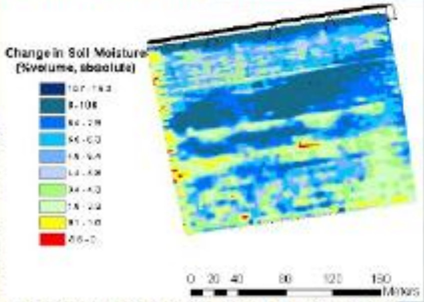
NCEA

Lucerne lateral move irrigator performance

The Lucerne system:
Machine Make: Reinke
Sprinkler Wetted Radius: (m) 6
Machine Length: (m) 210
Sprinkler Height: (m) 1.49
Underground water supply

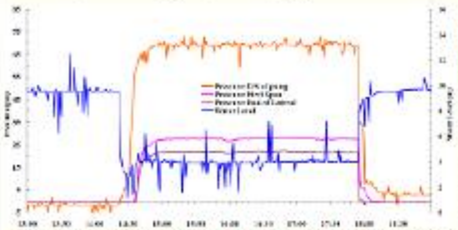
CU was above required levels, farm irrigation management efficiency had increased significantly since considerable adjustments had been made to the lateral move (LM). However the sprinkler package and total flow were identified as issues of concern.

PIMS data confirmed pressure along the LM was maintained at <20psi above regulated pressure. Bore draw down (6m) was significant, but remained constant at 4m throughout the duty cycle. However both these aspects will be exacerbated as pump distance increases and topography changes down field.



EM38 survey of a lucerne field irrigated by a LM set to apply 25mm of water. The map represents the spatial variability of applied irrigation water.

The LM set to apply 25mm achieved an average application depth of 15mm during the catch can test. According to an EM38 applied water survey, the % change in soil water volume ranged from 2-15%. Suggesting very high water application at the top and mid field sections and limited application elsewhere. The spatial variability map of applied irrigation water was indicative of inconsistent travel speed over the length of the field, However on paper (DU 84.6%) appeared reasonable across the field.



PIMS output of bore drawdown, pump and irrigator pressures for the irrigation of a lucerne field over 4 hour period.

IRRIGATION FUTURES

National Centre for Engineering in Agriculture, University of Southern Queensland
Member of the CRC for Irrigation Futures

USQ
Queensland Government

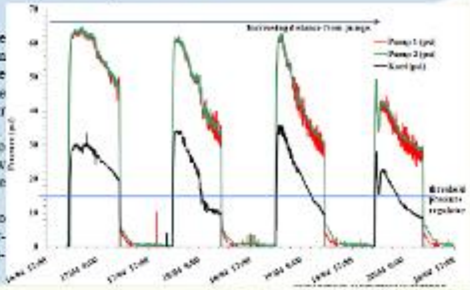
Pasture lateral move (LM) irrigator performance

Irrigation performance assessment	Lucerne	Pasture
Pressure at Inlet (kPa)	179	220
Pressure at End (kPa)	124	213
Pressure Regulator Value (kPa)	68.9	68.9
Average Depth Applied (mm)	14.97	27.70
Mean application rate (mm/hr)	-	21.9
Speed Setting (m/hr)	37.38	18
DU (%)	84.62	84.16
CU (%)	90.52	89.64

This system would be very hard to diagnose the exact problems without using PIMS over the entire duty cycle. Often these types of installations have problems which go undiagnosed for years. The LM operates over a slight 6m rise for approximately 400m, with pipe friction total head loss was10m approximately. In addition the two bore hole pumps operating the LM were not matched at their best efficiency points, therefore one bore was being drawn down more over time. Draw-down was considerable over two to three days which had a significant impact on the inlet pressure at the machine. The pressure regulators at 10psi will regulate up to 50psi inlet pressure. However as the machine travels up the hill, further from the pumps, the inlet pressure drops below 15psi and spray pressure becomes untenable, adversely affect the DU.

Suggestions:

- Re-nozzling the sprays could be the solution. However system capacity will be reduced as the extraction of water from the bores is restricted to 6 hours per day.
- Installing gypsum blocks to schedule irrigation would allow more recovery time for the bore levels.
- Utilise an existing ring tank to store water that could be harvested from the bores at a sustainable rate.



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SEQ Irrigation Futures R&D Support

TURF

NCEA
NATIONAL CENTRE FOR ENGINEERING IN AGRICULTURE

Pressurised Irrigation Monitoring System (PIMS)

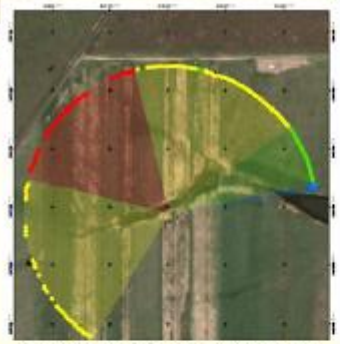
At the beginning of the SEQIF program a number of irrigation systems performance assessments were conducted by the QTPA IDO. One such performance assessment was on a Valley centre pivot irrigation system that operates on undulating country with a change in elevation of 21m around the perimeter of the circle. The manager had been experiencing runoff, water logging, and wheel rutting and sprinkler ground clearance at various points around the wetted area.

The irrigation system:

Machine Make: Valley 8120 Centre Pivot c/w end gun.
Measured Wetted Radius: (m) 276
Machine Length: (m) 256.50
Radius: (m) 266.02
Sprinkler Height: (m) 1.40
Pressure Regulator Value (kPa) 103.40
Variable speed pump
Surface water supply

Initial infrastructure inspection revealed:

- Inlet suction velocity exceeds 2m/s
- Outlets consisted of Angus flexible elbows and pipe
- Control panel not integrated with the pump
- Controller not calibrated to travel speed
- Sprinkler package mismatched to speed and height.
- Span re-assembly and alignment required
- Significant pressure variation on pivot perimeter.
- End gun running continuously.



Pressure at the end of a centre pivot operating on undulating country.
< 70 kPa | 70-110 kPa | 110-180 kPa | > 180 kPa

National Centre for Engineering in Agriculture, University of Southern Queensland
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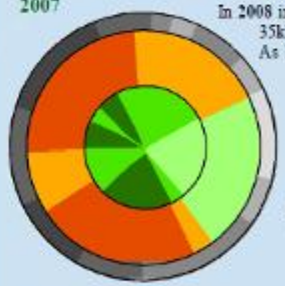
Turf pivot irrigator performance

2007



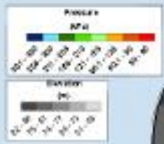
In 2007 system pressure was less than that required for appropriate operation of the pressure regulators (103kPa).

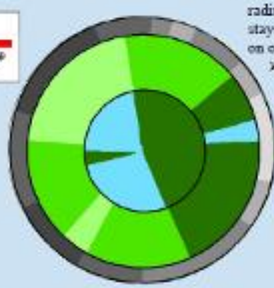
In 2008 inlet and outlet piping was changed and pressure adjusted to at least 35kPa greater than the pressure regulators.

As highlighted by PIMS output, there was still considerable pressure variation around the full duty cycle, but according to catch can test, the machine was operating at 87%, following the changes to initial condition. Therefore it looks reasonable on paper, but a lot more needs to be done to utilise machine capacity and optimise irrigation performance.

Further recommendations:

- Fully utilise pump variable speed options with transducers sensor on pivot perimeter and automate.
  - Remove end gun booster pump & operate gun in the corners.
    - Reduce instantaneous wetting rate by increasing wetted radius by either: (a) Raised sprinklers (2m), (b) Spread stays or (c) Fit extension "T" pieces and reduced nozzles on outer 1/4 of the pivot.
      - Optimise irrigation scheduling to higher ground.
        - Reconsider irrigation management in low lying areas.





2008

Irrigation performance (QTPA IDO) for an initial condition assessment in 2007 and post modification assessment in 2008.

Irrigation performance assessment	2007	2008
Pressure at Centre (kPa)	196.5	241
Pressure at End (kPa)	182.7	206
Average Depth Applied (mm)	2.74	2.66
Weighted Average (mm)	2.63	2.54
Wetted Radius of Pivot (m)	276	285
Wetted Radius of End Gun (m)	12.70	40
Weighted Av. (CU mod HH) (mm)	2.40	2.46
CU mod HH (effective area)	80.86	87.06

PIMS assessment of irrigation performance over the complete duty cycle conducted by NCEA for an initial condition assessment in 2007 and post modification assessment in 2008. Inner circle indicates pressure at the pivot point, middle circle is indicative of pressure on the pivot perimeter and the outer circle is the change in elevation at pivot perimeter.

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SEQ Irrigation Futures R&D Support

The Wireless Pressurised Irrigation Monitoring System (PIMS)

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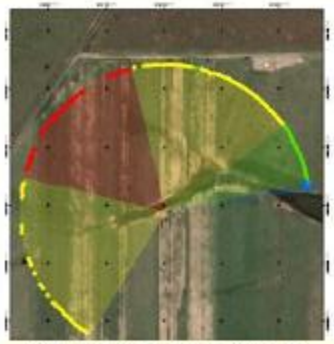
PIMS is a versatile tool kit which caters to irrigation consultants conducting irrigation performance assessments. Continuous irrigation system monitoring with the PIMS adds value to performance assessment by providing data on irrigation parameters across the complete irrigation cycle, which is essential if the pump performs variable duties during that cycle.

PIMS remotely monitors: Pump suction and storage or bore water level simultaneously and multiple pressure points. Additional sensors to monitor water quality, fuel consumption and global position of the mobile irrigator can be added to the system. Further optional customisations (eg 3G Modem) are also possible.

Pat Daley from Daley's Water Service says "I am very impressed with what a little information can give you, which often goes unaccounted. For example, initial data from a side roll irrigator has highlighted a pump suction problem when it is filling the spray line; it is taking far too long to get up to pressure at the sprays. I see the PIMS as being useful in logging the variable pressures you might have when operating a travelling irrigator or centre pivot over undulating ground. The assessment work I have carried out has shown 60% of distribution uniformity problems are from incorrect pressure at the water applicator. This particular trial data allowed me to calculate the pay back time of costs incurred rectifying system performance."



Pressure variation at the end of a centre pivot operating on undulating country.
< 7 kPa | 7.1-10 kPa | 11-18 kPa | > 18 kPa

Possible applications include:

- **Irrigation performance assessment**
- **Dynamic asset monitoring**
- **Block & complete duty cycle monitoring**
- **Identification of limitations**
- **Assessment of modifications**
- **Continuous resource monitoring**
- **Pressure uniformity mapping**
- **Disaggregation of water application**

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The Wireless Pressurised Irrigation Monitoring System (PIMS)

Operating Principle: PIMS was developed to continuously monitor water pump performance, storage water level, bore water level, irrigator applicator pressure, fuel consumption and position over single or multiple irrigation events. It does this whilst providing real-time display and logging capacity of the information in a central coordinator and the capacity for expansion. A wireless array of sensors and loggers are designed to adapt to all pressurised irrigation systems in all terrains under a range of operational conditions.

Telemetry: The PIMS internal wireless system offers a flexible approach to telemetry. It can be operated with short distance telemetry modules up to 1km and greater distances with external antennae. The transmission frequencies are in the free license range. The system is battery operated and can be deployed for weeks on end depending on the logging interval. It can be deployed indefinitely with a small solar cell. The wireless system comprises a coordinator unit and several end nodes.

End nodes: A device connected to the sensors outputs. It can interface with analogue outputs, frequency outputs from flow meters and digital switches. The end node is interrogated via telemetry from the coordinator and it sends the current readings. However the end nodes have the capacity to log sensor data independently of the coordinator, should it lose signal or not be warranted.

Coordinator: A coordinator interrogates the end nodes at a user specified time interval and logs the data onto an SD card for later retrieval. In the fully customised version, data can be retrieved via a 3G modem.

PIMS is flexible and can be customised to your specific application, which can provide:

- **An irrigation consultant tool kit to assess irrigation performance.**
- **Real time and remote monitoring of resources and irrigation assets.**

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EM38 — Assessing soil spatial variability

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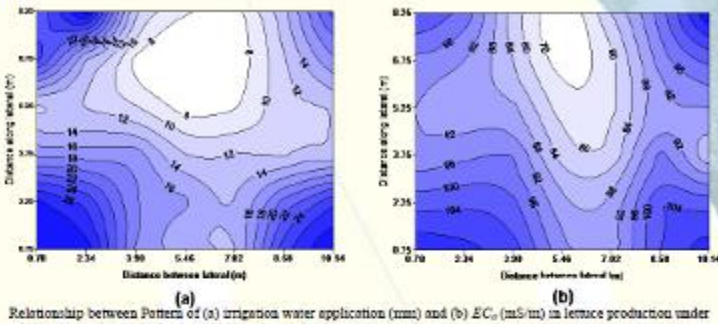
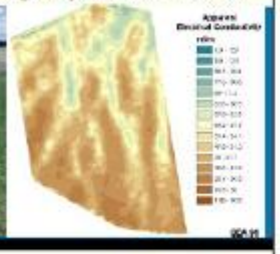
Electromagnetic induction (EMI) techniques are regularly used to assess soil spatial variability, type, salinity and the risk of deep drainage of water. EMI provides a measure of the apparent electrical conductivity (ECa) of the soil profile, which is affected by differences in soil moisture, therefore it can measure variability of soil moisture across fields.



Relationship between Pattern of (a) irrigation water application (mm) and (b) EC_a (mS/m) in lettuce production under solid set irrigation in the Lockyer Valley, Queensland.

- Traditional methods of soil moisture monitoring have been employed with some success but limitations in utilising them efficiently across both time and space have led to restrictions in their use.
- The chief value of the EMI lies in its ability to detect variations in soil type and moisture across a wide area in single point static mode or in mobile surveys. Then utilise that information to eliminate or at least manage the spatial variation.
- There is potential to use EMI to measuring irrigation uniformity and irrigation performance evaluation.



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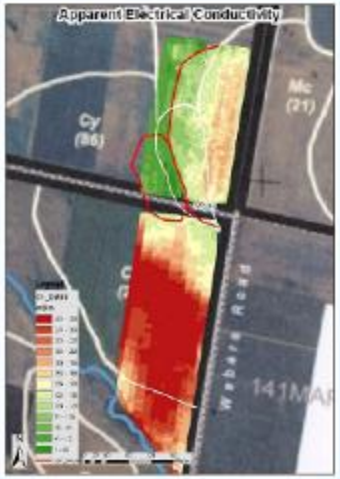
EM38 — Assessing soil spatial variability

EM38 is lightweight and at one metre long, it provides rapid surveys with excellent resolution at multiple soil depths. Measurements are made in either vertical or horizontal mode by placing the instrument on the ground or stand and recording the meter reading, or vehicle mounted in PC mode for spatial surveys.

Precision Agriculture. Farmland can be surveyed by EM38 tracking along the tramlines of a Controlled Traffic Farming system with a GPS-equipped ATV vehicle, efficiently. An onboard laptop synchronizes the streams of EC and dGPS data, which are collected at 2-3s intervals. Including geostatistical data interpolation and GIS map construction, 50-150 ha can be surveyed per day.



Dairy fodder production site with known salinity issues (lower zone) in red and realignment of soil survey boundaries (upper zone).

Subsoil constraints. Poor use of subsoil moisture by a crop is often indicative of subsoil constraints such as, salinity, sodicity, compaction, water logging, and other chemical constraints. The use of EM38 surveys in agriculture are an effective tool to determine zones of subsoil constraints.

Soil moisture deficit. The output from EM38 from irrigated cropping is well correlated to volumetric soil moisture. Surveys can provide a rapid non destructive assessment of the volume of water required to meet soil moisture deficit, thus minimising deep drainage and conserving natural resources.

Irrigation uniformity and crop water use. EMI techniques can provide a quick and efficient means for monitoring soil moisture patterns in cropping. Soil moisture data from cotton and lucerne fields in Central and SEQ clearly identified irrigation uniformity issues.

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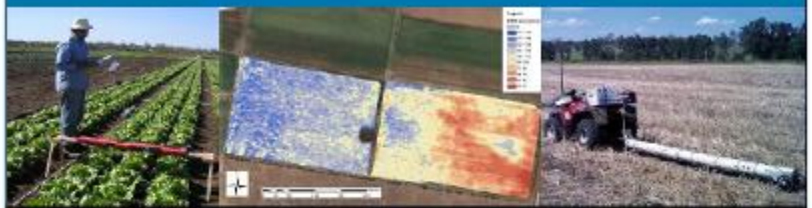

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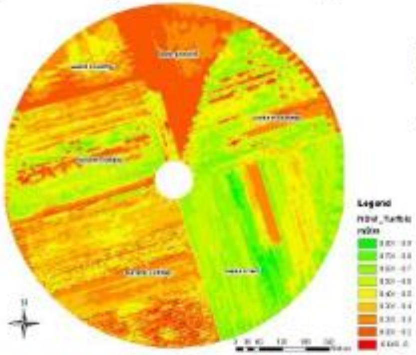
Normalised Difference Vegetation Index (NDVI) - Measuring crop performance

NCEA

NDVI technology is becoming common place in conducting on-farm trials and determining farming input recommendations. It assists in fine-tuning your knowledge of variability within fields and the contrasts that exist among management histories.

Greenseeker® ground-based optical sensor contains its own red and near-infrared (NIR) light source, allowing measurements to be taken at any time, day or night. NDVI is a common measurement of plant health or vigour because chlorophyll in plants absorbs red light as a source of energy. Simplistically healthier plants (more chlorophyll) will absorb more red and reflect more NIR, and consequently have a higher NDVI. Using Greenseekers®, researchers, agronomists and farmers can map crop health.



NDVI survey indicating levels of ground cover, crop vigour and spatial variability in turf production under a centre pivot irrigator.

Common applications

- Remote sensing and agronomic research.
- Biomass and plant canopy measurement.
- Nutrient response, yield potential, pest & disease impact measurement.
- Crop responses to irrigation performance and topography changes.

Common outputs

- **Turf growers** can better predict quality and quantity well before harvest.
- **Pasture management** can be improved by identifying areas affected by heavy animal movement, overgrazing or in need of replanting.
- **Cotton, wheat and corn producers** have used GreenSeeker® to make variable rate applications of nitrogen, based on a yield potential approach.

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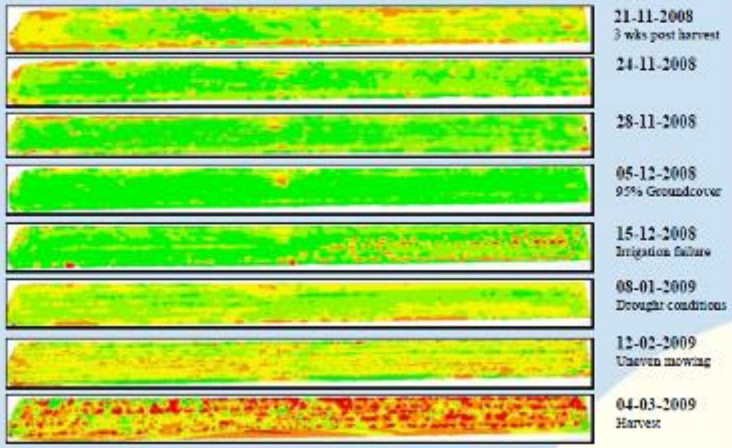
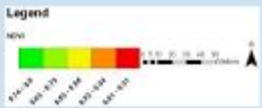
NDVI Sensor Application

Turf quality evaluation has been slow and subjective in the past. The NDVI sensor speeds up vigour evaluations and makes rapid plant health/quality observations verifiable. Time series NDVI sensor data was used to map field variability as a result of irrigation, climate and various management decisions.



NDVI time series surveys of turf production from post harvest (21/11/08) to harvest (4/3/2009), demonstrating the impact of an irrigation breakdown (Dec to Jan) on crop growth and close mowing (Feb 2009) on quality.



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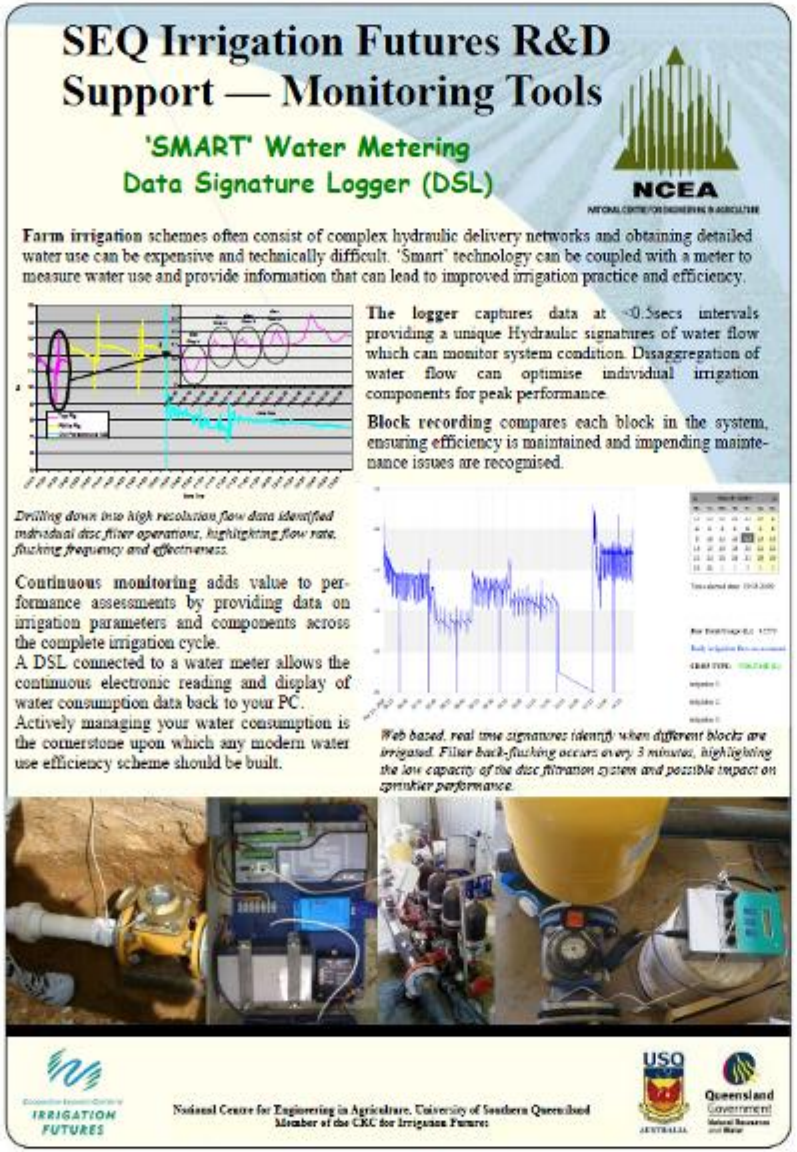
SEQ Irrigation Futures R&D Support — Monitoring Tools
'SMART' Water Metering
Data Signature Logger (DSL)
NCEA
Farm irrigation schemes often consist of complex hydraulic delivery networks and obtaining detailed water use can be expensive and technically difficult. 'Smart' technology can be coupled with a meter to measure water use and provide information that can lead to improved irrigation practice and efficiency.
The logger captures data at ~0.5secs intervals providing a unique Hydraulic signatures of water flow which can monitor system condition. Disaggregation of water flow can optimise individual irrigation components for peak performance.
Block recording compares each block in the system, ensuring efficiency is maintained and impending maintenance issues are recognised.
Drilling down into high resolution flow data identified individual disc filter operations, highlighting flow rate, flushing frequency and effectiveness.
Continuous monitoring adds value to performance assessments by providing data on irrigation parameters and components across the complete irrigation cycle.
A DSL connected to a water meter allows the continuous electronic reading and display of water consumption data back to your PC.
Actively managing your water consumption is the cornerstone upon which any modern water use efficiency scheme should be built.
Web based, real time signatures identify when different blocks are irrigated. Filter back-flushing occurs every 3 minutes, highlighting the low capacity of the disc filtration system and possible impact on sprinkler performance.
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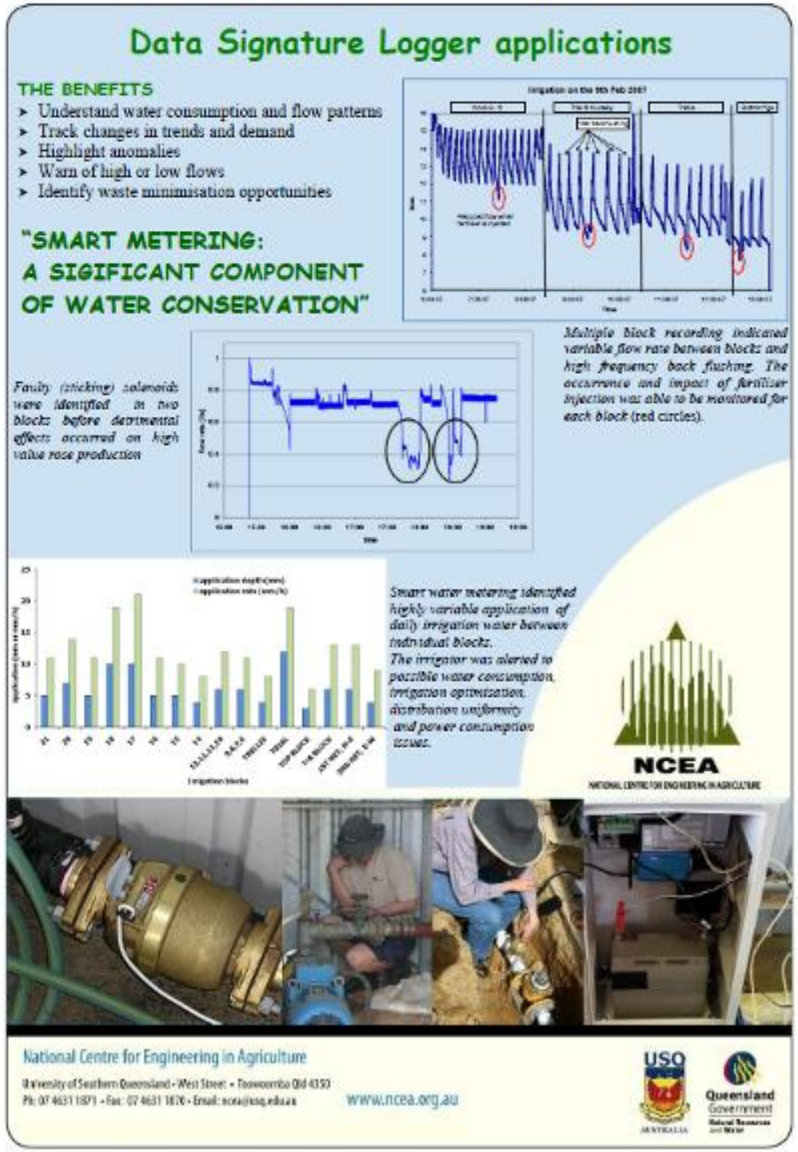
Data Signature Logger applications
THE BENEFITS
➤ Understand water consumption and flow patterns
➤ Track changes in trends and demand
➤ Highlight anomalies
➤ Warn of high or low flows
➤ Identify waste minimisation opportunities
"SMART METERING:
A SIGIFICANT COMPONENT
OF WATER CONSERVATION"
Multiple block recording indicated variable flow rate between blocks and high frequency back flushing. The occurrence and impact of fertiliser injection was able to be monitored for each block (red circles).
Faulty (sticking) solenoids were identified in two blocks before detrimental effects occurred on high value rose production
Smart water metering identified highly variable application of daily irrigation water between individual blocks.
The irrigator was alerted to possible water consumption, irrigation optimisation, distribution uniformity and power consumption issues.
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Continuously Logging Jetfill Tensiometers

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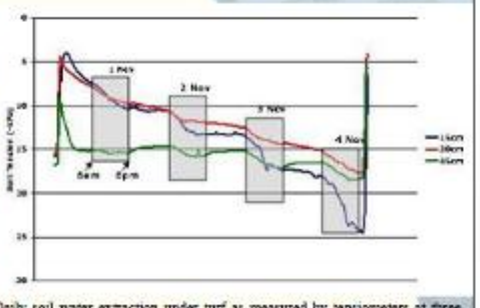
Providing a plant root view of soil water status a tensiometer senses the suction required to extract water from the soil.

As the soil dries, water in a closed tube is drawn out through a ceramic tip, which creates a vacuum in the tube.

The vacuum pressure can be continuously read by a pressure sensor or gauge. After an irrigation or rainfall event, water is drawn back into the tube, which decreases the vacuum.



Daily soil water extraction under turf as measured by tensiometers at three depths 15, 35 and 45cm over 4 day period.

High vacuum (high kPa reading) = soil is dry
Low vacuum (low kPa reading) = soil is moist

By acting like a plant root, a tensiometer gives you a continuous indication of plant water uptake. The drier the soil, the higher the reading, the harder it is for the plant to take up water. As soil water decreases more and more energy is required extract the soil water, which leaves less energy for growth and fruit production. Therefore based on tensiometers readings an irrigation manager can decide on the prevailing level of water stress he wishes to apply to the crop.

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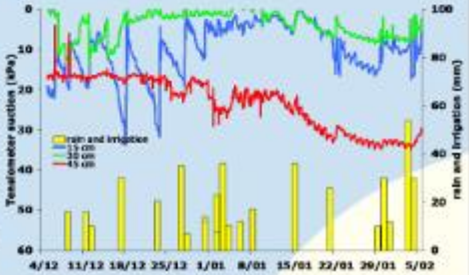
Fitting a GT3-15 Pressure transducers to Jetfill Tensiometers

Measuring Principle
The vacuum is measured by a pressure transducer, which gives a continuous analogue output signal.

Voltage requirements
The transducer works on 10V DC, with output from 0-100mV, +/- 3mV. As the output is ratio-metric to the input, power supply variation will cause transducer output to vary accordingly. Consequently a very stable regulated supply voltage is necessary for any vacuum transducer.
The reason for voltage variation and thus pressure variation may be:

- excessive cable length
- poor connections
- stable regulated voltage is not being supplied from the datalogger.

Voltage stabilisers
A 12V input to a GT3 Jetfill tensiometer vacuum transducer is conditioned by a voltage regulator to a very stable 10V. The transducer then outputs a continuous analogue signal to give accurate readings of soil water potential from 0 to -100kPa. The voltage regulator facilitates an output from the transducers that is used to interface with a wide variety of standard devices, including programmable logic controllers (PLCs) and dataloggers.



Soil water status under turf as measured by tensiometers at three depths 15, 35 and 45cm during the summer months in Southern Queensland.

Calibration of a GT3-15 voltage stabilised transducer with an analogue datalogger:

- Make a sealed system with a pressure meter installed.
- Read pressure step by step from 0 to -100kPa, (20kPa/step), check and calculate the linear relationship between any of the two readings.
- The GT3-15 transducers have a typical linear sensitivity of 0.47mV/kPa and 1mV=1kPa.

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Measuring ET with an Eddy Covariance (ECv) Station

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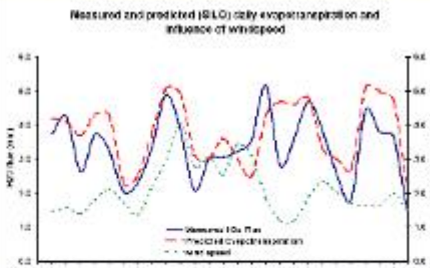
Advances in both instrumentation and theory have made it possible to measure net ecosystem flux of carbon, water vapour and other gases from vegetated areas and water bodies using the eddy covariance technique. This technique has been applied to measurements of forested areas, cropping, urban, water bodies for short and long term micrometeorology studies.

An ECv station measures net CO_2, water vapour, or heat fluxes by measuring:

Wind and temperature via CSAT3 (http://www.campbellsci.com/eddy-covariance)

CO_2 and H_2O density via CS7500 (http://www.campbellsci.com/eddy-covariance)

The CS7500 is an open-path, high-speed, high-precision, non-dispersive infrared gas analyser (IRGA) that accurately measures the in-situ densities of CO^2 and water vapour in turbulent air structures. The CS7500 is used in conjunction with a CSAT3 Sonic Anemometer to determine air movement and fluxes.



Applications

- Direct measurement of evapotranspiration in contrasting cropping systems
- Comparison of ECv output with other sources of ET_0 eg. Silo, FAO56, E_{Pan}.
- Characterisation of different plant physical structures between cultivars.
- Determination of wind speed and direction plus other climatic impacts on net ecosystem fluxes.
- Assist in the determination of carbon sequestration in the agricultural environment.

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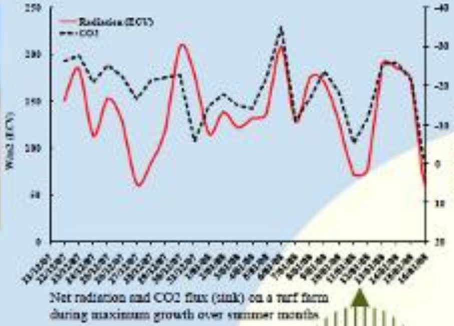
Eddy Covariance: Measures water vapour, carbon dioxide and heat flux

Eddy Covariance is a statistical method to compute turbulent fluxes and it can be used for many different purposes, each requiring unique settings and a different list of variables.

- The response of the evaporation from field crop to the nitrogen regime. The instantaneous measurements of water vapour along with sonic measurements above the canopy, but within the fetch for the studied field would also demonstrate crop water use and the influence of ground cover.
- A large scale example is computing GHG exchange under various farm operations or production systems to mitigate the impact of climate change. However mean CO^2 concentration profiles would also be highly desirable for computing the CO^2 storage term.



Net radiation and CO2 flux (sink) on a turf farm during maximum growth over summer months

Site Characteristics:

- Measures fluxes transported by eddies.
- Requires turbulent flow.
- Represent the ecosystem of interest.
- Large enough: sufficient fetch/footprint.
- Assumptions hold or are correctable.
- Terrain is reasonably flat and uniform.
- Accessible for maintenance.

Full details at:
http://www.licor.com/env/PDF_Files/EddyCovariance_readonly.pdf

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Portable Transit Time Flow Meter Series TXFP: Field Zeroing

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Background
Transit time flow meters measure very small changes in the time it takes for a sound wave to "transit" through a fluid filled pipe. The time it takes the sound wave to make a trip through the pipe and fluid is slightly longer going with the direction of flow than it is going against the direction of flow. It is this difference that the meter uses to calculate the velocity of the fluid through the pipe.
Once the meter is properly configured and the transducers are mounted on the pipe, the meter **must be manually zeroed to adjust for the zero flow transit time offset.**
A transit time flow meter sends an ultrasonic pulse from the transmitting transducer through the pipe wall and the fluid being measured. The initiation of this pulse is considered time zero. The receiving transducer "listens" for the sound and notes when the ultrasonic pulse is received using time zero as a reference.
In the next step the transmitting and receiving transducers exchange functions so that the transmitting transducer of the first pulse becomes the receiving transducer for the second pulse. Similarly the receiving transducer of the first pulse becomes the transmitter for the second pulse.
Under theoretical no-flow conditions the time taken for the first pulse would exactly equal that of the second pulse and would cancel each other out. Because there is no such thing as a "perfect" installation there is always a small, but measurable time difference between the forward and reverse pulses. If this time difference is not accounted for every time you set up, it shows up as an offset when the meter is actually measuring flow.
The offset can be either positive or negative. In other words if the offset is not removed the flow will either be a little greater than the actual flow or in the case of a negative offset the flow will be a little less.

Two methods of eliminating the offset: 1. No Flow and 2. Flow

1. Zero with full pipe and no flow
The best way and also the most convenient way to eliminate the offset is to zero it on the pipe using the "UltraLink" software utility. UltraLink has a built-in calibration routine that makes zeroing the meter an easy process.

Note: For a proper zero set to be preformed the pipe must be full of fluid and there must be no flow in the pipe.

.....Open UltraLink, and
.....Click on the "Calibration" tab.
.....Click "Next" until screen 2 of 3 is visible (Figure 1).
Follow the instructions in the upper left hand corner of the screen.
.....Click "Next" again, and then, without changing anything in screen 3 of 3,
.....Click "Finish"


Figure 1. UltraLink calibration page 2 of 3

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DYNASONICS
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dynasonics_technical@racinefed.com

Portable Transit Time Flow Meter-Series TXFP
Field Zeroing

2. Zeroing with full pipe and stable flow.
Most times it is not possible to shut down the flow to perform a zeroing as described above, nor is the pipe normally full under no flow conditions, however it is possible to get a reasonable zero point using the differences in transit time with a full pipe and stable flow condition.
This method relies on measuring the transit time differences between the forward and reverse transducers. The procedure is as follows:
1. Using "UltraLink", record the transit time in the forward direction and note the signed value (+ or -).
2. Reverse the transducers. *Swap the transducer connections without disturbing the transducers.*
3. Record the transit time with transducers reversed and note the signed value (+ or -).
4. Find the difference between the absolute values for the forward and reverse transit times. If the difference is near zero (within 2nS) the unit is properly zeroed. If the difference is >2nS an adjustment is required.
5. Go to screen 2 of 3 (Figure 1) in UltraLink calibration routine as described in Method 1. On the screen is a greyed out box labelled "Current Delta T". Add or subtract (*decision is based on the sign of the largest absolute transit time value*) one half of the difference found in step 4 to the signed value in the current delta T box. Enter this number into the white box directly to the right of the current delta T box (Figure 1).
Click "Set"..........Click "Next" to advance to screen 3 of 3......Click "Finish" to store the new zero point.

Example:
Record forward transit time: +87803.56 nS (notate + or -)
Record reverse transit time: -86925.04 nS (notate + or -)
Record current Delta T: +28.73 nS (from greyed-out box)

1) Find the difference: 87803.56 – 86925.04 (absolute values) = 878.52

2) Find half of the difference: $\frac{878.52}{2} = 439.26$

3) Add (*because the largest transit time value is positive*) half of the difference to the signed Current Delta T in greyed-out box:
28.73 + 439.26 = 467.99
4) This (467.99) is the corrected zero value that is placed in the white box directly to the right of the current delta T box (Figure 1).

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IRRIGATION FUTURES — USQ AUSTRALIA — Queensland Government Natural Resources and Water

Field evaluation of nitrate and salt movement: Lettuce Production in South-East Queensland

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South-East Queensland Irrigation Futures
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University of Southern Queensland

Executive Summary

Leaching of excess nitrogen from cropping systems is one cause of high nitrogen concentrations in waterways and ground water, which can lead to health problems for aquatic life, livestock and humans. The aim of this work was to determine nitrogen flux and salinity in root zone under lettuce production.

Two field trials (early and late season) were conducted during the summer of 2008-2009 for 'Iceberg lettuce' grown in a clay soil in SE Queensland. After transplanting, the trials were sprinkler irrigated until the plants were well established, after which they were irrigated by surface drip irrigation located between the plant rows.

During each trial, four replicates of six solute samplers were installed to monitor soil water nitrate and electrical conductivity in the root zone. Solute samplers were installed at depths of 15, 30 and 50 cm below the soil surface and at 0, 15 and 30 cm from the closest drip emitter. Suction for each sampler was set at 20 kPa prior to each sampling event.

Daily water and nitrogen balances were calculated for each trial using the metered volumes of irrigation water, fertiliser applied, on-site rainfall, estimated crop uptake from previous studies and on-site weather data. Soil cores were taken at the beginning and end of each trial to determine; initial and final moisture contents, nitrate and ammonium concentrations, and water holding capacity of the soil. Once the water holding capacity of the soil had been exceeded in the daily balances the remaining water was assumed to have leached, transporting nitrogen and mobilising salts below the root zone.

The calculated daily balances during the early season trial indicated that 1944 kL of water leached 118 kg of nitrogen per hectare. In the late season trial lower initial soil nitrogen concentrations and lower rainfall resulted in only 456 kL of water leaching 16 kg of nitrogen per hectare. The majority of the leaching occurred as a result of major rainfall events, however minor leaching was predicted to occur as a result of excess irrigation, especially at the beginning and end of the cropping cycles.

Whilst the field data measured higher soil water nitrate-nitrogen concentrations than those calculated by the daily water and nitrogen balances, it did confirm the timing of leaching events and the difference in average soil water nitrate concentration between the two trials. The late season trial had much lower nitrate-nitrogen soil concentration than the early season trial, presumably due to leaching during the large rainfall events that occurred in the fallow period between the two trials.