

BSES Limited



**FINAL REPORT – SRDC PROJECT BSS297
DELIVERING WEB-BASED IRRIGATION MANAGEMENT
by
TREVOR WILLCOX
SD09004**

Contact:

Trevor Willcox
Principal Extension Officer
BSES Limited
PMB 4
Bundaberg Q 4670
Telephone: 07 4155 7400
Facsimile: 07 4159 3956
Email: twillcox@bses.org.au



BSES is not a partner, joint venturer, employee or agent of SRDC and has no authority to legally bind SRDC, in any publication of substantive details or results of this Project.

Copyright © 2009 by BSES Limited

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior permission of BSES Limited.

Warning: Our tests, inspections and recommendations should not be relied on without further, independent inquiries. They may not be accurate, complete or applicable for your particular needs for many reasons, including (for example) BSES Limited being unaware of other matters relevant to individual crops, the analysis of unrepresentative samples or the influence of environmental, managerial or other factors on production.

Disclaimer: Except as required by law and only to the extent so required, none of BSES Limited, its directors, officers or agents makes any representation or warranty, express or implied, as to, or shall in any way be liable (including liability in negligence) directly or indirectly for any loss, damages, costs, expenses or reliance arising out of or in connection with, the accuracy, currency, completeness or balance of (or otherwise), or any errors in or omissions from, any test results, recommendations statements or other information provided to you.

CONTENTS

	Page No
SUMMARY	i
1.0 BACKGROUND	1
2.0 OBJECTIVES.....	1
3.0 METHODOLOGY	4
4.0 WORKING GROUPS ESTABLISHED	5
4.1 Initial Groups	5
4.2 Groups expand in Year 2.....	6
5.0 BASELINE SURVEY	6
6.0 REVIEW AND MONITORING PROGRAM OUTCOMES.....	8
6.1 First season	8
6.2 Second season	10
6.3 Final season.....	16
6.3.1 Mareeba	17
6.3.2 Burdekin	17
6.3.3 Mackay-Plane Creek.....	18
6.3.4 Bundaberg, Isis and Maryborough	18
7.0 PARALLEL WATERSENSE – ENVIROSCAN MONITORING.....	19
8.0 COMMUNICATION ACTIVITIES	23
8.1 First season	23
8.2 Second season	23
8.3 Final season.....	24
9.0 COMMERCIAL ASSESSMENT.....	25
10.0 OUTPUTS	27
11.0 EXPECTED OUTCOMES	27
12.0 FUTURE NEEDS AND RECOMMENDATIONS.....	28
13.0 PUBLICATIONS ARISING FROM THE PROJECT	29

14.0 ACKNOWLEDGMENTS	29
15.0 REFERENCES	29
APPENDIX 1 - DISTRICT CASE STUDIES	30
APPENDIX 2 – ADVISORY NOTES.....	64
APPENDIX 3 - OPERATOR’S MANUAL	66
APPENDIX 4 - COMMUNICATION VIA INDUSTRY PUBLICATIONS AND RADIO INTERVIEWS	67
APPENDIX 5 - COMMERCIAL ASSESSMENT.....	72
APPENDIX 6 - ENHANCING IRRIGATION MANAGEMENT PLANNING WITH ENVIROSCAN AND WATERSENSE	77
APPENDIX 7 – BURDEKIN EMAIL.....	78

SUMMARY

WaterSense is a web-based sugarcane irrigation scheduling and planning tool that allows the user to optimise irrigation inputs over multiple fields and enhance potential yields while limiting offsite impacts. This project furthered the development of WaterSense by working with growers, CSIRO Sustainable Ecosystems, CRC for Irrigation Futures, BSES Limited, SRDC, Bundaberg Sugar Services Limited and other industry service organisations.

Working groups were set up in the major irrigation areas, Burdekin, Bundaberg, Maryborough and Atherton Tablelands, to introduce WaterSense to growers and compare it to other irrigation scheduling tools over a three-year period. User groups indicated that the number of individuals wanting to use WaterSense directly is limited, but all areas are keen to have district irrigation advice, produced from WaterSense, made available. Letters of support for WaterSense have been received from Pioneer Cane Growers Organisation Limited and Bundaberg CANEGROWERS Ltd.

The use of WaterSense highlighted knowledge gaps. Information such as water holding capacity of soils, amount of irrigation water applied per irrigation and depth of water extraction by the plant at differing crop stages was not understood by many irrigators. This project assisted to develop knowledge and skills for best-management irrigation practice. Starting irrigation after rain events is often difficult to get right and is complicated because the rain has put their system 'out of sync' because all fields now have the same soil water deficit and will require irrigation at the same time. WaterSense's ability to anticipate the date of the next irrigation allowed farmers to better plan their irrigation start up and then to apply smaller amounts which minimised the potential for runoff and/or deep drainage.

From time to time heavy rainfall disrupted irrigation scheduling - this created an opportunity to use the WaterSense program to demonstrate potential runoff and drainage impact on effective rainfall. WaterSense's graphics provided users with a visualisation of water moving through the profile, and ending up as deep drainage. In a similar manner, the graphics clearly showed when irrigation or rainfall events did not fill the profile.

From a natural resource management perspective, WaterSense added substantial benefit to the understanding of users. WaterSense improved irrigators understanding of the concept of applying the right amount of water at the right time, which helps to minimize runoff and drainage loss and maximizes productivity. It is the ability of WaterSense to calculate daily climatic impacts on the sugarcane crop that leads to better understanding of the factors contributing to the soil water balance. This provides irrigators with a timely opportunity to manage long-term changes and daily variability in climate influences.

Sugarcane farmers have long relied on past experiences to help manage climate risk. However, as climate variability increases, these past experiences may not provide sufficient insight. WaterSense offers farmers another tool by which they can manage this variability and assist make the best use of limited water

resources. One Maryborough grower in particular, expressed a high level of satisfaction with WaterSense and indicated that he would find it very difficult to operate his centre pivot irrigators without the aid of WaterSense.

To keep WaterSense operating into the future, the approach that appears most likely to succeed is for an industry-wide organisation such as BSES Limited or CANEGROWERS to arrange a project with CSIRO to provide the service. District information on irrigation requirements could then be made available to customers of the organisation providing the service. Where individuals want access to WaterSense directly, this could be made available for a fee. It is likely that over time the numbers using the service directly would increase. Customers who have indicated they would want direct access are mostly larger corporate farms.

1.0 BACKGROUND

Defining crop-water requirements is a key component in managing irrigation to optimise sugarcane yield. Determination of when soil-water depletion becomes a limiting factor for yield, using evaporative demand (AED) measured by evaporation pan, has been applied successfully to schedule irrigation in cane that has commenced stalk elongation. It is most effective when irrigation replenishes soil plant-available water (PAWC). However, this method has limitations when estimating evapotranspiration in developing crops prior to the stalk elongation phase and when scheduling drip and overhead irrigation systems that often apply less irrigation than is required to fully replenish PAWC.

Soil-moisture capacitance-monitoring devices assess relative change in soil moisture in response to crop demand and environmental factors. However, the effectiveness of this technology is limited by its accessibility to only representative fields. Recently, computer-managed web-based systems designed to provide real-time irrigation scheduling have neared successful completion of their development.

These systems estimate reference evaporation and crop evapotranspiration that are more consistent with actual crop water use and are determined by applying the Penman Monteith equation to standard weather data (Attard *et al.*, 2003).

This approach to irrigation planning and scheduling calculates daily crop requirement for water, based on crop response to soil-water deficits and AED, over multiple fields and for the entire range of crop growth; it thus provides the potential to maximise productivity, optimise inputs and limit the offsite impacts of irrigation. Pilot use of the web-based management tools at Bundaberg has found them to be user-friendly and useful learning systems for irrigation best management practice. Participants in the pilot program indicated that the programs' strength lies in their ability to utilise individual farm information (rainfall, soil RAW values, harvest and planting date) to develop a reliable current water balance for each field, providing the major component on which to base irrigation schedules.

2.0 OBJECTIVES

The project aimed to facilitate grower uptake of irrigation planning and scheduling tools developed by the CSIRO Sustainable Ecosystems (CSE) 'Beyond Case Studies' project CSE009. These enhance irrigation management, assist to maximise economic outcomes and reduce environmental impact from irrigation.

Specific objectives were to:

1. Evaluate 'Cane Optimiser' and 'WaterSense' irrigation-management tools with grower-based on-farm groups in five sugar irrigation regions;
2. Develop skills and techniques in the use of management aids to maximise efficiencies of best-management irrigation practice (BMP) for irrigation scheduling.
3. Minimise potential environmental impacts of irrigation by enhancing awareness of contributors to the transport of nutrients and pesticides through runoff and deep infiltration;
4. Build capacity and understanding of operational procedures and relationships between web-based irrigation management tools and BMP for irrigators, advisors, technicians, agribusiness and consultants through provision of training;
5. Communicate project outcomes through group activities, information services, demonstrations, field days and media;
6. Evaluate possibilities for strategically located, commercial, web-based irrigation advisory services.

Each objective was achieved as summarised below.

Objective 1: Evaluate 'Cane Optimiser' and 'WaterSense' irrigation-management tools with grower-based on-farm groups in five sugar irrigation regions.

Working groups of irrigators were established initially at Maryborough, Bundaberg, Burdekin, and Atherton Tablelands, and later at Mackay. Facilitators worked with these groups and individuals within the groups to set their farms up on the WaterSense web-site (www.clw.csiro.au/watersense/pages/main.aspx.) and operate the system. Crop-water demand calculated with Cane Optimiser and WaterSense was compared with requirements measured using EnviroSCANS. Despite some teething problems that were worked through early in the project, exit surveys and interviews showed that the groups found WaterSense to be a valuable tool. While only a few people in each group kept using the web-based tool directly, all valued the district-wide irrigation scheduling information generated with the system. The Mackay group did not operate successfully for a number of reasons, but interest was generated in the tool there.

Objective 2: Develop skills and techniques in the use of management aids to maximise efficiencies of best-management irrigation practice (BMP) for irrigation scheduling.

The working groups in each area compared WaterSense as an irrigation management tool to EnviroSCAN soil moisture probes and related this to their previous irrigation schedules. The use of these tools has made growers more aware of the differing irrigation demands due to crop size and weather conditions, and how schedules vary with different soil types and depth of soil.

Objective 3: Minimise potential environmental impacts of irrigation by enhancing awareness of contributors to the transport of nutrients and pesticides through runoff and deep infiltration.

The potential of irrigation water to convey soluble nutrients such as nitrates and herbicides such as atrazine from cane fields in runoff and deep drainage is becoming well-recognised in the Australian industry. This has received considerable emphasis recently as growers participate in the Caring for Our Country, Reef Rescue incentive program. Correct scheduling of irrigation to limit deep drainage and runoff using tools such as WaterSense is rated as a BMP and as an A or B practice on irrigated farms.

Objective 4: Build capacity and understanding of operational procedures and relationships between web-based irrigation management tools and BMP for irrigators, advisors, technicians, agribusiness and consultants through provision of training.

Initially, project investigators in each district received tuition in how to set up and use WaterSense. Group sessions were then held in each district followed up with individual tuition, servicing and problem solving. Project investigators also received training in the use of EnviroSCAN software. This built capacity and understanding of these tools and also increased knowledge of the principles of BMP irrigation, such as crop water demand at various stages and times of the year, and soil water holding capacity. A wide cross section of growers and industry service providers were exposed to this information at field days, discussion group meetings and technical conferences such as Australian Society of Sugar Cane Technologists (ASSCT) and Irrigation Australia (IA).

Objective 5: Communicate project outcomes through group activities, information services, demonstrations, field days and media.

The value of WaterSense as a tool to manage irrigation was promoted through Cane Productivity Initiative (CPI) meetings at Burdekin and CaneTalk discussion group meetings at Bundaberg. Information was also on show at field days at Maryborough, Isis, Bundaberg, Mackay, Burdekin and the Atherton Tablelands. Media articles included regular newsletter articles, *BSES Bulletin* and newspaper articles. Technical papers were also presented at IA and ASSCT conferences. Text messaging and emails were also used at various centres to forward irrigation requirements calculated with WaterSense to growers and advisors.

Objective 6: Evaluate possibilities for strategically located, commercial, web-based irrigation advisory services.

The principal market for WaterSense is the three main irrigation regions – Southern, Central and Burdekin. User groups have indicated that the number of individuals wanting to use WaterSense directly is limited, but all areas are keen to have district irrigation advice produced from WaterSense made available. Letters of support for WaterSense have been received from Pioneer Cane Growers Organisation Limited and Bundaberg CANEGROWERS Ltd.

The marketing approach that appears most likely to succeed is for an industry-wide organisation such as BSES Limited or CANEGROWERS to arrange a project with CSIRO to provide the service. District information on irrigation requirements could then be made available to customers of the organisation providing the service. Where individuals want access to WaterSense directly, this could be made available for a fee. It is likely that over time the numbers using the service directly would increase. Customers who have indicated they would want direct access are mostly larger corporate farms.

3.0 METHODOLOGY

Working groups of irrigators were established at Maryborough, Bundaberg, Burdekin and Atherton Tablelands in year 1. In years 2 and 3 additional growers were added to these groups. Additional groups were commenced at Mackay but these did not persist. Groups were of mixed irrigation type, except in Maryborough where the group is mostly centre pivot. Web links were established for each participant to enable live operation of farm programs individually and for access to all participants for the facilitators. Tuition in use of the Cane Optimiser and WaterSense programs was provided to participants and facilitators prior to their first irrigation season, as well as for servicing requirements and introduction of new groups and participants. This was supplied by CSE and project investigators following expertise gained in Beyond Case Studies project. Group linkages were established in the initial phase for mentoring purposes and to foster group interaction. This ensured that each farm module was set up appropriately and growers have sufficient expertise to operate programs.

Strategically located monitoring stations were used to support the web-based data and provide a means of validating outcomes from the web-based aids and resultant irrigation practices. These included additional weather stations, access to Bureau of Meteorology (BoM) SILO weather data and rainfall recording, to provide more accurate weather data. Capacitance meters, such as EnviroSCAN and Diviner, were used to monitor soil moisture during the active phases of the project providing a practical method of gauging the effectiveness of the web-based scheduling aids. Collectively, data generated provided an excellent record on which to base irrigation management and evaluate outcomes.

Following the establishment phase, growers conducted real-time scheduling at farm or enterprise level according to crop requirements and local irrigation constraints, especially in relation to the quantity of available water. Mentoring was provided by CSE, Bundaberg Sugar Services Limited (BSSL) and BSES facilitators, servicing difficulties and making appropriate adjustments to schedules. Construction of district scheduling programs was facilitated for the provision of regular scheduling advisory services for each centre.

Periodic group reviews and interactive sessions enhanced the action-learning process by providing feedback to group members. Feedback included scheduling and monitoring data and evaluation of the scheduling adopted. End-of-season

group reviews gave a holistic evaluation of practices and indicated necessary changes to management practices for implementation in the following season. Extension activities focused initially on action learning and group interaction. Extension of outcomes occurred in parallel with each stage involving both intra-industry pathways and existing regional extension programs, including the media.

Incorporation of commercial service providers occurred at Bundaberg and Atherton Tablelands following the establishment of working groups. Commercial providers participated in active phases of the project to allow their evaluation of the possibilities of providing a future commercial service.

Expansion of grower participants occurred in years 2 and 3 through additions to, and creation of additional, working groups. Program activities in these years reflected the outcomes of the annual review. A focus on action learning, mentoring and group interaction was maintained.

Extension of outcomes to the wider irrigator audience during the later part of the project fostered demonstration activities by grower participants as well as via the established extension pathways. This was enhanced by reports in internal and external media and publication of journal articles and papers in proceedings of IA and ASSCT.

4.0 WORKING GROUPS ESTABLISHED

4.1 Initial Groups

Working groups of irrigators were established at Maryborough, Bundaberg, Burdekin and Atherton Tablelands. Group participants were somewhat dependent on available computing and on-line facilities and included some growers with previous exposure to irrigation efficiency programs, scheduling and research activities, as well as others new to these interests. Several group members were recruited through presentations of irrigation related activities such as Land & Water Management Planning workshops, water use efficiency programs and promotion of WaterSense and other water use efficiency programs, eg presentation to the Women in Sugar group at Bundaberg. Six participants were recruited at Bundaberg in this manner. At Atherton and Bundaberg eight growers involved in previous and current irrigation efficiency programs have joined the irrigator groups. By March 2007, 30 participating growers had been confirmed across districts.

The groups represented a wide variation in farm size, including a number of large enterprises over each of the centres. These include milling plantations at Bundaberg and Maryborough and large private enterprises in the Burdekin and Atherton.

Meetings held with participating growers at Maryborough, Bundaberg and Atherton introduced the project, provided an overview of how the WaterSense

program operates to demonstrate its capabilities as a scheduling tool. These meetings received a very positive reaction, with ready agreement of participants to be involved in working irrigator groups. In the Burdekin, individual discussions were held with participating growers.

Following the initial meetings with facilitators and participants, web links were progressively established with participants and program tuition occurred. Once group tuition was completed, individual instruction was undertaken. Servicing was required as irrigators processed their first scheduling exercises.

4.2 Groups expand in Year 2

To gauge interest in the project in the Central Area, WaterSense was demonstrated to the Mackay and Plane Creek Irrigation Reference Groups, which together comprised 19 growers. The groups were shown by Steve Attard (CSE) how the program operates and its outputs, with demonstrations of setting up the farm blocks, grower inputs, running procedures, accessing appropriate weather data, and program outputs. The Plane Creek group irrigate mainly from on-farm water storages and thus provide a different irrigation environment from the majority of others. Together the groups provide a broad representation of irrigators in the Central Area. In addition to the group demonstrations, Messrs Attard and Abbey conducted continuous demonstrations of WaterSense at the BSES Mackay Field Day over two days.

Recruitment of additional irrigators at existing project centres proved difficult in the smaller areas as more growers became involved in alternative crops and off-farm activities.

In addition to the original operator groups at Maryborough and Bundaberg, a further nine growers joined the project groups in the south. At Bundaberg, new farms represented were geographically spread (Wallaville, South Kolan, Sharon, Meadowvale, Moorlands) and covered a wide range of soil types. This second intake resulted in good district representation across all groups, which led to improved quality of irrigation scheduling information for the district overall.

In the Burdekin, an additional 13 growers, several of whom were from the Kalamia Young Farmers group, were provided with access to WaterSense. This brought the total number of group members to 21.

At Atherton, three new members received initial tuition.

5.0 BASELINE SURVEY

A survey of participating growers' current irrigation practices was conducted to establish a baseline assessment of irrigation practices, skills and attitudes. Data showed a wide variation of irrigation type dependant upon district, water

availability and supply, and industry age. In southern centres, traveller guns were in use on 87% of farms, and, thus, were dominant as an irrigation type, but low pressure overhead sprays were also in use on 33% of participant farms. These included both lateral-move and centre-pivot units. The latter were mostly at Maryborough, where an estimated 30 units operated across the district. At Atherton, centre-pivot units were the most common form of irrigation in the working group, reflecting the relatively young age of the industry there, as well as a plentiful water supply. Flood irrigation was commonly represented in southern centres and was clearly dominant in the Burdekin.

Most participants used a rudimentary method of calculating application rates. With travelling guns, for example, the travelling time factored against pumping capacity was used to gauge application rates, or a basic formula derived in a similar fashion was applied. Regardless of irrigation type, only a few irrigators (18%) regularly read their water meters to estimate application levels.

Similarly, few used any regular monitoring system to measure irrigation inputs and effects, although some had used basic monitoring, eg tensiometers in the past. 50% of participants did not monitor in any fashion, although a few used operational formula to vary application. Others took advantage of in situ project monitoring where capacitance meters and other monitoring techniques were used. These were most commonly associated with the Rural Water Use Efficiency Initiatives and, at Atherton, where a BSES advisory service operates.

Information on soil water holding characteristics was only easily accessible to growers at Maryborough and Bundaberg. DERM soil classification is not complete at the other centres and information of this nature is scant. A wide range of RAW values was encountered (<35 - >105 mm) both across districts and within farms. Given the paucity of monitoring of application rates and soil moisture levels, this presented a reasonably high risk of inefficient irrigation, lowered irrigation response and returns and possible significant levels of waste.

A wide range of water use productivity ratios was encountered in each area and considerable variation was indicated between districts. While gross irrigation/yield comparisons are not definitive due to the probability of variable effects from rainfall variation, the data indicate good potential for improved water use. Table 1 illustrates the variation encountered.

Table 1 Water applied by productivity relationships in the 2006 crop

District	Av. Tonnes cane/ML water applied	Range Tonnes cane/ML water applied
Maryborough	31.6	20.9 – 57.5
Bundaberg	22.8	13.9 – 34.1
Burdekin	15.3	13.3 – 18.8
Atherton Tablelands	15.6	12.6 – 22.2

Most irrigators had a basic irrigation plan tempered by availability of water. Where necessary, water was prioritized to plant cane. Irrigations were generally designed to replenish soil moisture levels to RAW values or better. Irrigation cycles, however, appeared to be more determined by system capacity than irrigation requirement with some exceptions where water was plentiful.

When considering aspects of irrigation where improvement to productivity could be gained, irrigators ranked on-farm infrastructure (pumps, pipes, irrigator, etc) as the most important factor, with increase in water allocation and whole-farm scheduling in the next two close rankings (Table 2). Additional labour time was given some prominence by larger growers but monitoring equipment and improved soils information were ranked in the lower orders. Other items related to application efficiency such as farm layout and land improvement were mentioned on occasion.

Table 2 **Ranking of factors for potential improvement of productivity**
(Ranking 1 = highest rank)

Factor	Average ranking score
Better on-farm infrastructure (pumps, pipes, irrigator, etc)	1.8
Increased water allocation	2.7
Whole of farm irrigation scheduling	2.7
Additional labour (time)	3.9
Additional monitoring equipment	4.1
Better soils information	5.1
Other nominations: Improved farm layout; land improvements; improved application efficiency; better understanding of crop physiology	

Irrigators universally followed weather forecasts, 72% accessing more than one source of information. The internet and radio were the most popular sources with TV also used frequently. Internet users invariably used at least one other source of weather information. 40% of participants used BSES or productivity/water officers to consult on irrigation matters; a majority of these were associated with current water use efficiency related programs.

6.0 REVIEW AND MONITORING PROGRAM OUTCOMES

6.1 First season

Outcomes of the first season's operations varied across irrigator groups and individual irrigators due to the wide variation in the use of, and experience with, WaterSense. New operators experienced some difficulties both with computers and web-links and required regular support from facilitators to overcome the initial

operating hurdles. At some centres, disruptions occurred due to low water allocations, which became the overriding consideration for scheduling. However, the program demonstrated its usefulness by providing a ready insight into operational boundaries and prediction of critical soil moisture levels. Operations in the first season demonstrated several important management principles that involved soil characteristics, differential irrigation levels and scheduling requirements, infiltration considerations, soil moisture run-down and start-up following rain. These raised awareness of the shortfalls of past irrigation practices.

A very positive outcome overall was that, where valid comparison of WaterSense outputs and those of EnviroSCAN could be made, close correlation was achieved for moisture status between rainfall and/or irrigation events. This resulted in irrigation triggers of the systems coming into close alignment and validated the outputs of WaterSense. Good correlations were observed throughout the irrigation season in Southern centres, while in the North late commencement to the program meant comparisons were made only in well developed crops. In the Burdekin, however, deficiencies were identified in evaluations for early growth stages.

Specific items identified that required attention or adjustment to improve scheduling included:

- A tendency with many irrigators to commence WaterSense evaluations relatively late in the irrigation season, between irrigations and/or rainfall events. Start-up after rain meant that the predictive value of the program was not being used effectively. This resulted in a firm recommendation to commence evaluations early and to update regularly. This approach was reinforced at Atherton where early evaluations showed start-up times needed to occur sooner than was local practice.
- Difficulties were encountered in determining readily available water and the optimum deficit to trigger irrigation. This remains a problem in the Burdekin where soil types differ from the program choices and/or operators use an inappropriate 'best-fit' soil classification. Inappropriate selection of soil type (and thus water holding characteristics) can easily result in incorrect scheduling predictions leading to either wasteful irrigation or significantly depleted soil moisture reserves. The latter can become highly yield-depressive where applications are small and regular as with trickle irrigation, low pressure overhead systems and irrigation of sandy soils. Where soil information is scant or not reliable, calibration of soil moisture levels with growth may be necessary to establish trigger points. Alternatively, selection of a realistic moisture deficit is necessary, rather than to rely upon accuracy of the soil type selection.
- Vagaries of local weather, such as widely scattered rainfall, led to misleading outcomes in some instances. While this problem was mollified by the addition of several BoM sites, it added extra weight to the recommended use of on-farm rainfall data wherever possible.
- Rainfall intensity and resultant run-off were identified as factors requiring consideration. Variability of storm activity meant adjustments were necessary to rainfall data to achieve realistic evaluations.

- Accuracy of irrigation application levels also required close attention to ensure reliable evaluations. In metered systems, application rates could be measured at an acceptable level of accuracy but other systems were found to require specific checks such as use of a flow meter or measurement by catch cans where overhead irrigation was practiced.

6.2 Second season

Throughout the irrigation districts, widespread early summer rainfall which commenced in November 2007, led to late start-up of irrigation programs in a majority of irrigation areas. Where heavy rainfall was received, extensive flooding occurred with some localities enduring a number of flooding events. Soils remained waterlogged for extensive periods and start-up irrigation was delayed for many weeks in most areas. In a number of cases, attempts to commence irrigation seasons were short-lived as further rainfall occurred. This meant that no centre practised an early scheduling program; rather isolated irrigation events took place between bouts of rain. Similarly, soil moisture monitoring had few meaningful outcomes early in the season. The extensive nature of rainfall during the summer period is illustrated by rainfall recorded in January–April 2008 compared with averages, as shown in Table 3.

Table 3 District rainfall in January-April 2008

Location	Rainfall (mm)	Average rainfall same period (mm)	% above average rainfall
Mareeba	1174	680	73
Ayr	1139	647	76
Mackay	1853	987	88
Bundaberg	662	489	35
Maryborough	697	581	20

However, where opportunity existed between rainfall events, operation of WaterSense occurred in all centres providing useful and accurate information of moisture run-down which led to effective scheduling outcomes. This is illustrated in recordings at Bundaberg where, following extensive rain in February (340 mm), irrigation was projected for early and late March, the latter being satisfied by further rain (Figures 1 and 2). In these examples, start-up following rain was adequately timed, in tandem with weather forecasts, and unnecessary irrigations were avoided. Similar outcomes were achieved in other instances at Maryborough, Bundaberg, Mackay, Burdekin and Mareeba. The level of activity, however, varied widely between the centres: two group members operated at Atherton, five in the Burdekin, six at Mackay and a total of 14 at Bundaberg and

Maryborough.

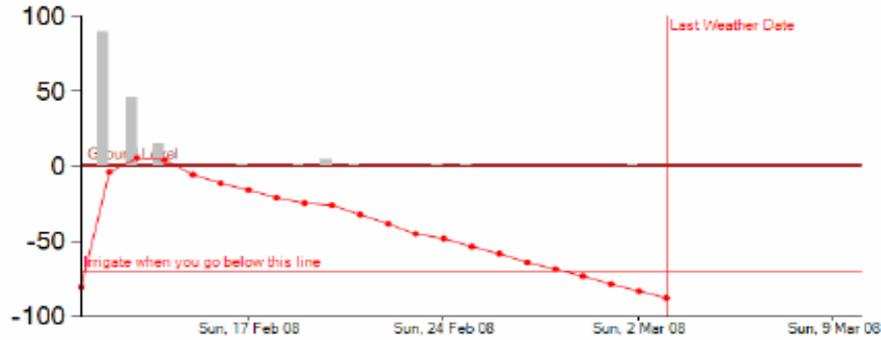


Figure 1 Soil moisture run-down following a period of significant rainfall

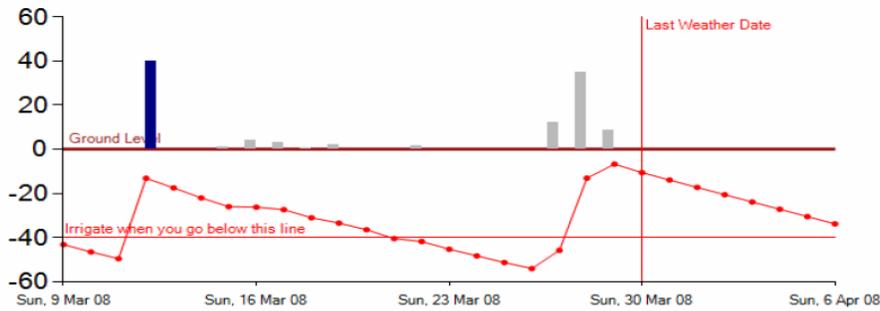


Figure 2 Value of WaterSense predictions during periods of regular rainfall

Overall, grower activity and interaction was generally dependant upon facilitator activity, ie the greater the visitation, contact and assistance provided by the facilitator, the more WaterSense was used. Few growers appeared keen to use the program independently, although wet weather disruptions continually hampered use. It proved particularly difficult to get growers to operate WaterSense during these wet periods and a majority used the program only when assisted. This has obvious implications as to whether irrigators want access to the program for independent use or access to a provided service that incorporates WaterSense.

Despite the limited opportunity for scheduling with WaterSense, positive outcomes were reported where growers used the program, together with a number of tips for more accurate outcomes. These included:

- WaterSense better indicated profile moisture reserves at levels lower than 1.0 metre than with EnviroSCAN probes.
- Lack of soils information and understanding of soil characteristics remained of concern to some groups.
- WaterSense proved useful for rapid identification of inefficient irrigation practices and where opportunities for improvement lay.
- The currency of weather information was very important, particularly rainfall. Time of daily updating (from automatic weather stations or BoM) required careful noting as it can be 24 hours or more behind.
- Changes to weather factors affecting water use, such as temperature, were quickly apparent allowing adjustment to irrigation schedules.
- Effects of wind were recorded (and included in predictive modelling).
- Care is necessary concerning crop cover e.g. with late cut ratoons.
- Biomass levels should be set to practical levels according to the circumstances e.g. lower with dry conditions and/or low water allocations.
- The program was found especially helpful with OHLP systems such as centre pivot; rapid adjustment to run speed and application rate to suit soil infiltration rate and counter run-off was demonstrated.
- Growers experienced in the use of WaterSense indicated that the program is useful both as a predictive tool and as a check on current irrigation practice, especially for trickle irrigation and OHLP systems, with its predictive function is probably the best value.

Progressive seasonal monitoring was possible in some southern areas and provided a good insight into scheduling practice across the season. The records indicate that most schedules ran with acceptable soil moisture deficits but also indicate delays to irrigation where expected (forecast) rain did not eventuate. Figure 3 illustrates one seasonal history (January-April) which shows the soil moisture run-down during showery conditions and associated delays to irrigation, as well as the lower growth rate when the deficit was overextended.

Bundy Sugar Block 3 D Progressive scheduling

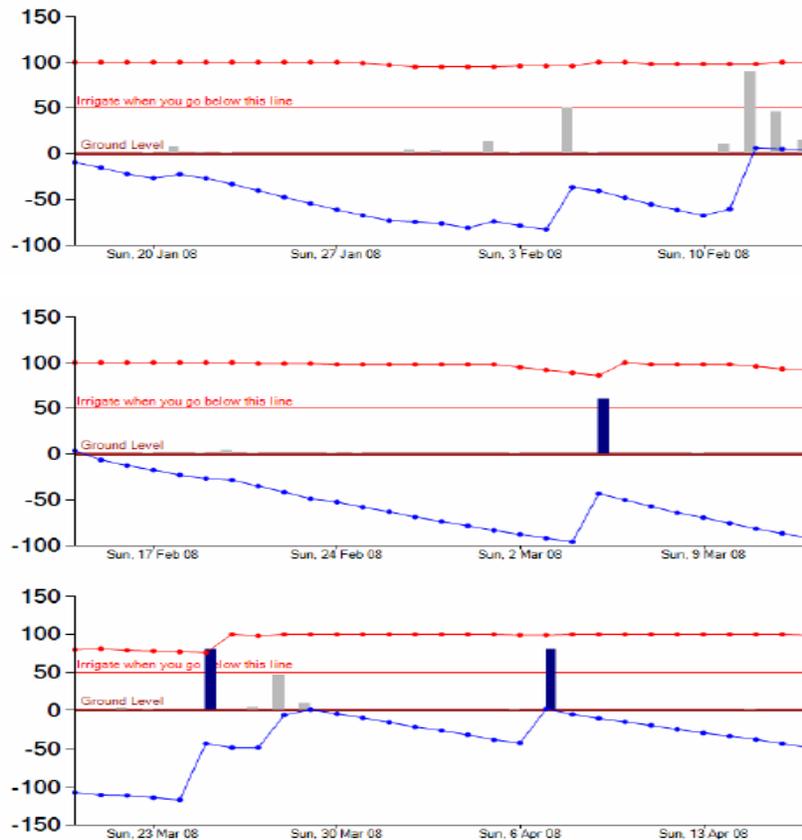


Figure 3 Seasonal record illustrating instances of extended soil moisture run-down in anticipation of rain and associated reduction of growth

While the highly erratic nature of the 2008 irrigation season was not generally conducive to practical application of WaterSense for irrigation scheduling, several monitoring outcomes illustrated the value of WaterSense in the identification of improvements to irrigation practice including:

- Improvement in getting irrigators to follow up after rain: Growers appear to be monitoring their farm situations more closely to help pinpoint best start-up times, with due consideration of the prevailing weather. Unfortunately, regular rainfall reduced the value of this exercise in many instances and provided a disincentive for proactive monitoring causing some group members to cease monitoring entirely.
- Despite delays to irrigation due to forecast rain, timing of irrigation was generally improved through use of WaterSense. Where local weather patterns were stable, irrigation schedules closely followed selected soil moisture deficits. Similarly, withholding irrigation when rainfall was forecast, then did not eventuate, increased deficits substantially and had a corresponding negative effect upon growth (Figure 4).

- Correction of over-run with overhead systems: Overlap in any overhead system can be highly wasteful and inefficient. Monitoring provided an alert for these types of problems as demonstrated at Maryborough with centre pivot units, as well as to assist formulation of application standards for BMP. Similar use was found in bringing application rates for centre pivot units in sync with soil infiltration rates.
- Reduction of irrigation interval or increase in application: Monitoring has identified changes to water use patterns and provided timely warnings for adjustment to schedules. The example in Figure 4 shows how an existing 13-day cycle led to a significant deficit requiring either shortening the cycle by 50% or shortening the cycle and increasing application in tandem. Although application rate was increased in this instance, soil moisture reserves continued to trend down.

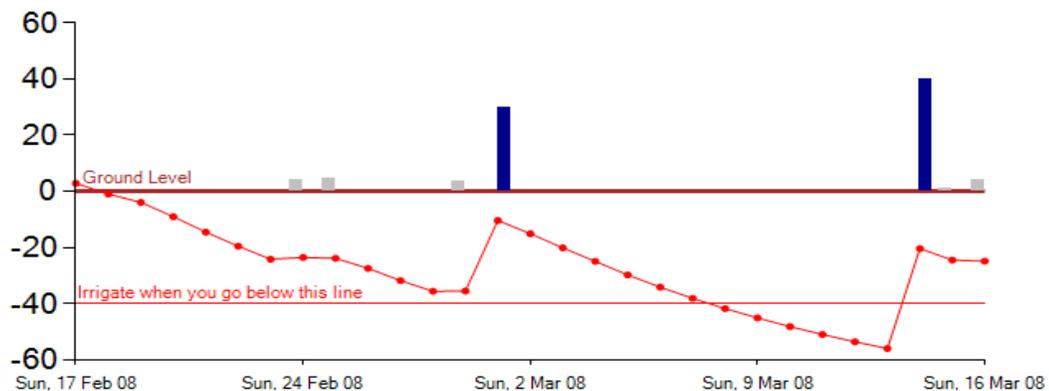


Figure 4 Illustrating how WaterSense monitoring alerts of unexpected water use and indicates advisable practice change

- Improved prediction of irrigation requirement with weather factor change: Similar to the previous outcome, the effects of changes to specific components of weather such as temperature, wind and sunlight are readily factored into WaterSense predictions. This has led to two-way modification of irrigation intervals as water use varies under the prevailing conditions e.g. cloudy days and cool temperatures allowing longer intervals (Burdekin) and lengthy wind periods predisposing shorter intervals (Bundaberg).
- Identification of insufficient application rate: Identification of insufficient irrigation with an every-second-row strategy was identified in one instance in the Burdekin. Similarly, regular but small applications through a centre pivot at Maryborough required a rate increase to raise soil moisture to preferred levels. (Figure 5)

Ashley Peterson Harvey Bay

WaterSense Summary Page

Paddock	Next Irrig	Last Irrig	Last run	SW Deficit	Crop Cover %	Harvest	Tot Irrig Crop	Tot Rain Crop
Pivot Dundowran	16-Mar	7-Mar	10-Mar	8mm	97	15-Sep-08	1.4 ML/ha	7.8 ML/ha

Irrigation information may not be up to date – please advise if additional irrigation has occurred.

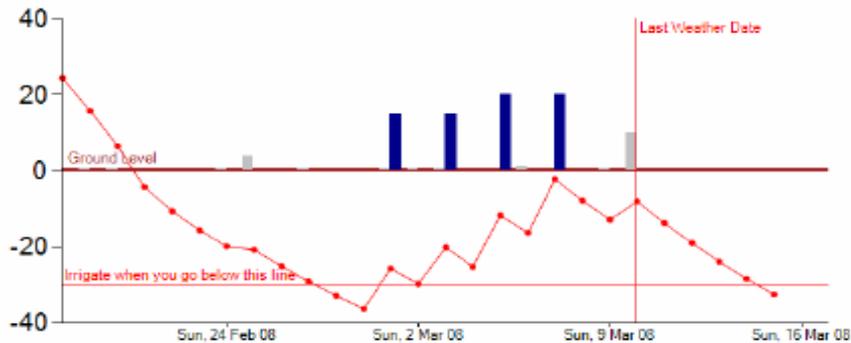


Figure 5 Illustrating adoption of increased application rate to replenish profile moisture with a centre pivot low pressure system

- Improved adjustment of trigger point to suit soil type and conditions: Adjustment of the trigger point to align better with soil RAW values was assisted by WaterSense monitoring. This is a useful facility where matching of farm soil type to those in the program is difficult and helps to counteract this problem where soils information is limited. It is an advisable adjustment where availability of water (rain, irrigation supplies) is restricted, or change occurs during the irrigation season, which requires a different approach than of on-demand irrigation.

The second season's outcomes highlighted a number of overriding issues impacting upon project outcomes. These were discussed in some detail at a meeting of the facilitators and project investigators in April 2008 and included strategic and management issues as well as operational matters.

- (1) The project model, used to introduce WaterSense to sugar industry irrigators, of initial group training workshops followed by one-to-one interaction to assist individual use of the program, had met with only limited success. Few growers were regularly using WaterSense independently; moreover, use appeared dependent on the level of personal interaction with facilitators. This is illustrated by the better use of the program with growers on whose properties there is a monitoring site and/or who receive regular visitations from their facilitator. The level of expertise of users follows a similar trend and ranges from excellent to minimal.

Where significant use has occurred, there is evidence of well developed appreciation and understanding of the scheduling, planning and evaluation credentials of the program, indicating that persistence with irrigators at a

personal level would be worthwhile. As an adjunct to the current approach, a 'grower-direct' service is being developed at Bundaberg/Maryborough to provide WaterSense monitoring of indicator blocks to growers. As updating data is supplied to facilitators, evaluation runs can be quickly generated and results faxed or emailed to clients. A successful pilot of this program was conducted during the second season and showed promise of a method of involving more irrigators in real-time scheduling.

- (2) All members of the management team have increased trust in WaterSense and most are confident to use the program as a primary source of determining crop water requirement both at individual farm and district/area level.
- (3) The establishment of a home base for WaterSense was seen as a crucial requirement for a meaningful uptake of the program by irrigators. The possibility of having it placed with an existing industry body for a reasonable period to test a scheduling service was recommended.
- (4) Lack of specific soils information or misunderstanding of the same, continued to bug operations in some areas. As provision of compatible soil classifications is not likely to occur in the near future, this concern is probably best addressed through program training of facilitators, extension officers and water officers to better understand how WaterSense operates and how its parameters can be set up to cater for specific soil characteristics. Similarly, concerns held for run-off and drain-through calculations, and how to adjust rainfall to better allow for these, can be addressed. Availability of an adjustable run-off curve was considered to be a useful addition to the program also. However, the parameters are many and could be different for each area requiring varying emphasis. The cost of building and incorporating such a facility in the program was considered outside the scope of this project.
- (5) An additional request was to include a facility in WaterSense to estimate projected losses of not adopting the advised schedules. This would provide early warning of consequences of inappropriate scheduling practices as well as an estimate of potential gain from a change in irrigation practice. However, this would probably require additional funds to incorporate such a facility in the current program due to the additional programming required. Similar information can be gained by evaluating different scheduling scenarios although more effort is required of the operator.

6.3 Final season

A number of growers in some areas continued to be active in using WaterSense but the previously noted barriers to continuous involvement were also evident in this review period. Farm sales, changing their supply mill, or not irrigating due to low water allocation were reasons for original users not continuing in the Bundaberg area. In other districts there was a reticence to use the program independently and many only used the program when assisted.

The reluctance of some growers to operate the program independently is in contrast to the general acceptance of information derived from WaterSense. The

reluctance of some growers to use WaterSense appears related to the lack of effort (or time) to keep the program up to date for their farm. When the information on crop water use derived from WaterSense is supplied by extension officers, it is readily accepted. This, no doubt, has implications on the future delivery of the program to industry.

The following district reports outline feedback from irrigators.

6.3.1 Mareeba

No growers are currently using WaterSense directly for irrigation scheduling. Growers are aware WaterSense exists. However, the fact that BSES extension staff are not being knocked over by the rush of growers wanting to use it is evidence that they are just not interested. If the State government introduced legislation prescribing irrigators provide evidence to substantiate the need to irrigate; this would create an immediate demand for this technology.

One-on-one discussion with growers indicates that WaterSense is a difficult product to master unless used regularly. Growers' use is sporadic with often lengthy periods of inactivity coinciding with a lack of irrigation activity on farm. Unlike researchers/scientists, growers will not continue updating WaterSense unless there is a practical reason to do so. As a result, they forget how to access and/or use the product, interest wanes and they lose the desire to proceed further.

In addition, to obtain realistic outputs requires a sound knowledge of the different soils in a district and their PAWC. There is also the issue of a limited number of automatic weather stations from which to choose and the time required to log on and set up blocks to monitor. Most growers are content to have someone like their local extension officer interact with WaterSense and send them a simple weekly SMS text message advising the amount of irrigation needed.

How much growers are prepared to pay for such a service is debatable and it is unlikely that a stand alone fee for service operation would generate enough revenue to pay its way. Embedding access to WaterSense as part of the service fee (or for a small additional charge) to an organization such as BSES or provided free of charge to customers of agribusinesses with a vested interest in promoting greater irrigation usage (eg Sunwater, Ergon Energy) is more likely to succeed and be sustainable.

6.3.2 Burdekin

During the Cane Productivity Initiative meetings in March 2009, 19 growers indicated that they were interested in being signed up for the online program.

Online Participation:

Total number of growers participating	45
Nothing entered or set-up	28
Farm set-up no data entered	3
Last activated in 2007	6
Last activated in 2008	6
Been active in 2009	2

When considering these numbers, it is important to remember that 19 of the growers were only just signed up in March 2009. The responses to the grower survey in the Burdekin were limited and the level of online participation was considered a clear indication of the success of directly accessing WaterSense online. Throughout the surveys there was an indication that two growers had changed a management practice despite not continuing with the program. One grower indicated that they have started to irrigate their young plant and ratoon cane less as a result of the limited time that they used the program. Another grower indicated that they have started to vary the irrigation schedule between soil types as a result - 7 days on light soil and 9-10 on heavier soils.

Throughout the entire project it has been difficult to maintain grower interest and enthusiasm. Growers often do not have the basic information required to create good predictions. This information includes soil water holding information, appropriate predicted deficits or how much water that is being applied. Many growers have only believed the information if it was mirroring what they were doing anyway and then saw no point in continuing as they were right in the first place.

A suggestion has been made that with more on-ground support there may have been more faith in the data resulting in growers being more willing to maintain the database and make on-ground changes.

6.3.3 Mackay-Plane Creek

One outcome of the work in Mackay-Plane Creek is that grower interest in WaterSense has been kindled and several growers were disappointed that the sub-group did not continue. These growers want to be part of the program in 2009-2010, if it is available.

6.3.4 Bundaberg, Isis and Maryborough

Growers who have been using WaterSense found it had limitations, but it is easy to adjust to suit conditions. One limitation noted with WaterSense was that irrigation could be started sooner than required if incorrect input data related to applied irrigation volume was entered in the program. This is a human factor which highlighted the need for better understanding of irrigation system performance.

The per cent biomass accumulation can be set on WaterSense to allow for adjustments. Block variability can make a huge difference to yield and irrigation scheduling when using probes. WaterSense overcomes the complication of variability and allows for easier management.

Growers who have been using WaterSense want it to continue, but not be commercialised. It should be managed by an organisation such as CANEGROWERS or BSES. The amount of input required to maintain WaterSense was relatively low. Input from the Queensland sugar industry would allow CSE to maintain the server access and software to continue to run WaterSense from CSE. For this to take place industry and regional support is required.

The main use for WaterSense would be for district irrigation advice and use of information systems such as text messaging. Text messaging in the Maryborough area does work with positive feed back from growers.

Maryborough Sugar plan to manage irrigation of their farms with WaterSense into the future.

7.0 PARALLEL WATERSENSE – ENVIROSCAN MONITORING

In the Burdekin in 2008 season, WaterSense monitoring compared favourably with outcomes of parallel monitoring with EnviroSCAN. The close correlation between the monitoring systems is illustrated in Figure 6 which involves a composite site in the Burdekin.

At Atherton, the monitoring program which utilizes WaterSense and EnviroSCAN was conducted on a number of blocks in different locations, relative to crop class and time of harvest.

At Maryborough and Bundaberg, regular rainfall meant few irrigations were necessary in spring and early summer 2008, as shown in Figures 7 and 8. These exemplify the value of the predictive facility of WaterSense as we approached this period when irrigation demand would normally be high.

Further examples of validation are presented in conjunction with the Case Studies (Appendix 1) at Bundaberg, Hervey Bay, Maryborough, Ayr and Mareeba.

WaterSense



EnviroSCAN

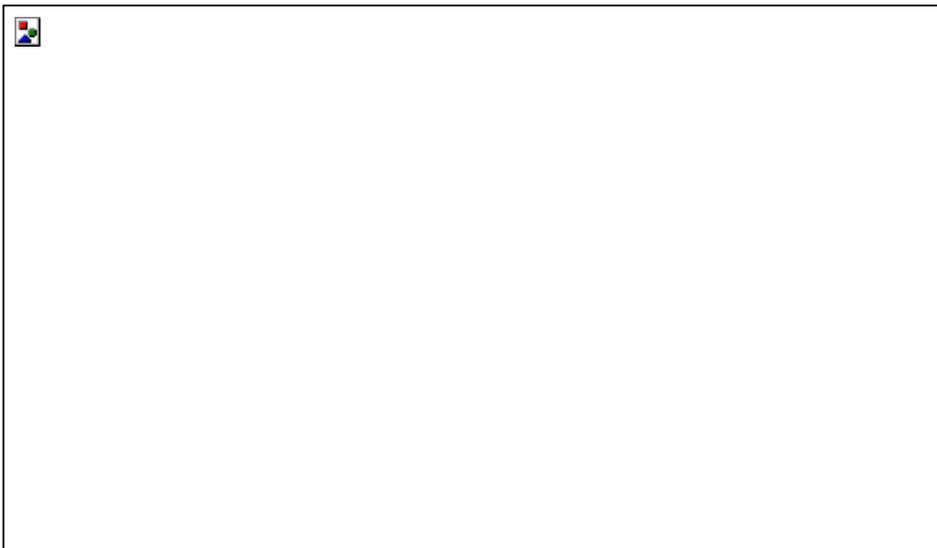


Figure 6 Close correlation between WaterSense and EnviroSCAN monitoring of a scheduled irrigation in the Burdekin, 2008.

Early season monitoring - Bundaberg

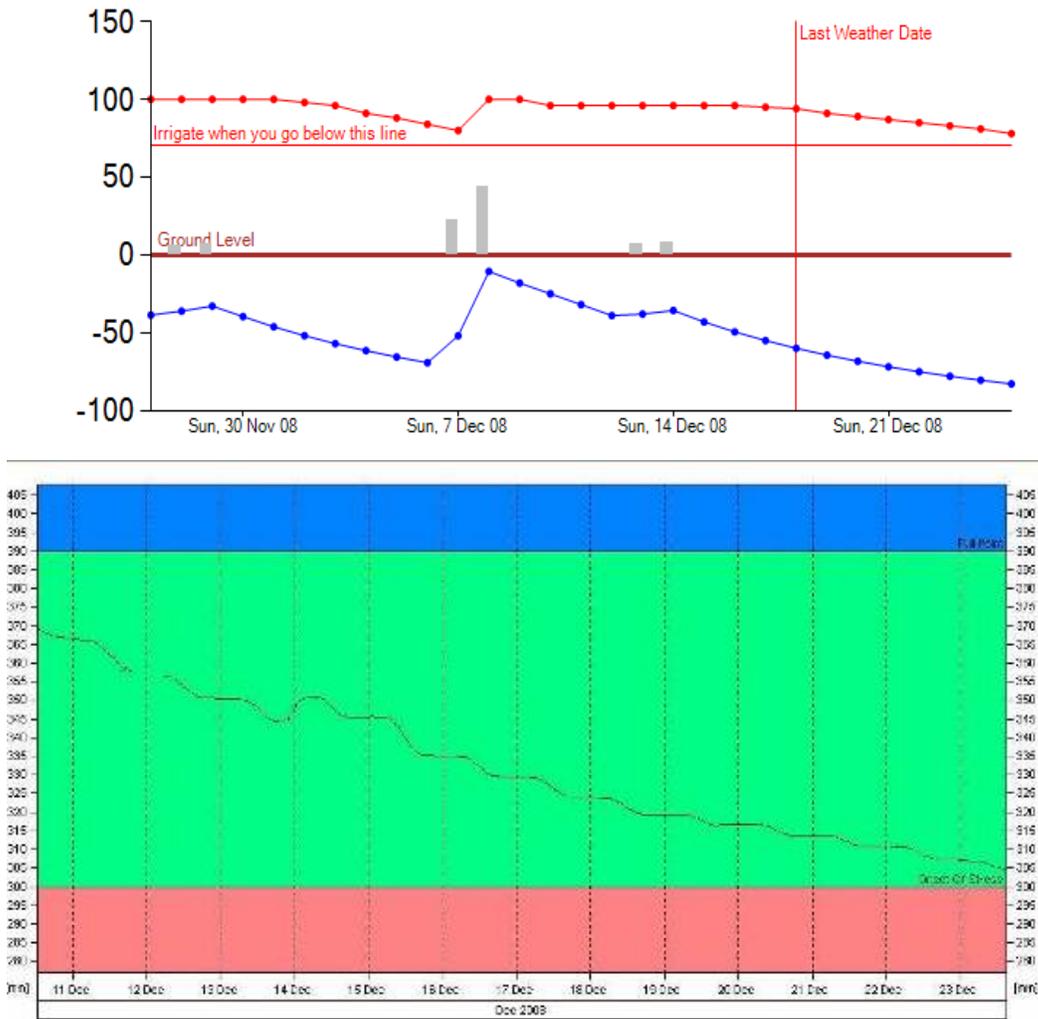


Figure 7 Comparison of early season monitoring with WaterSense (top) and EnviroSCAN (below) with WaterSense predictions for the Christmas period – QPIF, Bundaberg.

Early season monitoring - Tiaro

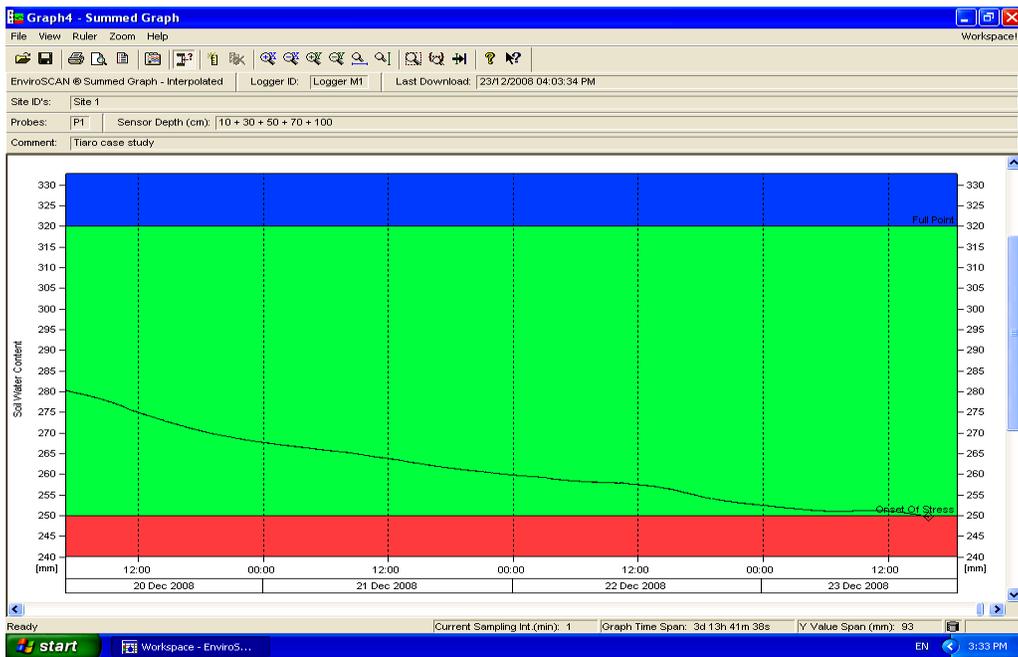
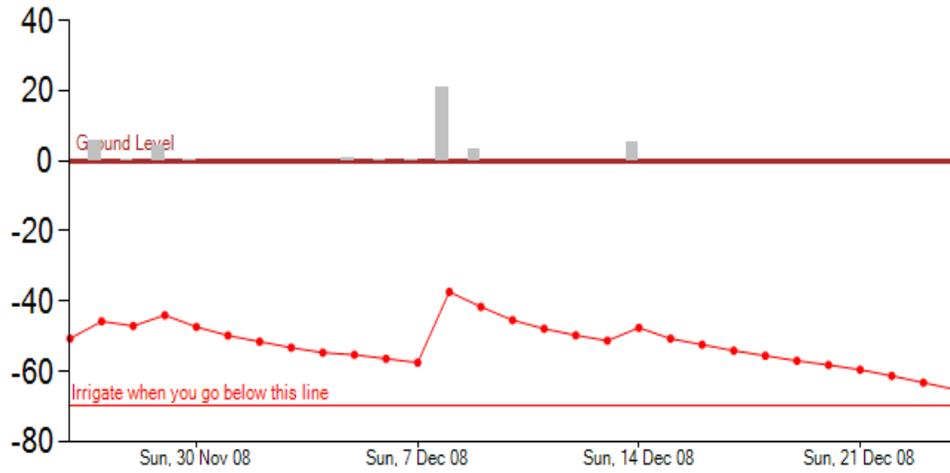


Figure 8 Comparison of early season monitoring with WaterSense (top) and EnviroSCAN (below) with WaterSense predictions for the Christmas period – Maryborough Sugar Co., Tiaro.

8.0 COMMUNICATION ACTIVITIES

8.1 First season

Communication of project outcomes reflected the stage of development at individual centres. Activities were most advanced at Bundaberg and Maryborough where several extension pathways were employed to disseminate information. Outputs included:

- Regular scheduling advisory notes in the CANEGROWERS newsletter at Bundaberg (Appendix 2). Notes were prepared for Maryborough and were faxed to irrigators. At Atherton, regular scheduling advice continued to be sent by text to local irrigators. These services appear to be effective, as was supported by outcomes of a survey that evaluated the impact of newsletters on the dissemination and uptake of new information and tools for irrigation scheduling at Bundaberg.
- Updating reports and discussions at industry meetings, including CANEGROWERS and Productivity Services.
- Production of a water-use-efficiency pamphlet incorporating use of WaterSense at Bundaberg.
- Inclusion of comment on WaterSense in a video prepared for the ANCID conference for 19-20 August 2007 at Bundaberg.
- Abstract prepared for a paper for the ANCID conference.
- Production of an Operator's Manual for use in all centres (Appendix 3).

8.2 Second season

Outputs were communicated to the broader irrigation community through established industry media and communication pathways. These included:

- An introductory article in *BSES Bulletin*.
- Involvement in allied workshops and seminars (1) SRDC workshop 'Exploring adoption processes for complex technologies' that used WaterSense as its centre piece, Brisbane, 30 August 2007.(2) SRDC Irrigation R & D planning workshop, Townsville, 4 December 2007
- Scheduling advisory notes in industry newsletters and electronic communication were provided throughout the irrigation season. At Atherton, weekly text messages were continued to virtually all irrigators (80), and a scheduling advisory service conveyed by email commenced in the Burdekin. At Bundaberg monthly district notes were supplied in the CANEGROWERS' newsletter to all growers. Emailed information was supplied to Maryborough participants where this service is to be further developed to include additional interested growers without computing facilities or expertise.
- Displays and demonstrations were conducted at a number of field days and grower meetings. Information was presented at four CPI meetings in the Burdekin involving 63 growers. A comprehensive power point presentation was given at a trial information day at Mackay at which 60 industry people attended including 30 growers. A display was conducted at a CANEGROWERS' field day at Bundaberg at which 200 growers were present.

- Facilitators and investigators attended a review and planning meeting at Mackay at which the project's progress was discussed in detail and strategies for the remainder of the program formulated.
- A paper concerning the operation of WaterSense, its potential and establishment in the Queensland sugar industry was prepared for presentation at the IAA conference – Melbourne, May 2008.

8.3 Final season

Communication was aimed largely at industry service level to make better known the positive outcomes of the project and the opportunities WaterSense provided for the cane industry. Additionally, activities continued to involve established industry communication pathways including industry media, internal reviews and discussions and industry updates.

The activities involved:

- Industry briefings were held in all project irrigation centres to update local industry on project outcomes and recommendations and to discuss future actions to increase the use of WaterSense in the cane industry. Six meetings were conducted at Maryborough, Bundaberg, Sarina, Mackay, Ayr and Atherton at which 56 representatives of CANEGROWERS, millers, productivity groups, BSES, NRW and QPIF and individual growers attended.
- Meetings were conducted also with Productivity Services groups at Bundaberg and Mackay to discuss what WaterSense offers and possible involvement of such groups in provision of irrigation scheduling services based on the program.
- Scheduling advisory notes in industry newsletters and electronic communication were provided at the close of the 2008 irrigation season. At Atherton, weekly text messages were continued to virtually all irrigators, and at Bundaberg monthly district notes were supplied in the CANEGROWERS' newsletter. Commencement of a scheduling advisory service in the Burdekin involved regular faxed/emailed communication of scheduling data to growers in the Millaroo-Dalbeg and McDesme areas from July, 2008 resulting in some 50 notices during the reporting period. Emailed information was supplied to Maryborough participants.
- Development of WaterSense was promoted in irrigation advisory articles published in rural newspapers such as *Australian Canegrower* and via radio interviews (Appendix 4).
- In the Burdekin district, information was presented to growers throughout the 2009 February and March Cane Productivity Initiative meetings. Bill Webb presented information to 12 of the 19 meetings highlighting the benefits of WaterSense and encouraging growers to sign-up to the online program. During the Cane Productivity Initiative meetings, 19 growers indicated that they were interested in being signed up for the online program.
- At Bundaberg, growers from Bundaberg, Isis and Maryborough were presented with information about WaterSense and the annual Cane Trends

Field Day. Over 200 growers attended the day that featured irrigation trends and equipment.

- At the Isis Field Day in June 2009, 83 growers and extension staff were presented information on WaterSense by Sandra Webb. Several growers expressed interest.

9.0 COMMERCIAL ASSESSMENT

Recruitment of commercial agricultural service providers to help assess the potential for provision of a commercial scheduling service for individual growers was conducted at Bundaberg and Atherton where providers are already operating. At Bundaberg, cooperation of a large commercial operator was achieved and preliminary discussions and investigations of a necessary support structure were completed. Attempts to establish a similar sub-program at Atherton were not successful. In this case and another at Bundaberg, commercial operators indicated that WaterSense appeared to be in competition with what they already offered.

Outcomes of the first investigatory session concerning a supporting structure were generally positive and indicated some requirements necessary for commercial sustainability. These included:

- The program provider needs definition and location. An estimate of associated costs to the service provider would be required.
- A collective approach is probably required initially but the system could be developed into a two-layered set up, viz. (1) data entry (2) technical interpretation.
- Construct data requires some form of monitoring and reporting on a regular basis – say every 6 hours.
- Weather information is seen as integral, requires regular updating, verification of the latter, and formal reporting to the service provider. Development of a protocol is recommended.
- Soil moisture monitoring should be conducted at strategic sites related to soil type and geography, dependent on size of operations. Options for cost recovery could be by direct customer contribution to a pool system or by the grower direct through choice and/or if size requires individual units. Monitoring units could be supplied on a basis of area or number of blocks, possibly on a rental basis, and the costs pooled. Any specific issues or requirements which arise would be considered additional to basic service requirements and additional charges applied.
- Regular data entry is essential – say weekly (e.g. rainfall, irrigation). Two options are available: (1) grower data entry with follow-up by the service provider, (2) data entry by the service provider. Data should be in an appropriate form for administrative input.
- Technical support will be necessary and should be provided by a body/organisation with agricultural experience for interpretation. This should be the same as whoever holds the data base. Options include (1) placing the

- server with a commercial provider, and (2) placing the server with an industry body and establish links to other support groups and the commercial provider.
- Issues of ownership of data need sorting out early in consideration of privacy laws. Assume the person who pays for the data owns it but can assign access to it.
 - Commercial entities should be granted a licence for a defined period, with review arrangements. Licences should include all software, training etc. to provide full operational functionality and reporting.
 - Reports require ability to be modified, updated, upgraded etc. as the service develops. There is a need for an ability to expand the reporting facility but not to an excessive number of options. It is important that reports are constructed at the server level (not service level).
 - The reporting facility should be reviewed before commercialisation and involve commercial operators.

Discussions were held with possible future service providers to ascertain interest for establishing an industry structure which would ensure continuance of WaterSense as a web-based service following completion of current projects. Discussions with BSES pursued opportunities at the industry level and included consideration of where to house and how to maintain dedicated operating computers (server), how this would be funded, how access would be provided to the service and on what cost basis, how programs could be updated and how that would be funded, and how the service would be managed to ensure industry-wide availability and effectiveness. CRC Irrigation Futures have ownership of WaterSense.

Possible provision of district-level services was discussed with productivity service management at Bundaberg and Mackay. While concerns were held for the responsibility of the operating system and inherent costs, interest was displayed in providing irrigation scheduling services based on WaterSense.

Commercial assessment of the program was furthered at Bundaberg where previously listed considerations for the establishment of a commercially based service were reviewed with the cooperating agricultural consultancy group and further options canvassed. Clearer definition was provided for each requirement listed. Overall, it was considered that, provided the mainframe program and supporting structure were stable and effective, a commercial farm level irrigation scheduling advisory service could be established and provided relatively easily. This, however, would remain dependant upon costs of provision of effective, reliable mother services to the commercial provider.

A Commercial Assessment of WaterSense was completed in 2009 and is attached as Appendix 5. The report detailed the principal market for WaterSense as the three main irrigation regions – Southern, Central and Burdekin. User groups have indicated that the number of individuals wanting to use WaterSense directly is limited, but all areas are keen to have district irrigation advice, produced from WaterSense, made available.

The marketing approach that appears most likely to succeed is for an industry-wide organisation such as BSES or CANEGROWERS to arrange a project with CSE to provide the service. District information on irrigation requirements could then be made available to customers of the organisation providing the service. Where individuals want access to WaterSense directly, this could be made available for a fee. It is likely that over time the numbers using the service directly would increase. Customers who have indicated they would want direct access are mostly larger corporate farms.

10.0 OUTPUTS

Outputs from the project included:

- Regular scheduling advisory notes in the CANEGROWERS newsletter at Bundaberg (Appendix 2). Notes were prepared for Maryborough and faxed to irrigators.
- At Atherton, regular scheduling advice texted to local irrigators.
- Production of a water-use-efficiency pamphlet incorporating use of WaterSense at Bundaberg.
- Production of an Operator's Manual for use in all centres (Appendix 3).
- An introductory article in *BSES Bulletin*.
- Promotion in irrigation advisory articles such as *Australian Canegrower* and via radio interviews. Examples are attached as Appendix 4.
- A scheduling advisory service conveyed by email in the Burdekin involved regular faxed/emailed communication of scheduling data to growers in the Millaroo-Dalbeg and McDesme areas from July, 2008 resulting in some 50 notices during the reporting period. An example of the Burdekin email advisory service is attached as Appendix 7.
- A paper concerning the operation of WaterSense, its potential and establishment in the Queensland sugar industry was presented at the IAA conference – Melbourne, May 2008. This is attached as Appendix 6.
- A Commercial Assessment of WaterSense was completed. This is attached as Appendix 5.
- Nine Case Studies were completed. These are attached as Appendix 1.

11.0 EXPECTED OUTCOMES

This project introduced a new irrigation scheduling tool, WaterSense to growers and extension officers in irrigation areas throughout Queensland. WaterSense is a web-based sugarcane irrigation scheduling and planning tool that allows the user to optimise irrigation inputs over multiple fields and enhance potential yields while limiting offsite impacts. WaterSense was developed by participative projects involving growers, CSE, BSES, SRDC, BSSL and other industry service organisations.

The principal market for WaterSense is the three main irrigation regions – Southern, Central and Burdekin. User groups have indicated that the number of individuals wanting to use WaterSense directly is limited, but all areas are keen to have district irrigation advice produced from WaterSense made available.

The marketing approach that appears most likely to succeed is for an industry-wide organisation such as BSES or CANEGROWERS to arrange a project with CSE to provide the service. District information on irrigation requirements could then be made available to customers of the organisation providing the service. Where individuals want access to WaterSense directly, this could be made available for a fee. It is likely that over time the numbers using the service directly would increase. Customers who have indicated they would want direct access are mostly larger corporate farms.

Participation in the project working groups helped to further growers' and extension officers' knowledge of the chief factors influencing crop water use and soil water holding capacity. This understanding together with the use of WaterSense has enabled growers to improve water use efficiency thereby limiting deep drainage and run-off of irrigation water.

12.0 FUTURE NEEDS AND RECOMMENDATIONS

During the developmental work to set up WaterSense in each irrigation area, several changes were made to factors associated with soil type and irrigation method. These are now part of the current WaterSense package. However, if WaterSense is extended further to new irrigation areas further adjustments will be required. For instance, further work is required to accurately describe soil types in the Mackay district.

Other items identified were that addition of functions to calculate runoff and economics would add value to the package from environmental and grower decision making perspectives.

An ability to estimate runoff from fields would add to the current ability to estimate deep drainage. This could help in the design of tailwater dams as well as highlighting high risk times for applying herbicides and fertilisers.

An economic component of the program could help growers with "what if?" questions such as "If I do not irrigate now, what will the likely cost in terms of yield and dollars?" and vice versa in terms of irrigation costs.

13.0 PUBLICATIONS ARISING FROM THE PROJECT

Linedale, Tony (2007). Making 'WaterSense' of Irrigation. *BSES Bulletin* 14, 12-13.

Haines, M.G., Inman-Bamber, N.G., Attard S.J. and Linedale, A.I. (2008). Enhancing irrigation management planning with EnviroSCAN and WaterSense. In: Share the water, share the benefits. Proceedings of the Irrigation Australia Congress May 2008, Melbourne, CDROM. (Appendix 6)

Attard, S.J., Inman-Bamber, N.G. and Hesp, C. (2009). Use of overhead irrigation in the lower Burdekin uses less water and does not penalise yield. *Proc. Aust. Soc. Sugar Cane Technol.* 31, 230-239.

14.0 ACKNOWLEDGMENTS

Thanks go to:

- The growers and industry service people who participated in the grower groups at Maryborough, Bundaberg, Mackay, Burdekin and Atherton Tablelands.
- Project staff Tony Linedale, Maurie Haines, Steve Attard, Geoff Inman-Bamber, Toni Anderson Drew Burgess, Andrew Dougall, Mark Hetherington, Joe Muscat, Evan Shannon, Frank Sestak and Kalya Abbey for their efforts.
- BSES, CSE, BSSL, Maryborough Cane Productivity Services and SRDC staff who have assisted with the project.
- SRDC, BSES, CSE and CRC for Irrigation Futures for co-funding this project.

15.0 REFERENCES

Inman-Bamber, N.G., Attard, S.J., Baillie, C., Lawson, D. and Simpson, L. (2005). A web-based system for planning use of limited irrigation water in sugarcane. *Proc. Aust. Soc. Sugar Cane Technol.*, 27, 170-181.

Inman-Bamber, N.G., Webb, W.A. and Verrall, S.A. (2006). Participatory irrigation research and scheduling in the Ord: R&D. *Proc. Aust. Soc. Sugar Cane Technol.*, 28, 155-163.

APPENDIX 1 - DISTRICT CASE STUDIES

Mareeba

WaterSense was compared at two sites during 2008/09 against the output from EnviroSCAN® soil moisture probes. Site 1 was west of Mareeba at Dimbulah (Salveti) on a shallow duplex soil (soil depth to bed rock approx. 1.2m) while site 2 was east of Mareeba at Tichum Ck (Marti) on a deep red volcanic soil.

Case Study #1

At site 1, the comparison commences during the wet season as limited EnviroSCAN® data was available earlier in the growth of the crop. WaterSense values have been adjusted so that they match the EnviroSCAN® values when the profile is saturated.

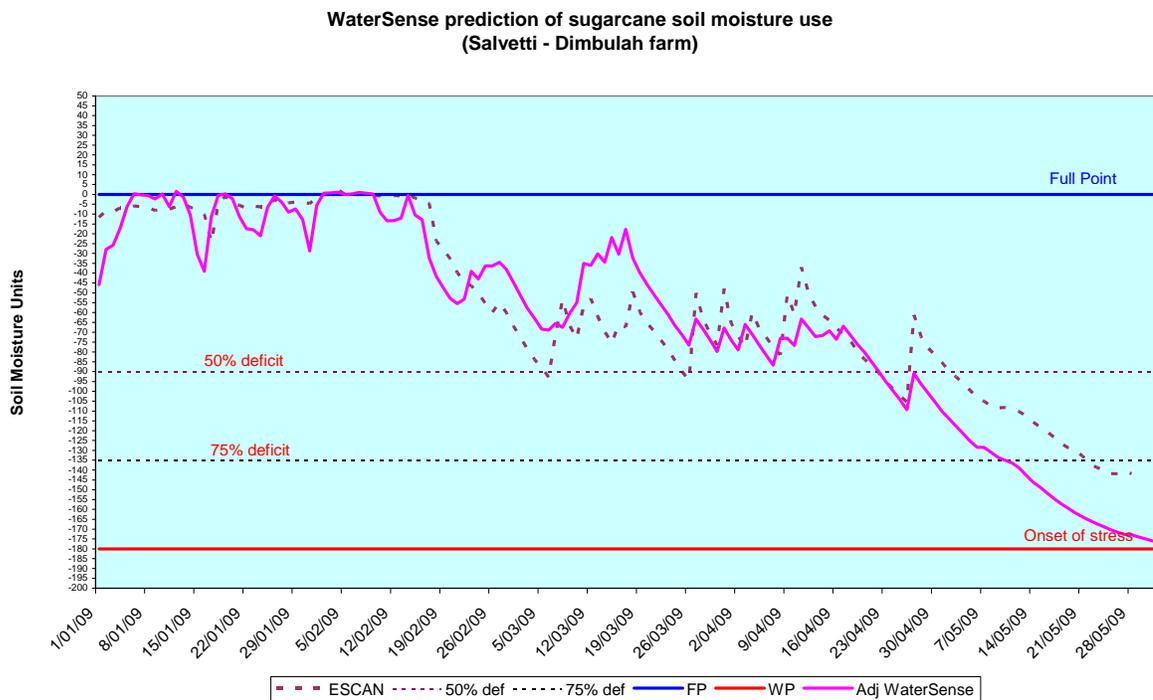


Figure 1 WaterSense prediction of sugarcane soil moisture use

During the immediate week's post wet season, WaterSense provides a reasonable prediction of crop water use when compared to the EnviroSCAN®. However, as the crop dries off for harvest (from late April), WaterSense predicts greater crop water use than the EnviroSCAN®.

This anomaly is due to WaterSense calculating crop water use from a deeper soil profile than actually exists at this site. The EnviroSCAN® is only measuring soil moisture changes to one metre and more closely represents likely crop water use at this site. At this site, reliance on WaterSense data by the grower would have resulted in additional irrigations to the crop prior to harvest even though not required.

Case Study #2

At Site 2, the comparison commences soon after the harvest of the previous ratoon crop. Once again, WaterSense values have been adjusted so that they match the EnviroSCAN® values when

the profile is saturated during the wet season. As for Site 1, WaterSense gave a reasonable prediction of crop water use compared to the EnviroSCAN[®] prior to, during and immediately post wet season.

However, as the crop dries off for harvest, WaterSense predicts greater crop water use than the EnviroSCAN[®]. As with Site 1, the EnviroSCAN[®] was measuring soil moisture changes only to one metre depth while WaterSense is estimating crop water use for the entire root zone (based on the soil selected from options available in WaterSense).

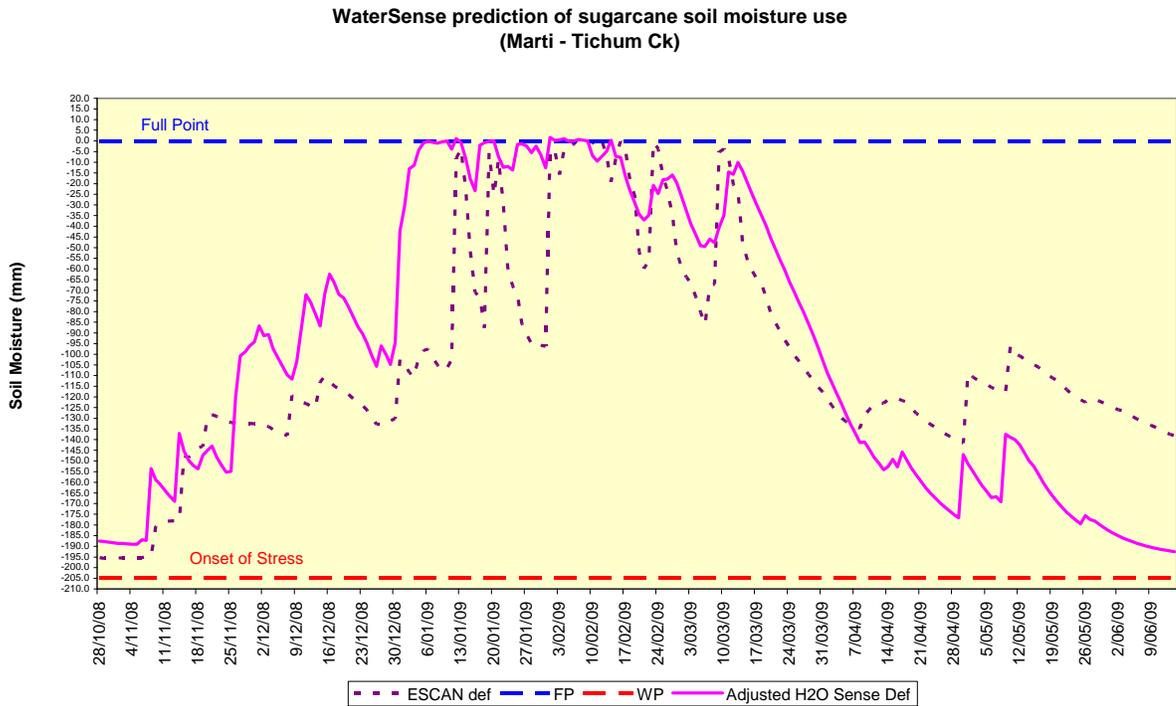


Figure 2 **WaterSense prediction of sugarcane soil moisture use**

Burdekin

Drip vs. furrow comparison

The case studies are based on a Burdekin Delta sugarcane farmer with furrow and drip irrigation who is a current user of the online WaterSense program with paddocks set-up and data entered for drip as well as furrow irrigation.

Case Studies # 1

Drip Irrigation

With the newly installed drip irrigation the grower wished to apply small amounts of water on a regular basis. Choice of irrigation scheduling system would therefore be a critical component in successfully using the new drip irrigation system. The grower wanted something that could indicate daily crop water use. Only one system currently has the capability of indicating volumetric daily crop water use and that system is WaterSense.

WaterSense has been used to determine irrigation timing and volume on the drip irrigation block throughout the whole season. A tensiometer was also used early in the season as a back-up for the WaterSense program.

The grower followed the WaterSense recommendations as closely as possible for the whole season. ET was used to determine how much water to apply.

An initial problem that was anticipated was the over prediction of crop water use early in the season. WaterSense calculates Evapotranspiration (ET) which includes evaporation from the soil surface. Sub-surface drip irrigations are rarely influenced by soil surface evaporation which means that the program will predict a higher crop ET than is actually being used by the crop. To reduce the influence of evaporation a trash blanket was simulated on the plant cane.

At certain periods the grower observed water running out of the drills due to excess water, it must be noted that there is a shallow aquifer at the bottom end of the paddock interacting with these irrigations. Due to the shallow watertable irrigating in accordance with any scheduling program would have over watered the lower parts of the paddock or under watered the rest. This is a limitation of the paddock not a limitation of the scheduling program. The effect and influence of this shallow aquifer is difficult to quantify without soil moisture monitoring equipment.

An indication of over prediction of crop water use under a trickle system is that the grower has now, 12 months since planting, used 9.6 ML/ha. This is a large amount of water considering there has been a lot of rain and cloud cover throughout the 2008-09 season.

WaterSense is a program which determines potential crop water use excluding influences other than those measured by a weather station or crop cover. Crop water use can be influenced by variety, rooting depth, unidentified soil constraints, disease and insect damage. So by its very nature WaterSense will determine the maximum potential use for any given day.



Figure 3 WaterSense indicating a severe drop in soil moisture

Figure 3 shows the WaterSense model indicating that soil moisture levels dropped to as low as 80 mm on a light soil. At an 80 mm deficit this crop should have displayed prominent stress symptoms, the grower and consulting agronomist indicated that in the weaker parts of the paddock signs of stress were evident. However, the heavier parts of the paddock were showing no signs of stress. This could be put down to either the model is still over predicting the crop water use or the shallow groundwater was supplementing the crops water needs. This question can not be answered without adequate soil moisture monitoring which was not in place.



Figure 4 Sum total graph indicating that excess water was being applied.

As can be seen in Figure 4 the opposite extreme was indicated by the WaterSense program. This over application of water was the result of the grower relying on the crop ET function to predict how much water to apply. The crop ET graph for the same time period can be seen in Figure 5.

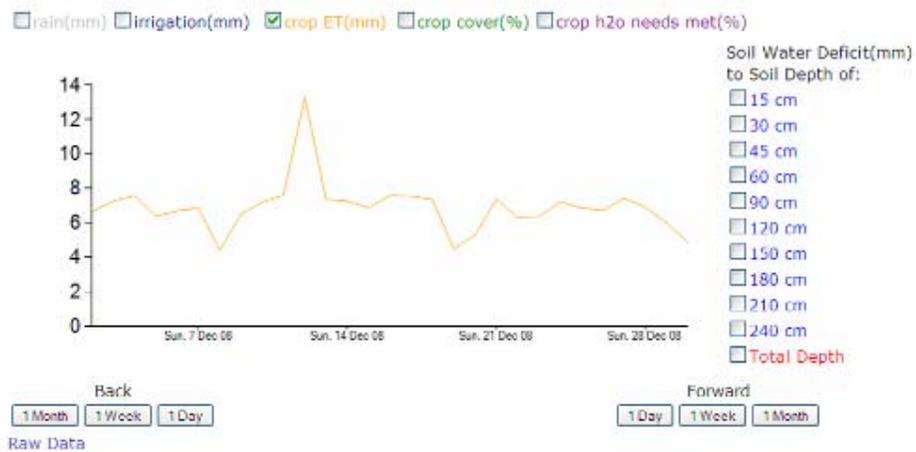


Figure 5 Daily crop water use indicated through the crop ET function.

Crop ET was indicating a daily water use of around 6.5 mm / day which is the amount of water that was being applied through the trickle irrigation. An issue with relying on the crop ET solely is that you no longer have the cumulative perspective. This is a small lesson learnt throughout the season.

Burdekin

Case study # 2

Furrow

The grower entered information into WaterSense for plant cane blocks only as the farm has over 100 blocks and to keep up-to-date on all blocks was going to take too much time.

The farm is located in the Delta which has a significant number of non metered outlets. The grower does not have meters on all of his pumps, however, he estimates his irrigation applications based on the channel water irrigations which are metered.

The grower questioned if there was a value in using WaterSense in the delta with furrow irrigation, with the following limitations and barriers:

- No meters;
- Short irrigation runs;
- Small blocks;
- Old irrigation infrastructure;
- Low cost of water; and
- No water restrictions.

Areas of limited confidence

The grower had limited confidence in the following issues:

- Limited soil types to choose from, there are lots of soil types within the district however only a few to choose from in the program;
- No confidence in being able to select a target deficit;
- Crop water use may be over predicting, example in figure one; and
- Not a great understanding of how the different soil types affect the crop water use calculations.

Many of the problems that have been identified by the grower are confidence issues and not problems directly related to the WaterSense program. Many of the problems that have been highlighted could have been eliminated with better back-up and support for the implementation of the program.

Growers in this region have very little knowledge of their current furrow irrigation practices with little recording, metering or knowledge of basic soils parameters. This information is vital to the WaterSense program.

Identified options to build confidence in users include:

- Having a meter to read,
- Reading and recording meters every irrigation,
- Having a better explanation of the soil types and the affect on readily available water, and
- Soil moisture monitoring.

The grower found that while the hardest part of using WaterSense is coming into the office and entering the data, he intends on continuing to use WaterSense for his plant cane blocks and thinks that WaterSense is a good tool and would hate to lose this resource.

Mackay

Taking control of your irrigation

By Joe Muscat

Centre pivots and lateral move irrigators are dotting the landscape in many parts of the central region as growers move towards more efficient methods of irrigating sugarcane and rotational crops on their farms.

The challenge that faced many of these irrigators was to ultimately manage the area beneath the pivot or lateral move irrigator.

For example if you had fallow area, different crop classes, small plant cane and ratoons ready for harvesting that required different amounts of irrigation or no irrigation at all how would you achieve this?

The FARMSCAN 7000 VRI together with WaterSense can now give you that level of management. FARMSCAN 7000 VRI allows you true variable rate irrigation management to apply the amounts calculated by WaterSense for different soil types and crop stages, further improving water use efficiency of the farm.

The Farmscan 7000 VRI will be installed on a centre pivot on John Fox's farm at Wagoora, north of Mackay. John is a member of the Precise Pivot Management grower group, an SRDC funded project. John will work closely with BSES Mackay to evaluate the controller in a sugarcane situation.

So what is it and what can it do? FARMSCAN 7000 VRI can create variable rate application maps on your office computer, and then transfer them to the Farmscan 7000 for automatic section control.

Prescription maps are created using PC desktop software. The application map divides the circular area covered by the pivot into 1-10° pie slices and every slice is divided into segments.

Rates calculated by WaterSense can be assigned to as many, or as few, of these segments as required. Maps are then transferred to the 7000 via a USB stick, radio link or mobile phone modem. The system can also be programmed to send SMS message to your mobile phone for status/error reporting. The GPS at the end of the pivot monitors actual position.

If watering rates need to increase above 100%, the pivot will be slowed down accordingly, similarly if less than 100% is required in zones, the pivot will walk faster. Watering zones are controlled by smart nodes placed along the pivot on a simple shared communication system.

Options for wireless communication are offered. The nodes control air solenoids to switch the watering zones. Using air/water control greatly reduces sensitivity to impurities in the water.

This unique and innovative system is 100% failsafe. If the 7000 is disconnected from power, the pivot will return to normal operation with all watering points on, and end gun and pivot speed under normal manual control.

The versatile 7000 can be programmed for fertiliser, pesticides and herbicide application. Chemical/fertiliser application on centre pivots is optimised through the reduction of water rates.

The Farmscan 7000 system enables variable water application rates. Using GPS, banks of sprinklers are cycled on/off according to a pre-determined prescription. Additionally, it controls pivot travel speed and end gun function for optimal efficiency.

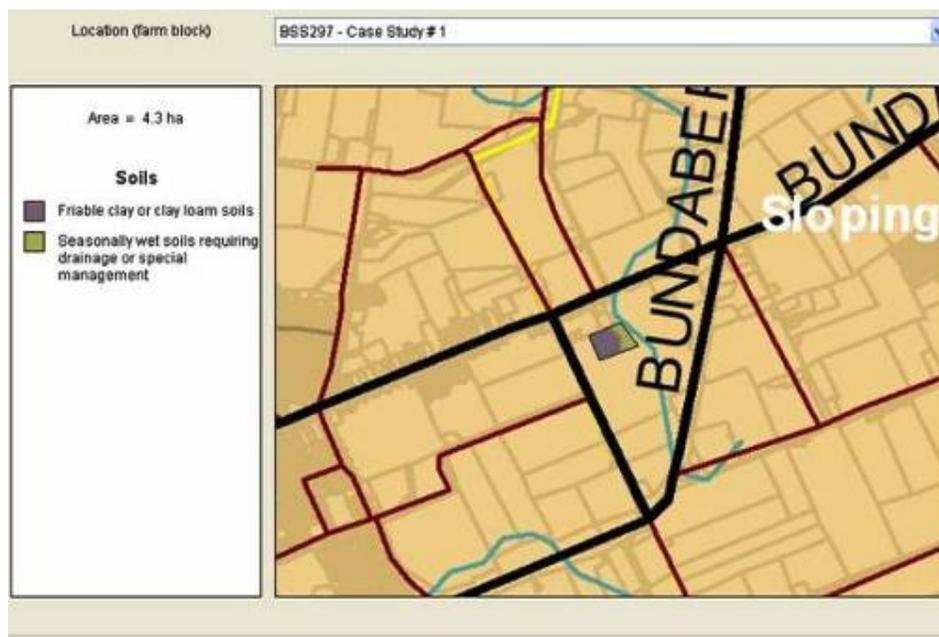
The system controls watering to account for spatial variability in the field. Because soils have different textures, water holding capacities, and irrigation requirements may differ between different zones in one field, application rates can be pre-determined using WaterSense for automatic rate control on different soil types. Each unique area is treated as a separate farm block in WaterSense and the program calculates irrigation requirements and documents the history of irrigation of each section.

Bundaberg

Case Study # 1

Location:

Ashfield Road Kalkie via Bundaberg



Soil and Soil Water Content:

Based on Bundaberg region soil mapping Zund et. al. al., DNR 1998

The case study site is a friable clay and clay loam soil described as Woongarra - Red Ferrosol (Euchrozem) 0.15 to 0.35m red light to light medium clay over brown light to light medium clay to 1.5m

Plant Available Water Content (PAWC) 150mm

Readily Available Water Content (RAWC) 80-90mm

EnviroSCAN records to 1 metre depth at the site indicate a probable soil water full point of approx. 400-420mm/m of soil.

WaterSense irrigation scheduling for the site is based on root extraction to a soil profile depth of 1.3m which therefore necessitates that higher maximum soil water content is applied. PAWC applied to WaterSense in this case study is 184mm.

Irrigation method

The farm where this case study was conducted operates in both a research and commercial capacity and as such has a range of irrigation systems that include furrow and high pressure travelling guns. The particular sugarcane paddock that the case study reviews was within the furrow irrigated sector.

Farming Method

At the site, sugarcane is produced on conventional 1.5m row spacing with surface mulch provided by green cane trash blanket. Fertiliser is applied behind coulters to incorporate the product in the soil below the trash. No other tillage operations are conducted and weeds are managed with an herbicide program.

Case study time frame

The case study took in the 2006, 2007 and 2008 crop. Yield details were 06 – 168tc/ha, 07 – 139tc/ha, 08- 139tc/ha., the 2009 crop was awaiting harvest at the time of writing.

For each crop, the main irrigation program was from late September to late May which is a period of about 200 to 250 crop days each year.

Rainfall and Irrigation

Harvest date, crop age, calculation of gross and effective rain and irrigation records were accessed from mill records, automatic weather station data and the WaterSense program (Table 1).

Crop age at harvest varied from year to year, the oldest being 2007 (407 days) and the youngest 2008 (358 days). Irrigation volumes also varied according to amount and timing of rainfall events and irrigation scheduling options selected in the WaterSense program.

Table 1 Rain, irrigation 2007-08

Crop Year	Harvest Date	Crop Days	Total Rain ML	Total Irrig ML	Total Runoff ML	Total Drain ML	Effective Rain ML
2006	Sep - 06	359	9.9	8.1	0.64	2.6	6.66
2007	Nov - 07	407	7.2	2.8	0.12	0	7.08
2008	Oct - 08	358	13.5	2.0	1.3	3	9.2

Irrigation scheduling options

Irrigation on the case study block was scheduled by the WaterSense program.

Within the WaterSense program there are two options for scheduling irrigation:

1. select a specific target based on an appropriate soil water deficit; and
2. Select a scheduling program based on biomass accumulation rate.

The 2006 crop was grown on the soil water target principle that, in this instance, applied a refill deficit of 80mm

In 2007, a crop biomass accumulation rate equal to 90% of peak crop growth was applied and in 2008 an accumulation rate of 85% was applied.

Monitoring

During 2007 and 2008, EnviroSCAN equipment was installed to monitor the validity of the irrigation schedule recommended by WaterSense.

The outcomes of this monitoring during the main summer irrigation period are shown in Figures 1 and 2. This data indicates the moisture volume from the soil surface to a depth of 1 metre was retained within PAWC levels over both summer irrigation periods.

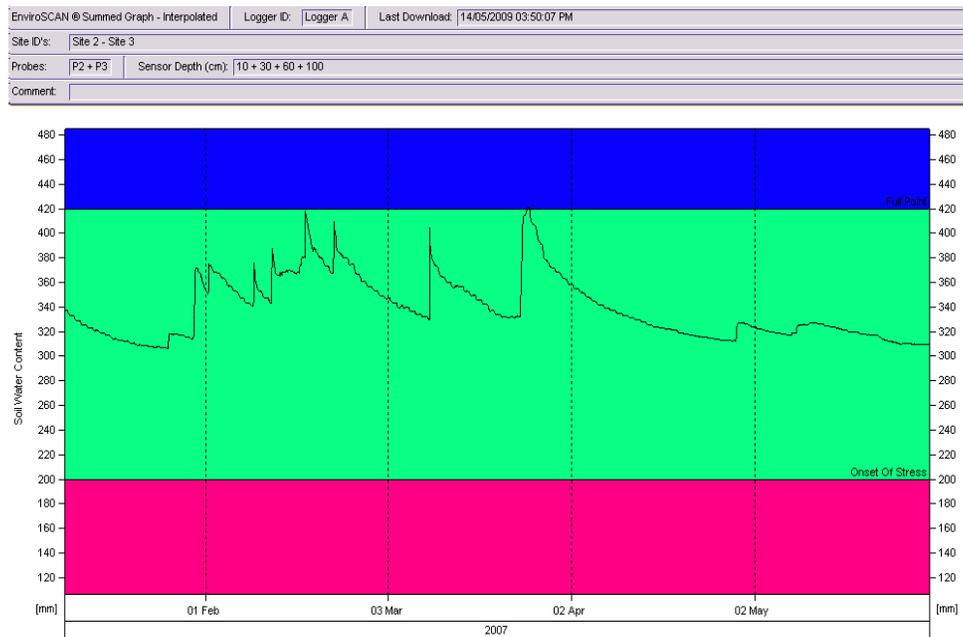


Figure 1 EnviroSCAN water balance (PAWC) January to June 2007

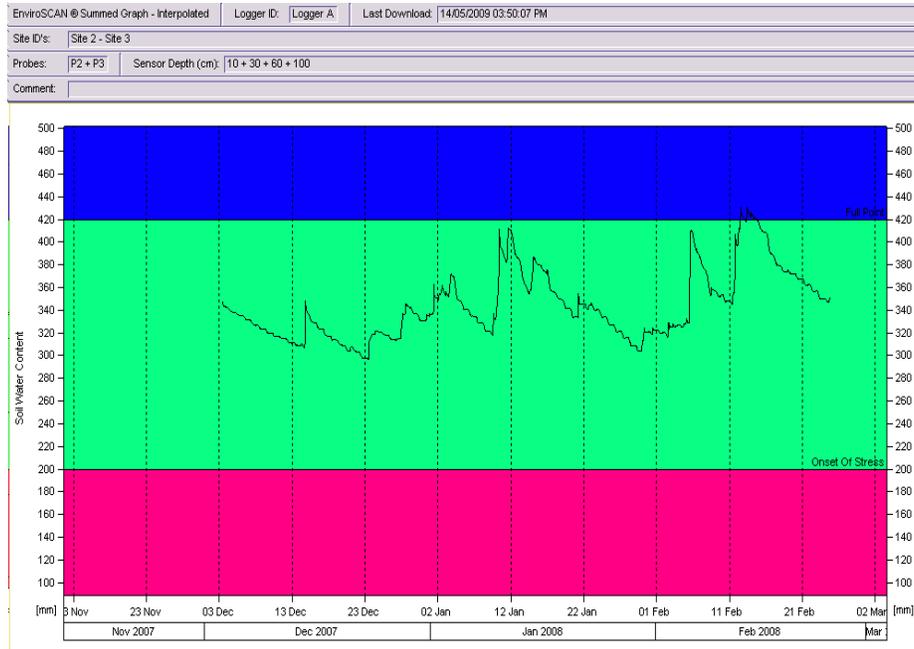


Figure 2 EnviroSCAN water balance (PAWC) December 2007 to March 2008

Irrigation schedules

Irrigation schedules recommended by WaterSense for crops 2006, 2007 and 2008 are shown in Figure 3.

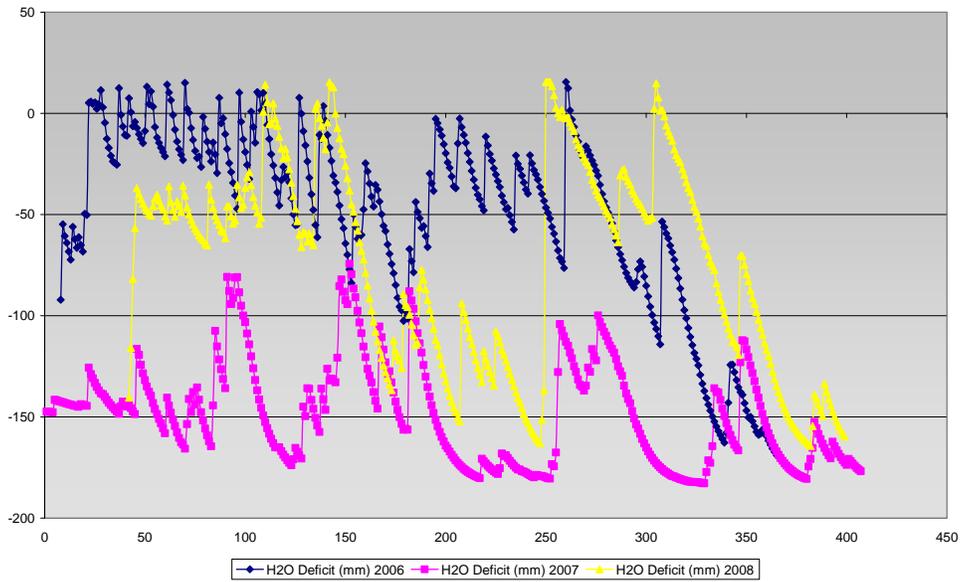


Figure 3 Yearly WaterSense schedules for each day commencing at harvest (0 days)

Interpretation

WaterSense expresses the schedule as a deficit (that is a deficit value relative to field capacity) this is in contrast to EnviroSCAN that represents the balance as a positive volume above zero

moisture. For this reason it is not relevant to directly compare the two systems without making adjustments to align each data set to a common value.

In this case study no attempt is made adjust to the data to a common value.

2007 WaterSense schedule indicates that using the biomass accumulation rate has on this block, maintained the soil water balance consistently within the range of PAWC relevant to WaterSense (less than 185mm) and importantly, this correlated with the most productive zone monitored by EnviroSCAN (RAWC - 320 to 400mm) for much of the summer period. Based on this information, the schedule as outlined by WaterSense for 2006 most likely indicates that, if monitoring had taken place, a very high moisture level would have been recorded which would have been consistent with the amount of irrigation applied.

Excessive irrigation inputs in 2006 appear to have impacted on effective rainfall thus resulting in poor efficiency which subsequently improved markedly when the biomass accumulation concept was adopted for 2007, 2008.

Year	Total Rainfall	Effective Rainfall	Irrigation ML/ha	Yield tc/ha	Tonnes cane/ML
2006	9.9	6.66	8.1	168	11.38
2007	7.2	7.08	2.8	139	14.06
2008	13.5	9.2	2.0	139	12.41

Conclusion

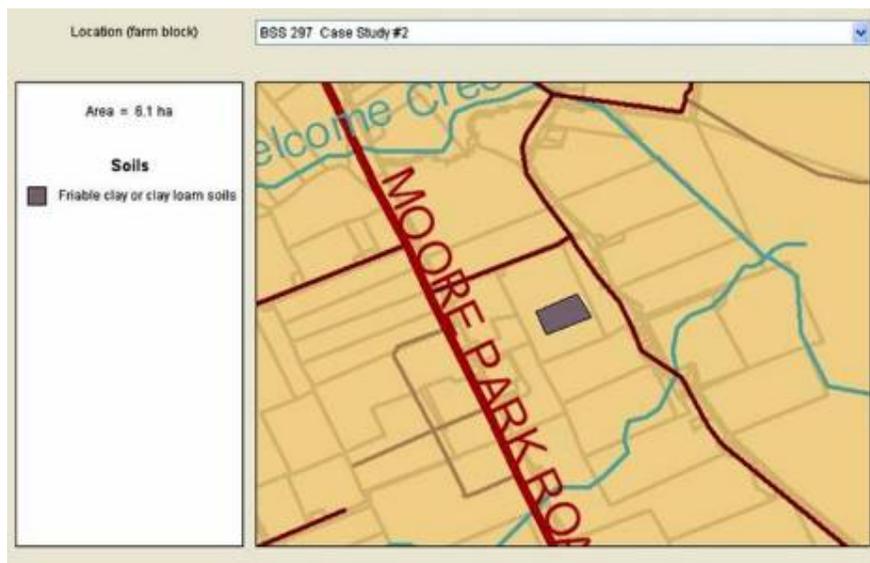
The WaterSense irrigation scheduling system has eliminated excessive water use in this instance and improved water use efficiency.

Bundaberg

Case Study # 2

Location:

Gooburrum Road via Bundaberg



Soil and Soil Water Content:

Based on Bundaberg region soil mapping Zund et.al. DNR 1998

The case study site is a friable clay loam soil described as Watalgan - Red Dermosol - 0.05 to 0.30m brown clay loam over red light to medium clay to 1.5m

Plant Available Water Content (PAWC) - Woongarra > 75 -100mm

Readily Available Water Content (RAWC) - Woongarra > 50 - 70mm

EnviroSCAN records to 1 metre depth at the site indicate a probable soil water full point of approx. 280-290mm/m of soil.

WaterSense irrigation scheduling for the site is based on root extraction to a soil profile depth of 1.6m which therefore necessitates that a higher maximum soil water content is applied. PAWC applied to WaterSense in this case study is 153mm.

Case study time frame

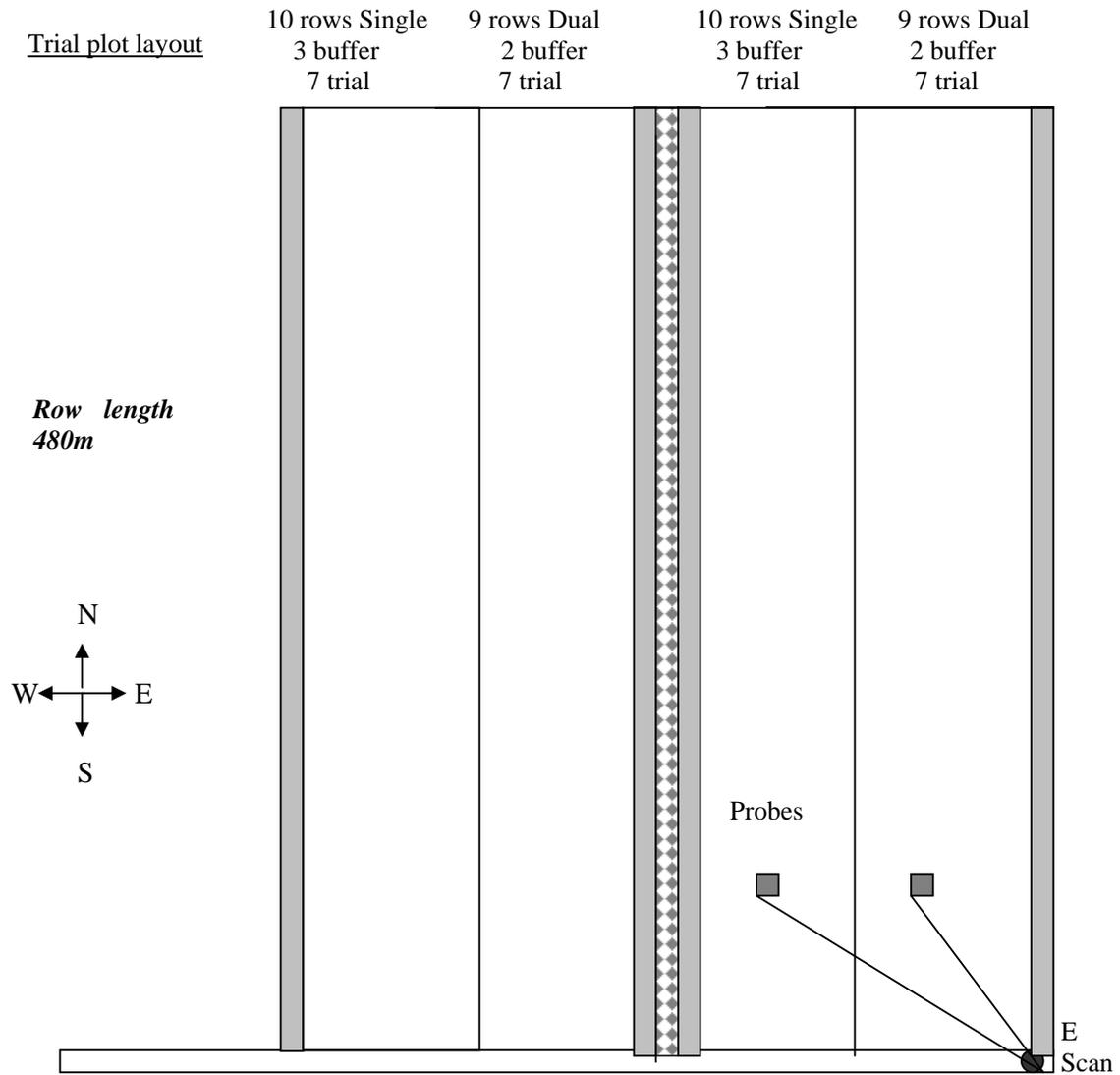
This case study is based on a trial of different planting methods conducted from 2005 to 2008. WaterSense and EnviroSCAN were used to schedule and monitor the impact of irrigation schedules.

Trial Details

A trial plan including four replicates of seven rows was prepared prior to planting. Two replicates of 7 rows x 1.8m x single row and two replicates of 7 rows x 1.8m x dual row were planted in October 2004.

Plant set volume (10 tc/ha) was the same for both the single furrow and dual furrow plots. Dual furrows were planted 500mm apart and the single furrow was 350mm wide. This sugar cane crop followed a peanut fallow that was harvested for its nut production.

Soil moisture at 30 minute intervals were monitored with EnviroSCAN sensors initially established in the plant crop and retained throughout the trial. The retention of tubes in the original position over time provided a reliable comparison of soil moisture between plant and ratoon crops. The WaterSense web based real time irrigation scheduling program was used in conjunction with EnviroSCAN to fine tune irrigation schedules.



Soil Moisture Monitoring

Soil moisture balance was monitored with EnviroSCAN sensors placed in both dual and single row 150mm either side of the centre of the planted zone (see examples) and rainfall was recorded by the nearby automatic weather station at Fairymead mill.



Irrigation scheduling

The development of a web-based irrigation optimising technique (WaterSense) by CSIRO in conjunction with industry stakeholders provided a means to constantly evaluate the daily crop water requirement, making it possible to calculate indicative “real time” irrigation schedules. Integration of the WaterSense predictive scheduling technique into this case study provided an irrigation scheduling and planning tool that optimized irrigation inputs and enhanced potential to maximize productivity.

Harvest Data

Mill weights and CCS data for each harvest were sourced for yield and CCS analysis.

Harvested Yields

The plant cane harvest indicated that yield on the 1.8m dual row section was approximately 9% higher than the 1.8m single row (Table 1).

Table 1 Plant cane results

Crop Class - year	Single row (tc/ha)	Dual row (tc/ha)
Plant	120.3	130.6

1st ratoon was harvested later in the season than expected (late October) and heavy suckering was evident in both the single and dual row which most likely influenced final yield.

Suckers in 2006 1st ratoon



Tonne cane/ha for both dual and single row over the 1st, 2nd and 3rd ratoon harvests are shown in Table 2.

Table 2 Ratoon results

Crop Class – year	Single row tc/ha	Dual row tc/ha
1 st Ratoon - 2006	158.1	154.3
2 nd Ratoon - 2007	92.4	95.5
3 rd Ratoon - 2008	107.6	101.9

Table 3 Crop cycle results

Plant and three (3) ratoons	Single row tc/ha	Dual row tc/ha
Gross yield/ha	478.4	482.3
4 year average	119.6	120.6

Irrigation program

All replicates were irrigated on each occasion with a single pass of a travelling boom to reduce the likely hood of major differences in the amount of water applied to each row per irrigation application.

Catch can tests were conducted to quantify volume applied and distribution uniformity of the irrigation equipment. Tests were conducted under a range of conditions viz. three different wind directions and three different wind speeds (Table 4) while the irrigator was operating in a west to east direction. Outcomes of monitoring were measured against the benchmark for assessing system uniformity (Christiansen's uniformity % - CU) which considers an irrigation system that exceeds 80% CU to be operating within an acceptable range.

Average application to each replicate was single row 50.19mm, dual row 50.33mm indicating minimal difference to the total volume applied per replicate per irrigation event.

Table 4 Results of catch can tests

Wind speed	Direction	Run application (mm)	Distribution uniformity (%)	Christiansen's uniformity (%)
Light	NW	50.79	79.25	88.72
Moderate	E	44.58	77.95	88.90
Moderate/fresh	NE	52.37	82.11	88.22



Collecting water applied to individual rows

Changes in soil moisture resulting from irrigation, rain and drainage and/or crop root extraction were monitored with non calibrated EnviroSCAN sensors (that is sensors not calibrated to the individual soil volumetric capacity) and as a result monitoring outcomes are actually a reflection of the extent of moisture change and not necessarily actual soil moisture content. However, as is common with this equipment output from the sensors is generally referred to as units of moisture. Sensor tubes installed in the plant crop remained in place over the term of the project.

The retention of tubes in the original position over time provided a reliable comparison of change in soil moisture between plant and ratoon crops. To do this, cane close to the sensor tubes was hand harvested each year so machinery could pass.

A single water balance interpolated from all four sensors (two in dual and two single rows) was used to monitor each season's irrigation schedule. Irrigation schedules endeavoured to maintain field water balance within a range of units deemed to represent soil Readily Available Water (RAW) values. EnviroSCAN water balance graphs for 2005 and 2006 (Figure 4 & 5) illustrate the relationship between the monitored soil water balance and published RAW for this soil.

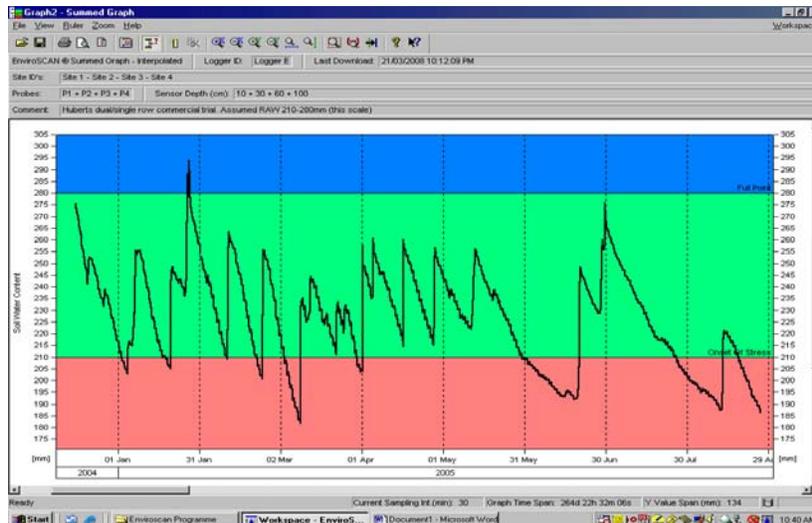


Figure 4 EnviroSCAN water balance 2004-05

The cultivated plant crop water balance (Fig: 4) shows considerable variability across the RAW range with the indicative moisture level dropping below the onset of stress on three occasions.

Season two (1st ratoon GCTB) water balance (Fig. 5) indicates that moisture was generally maintained within the upper level of RAW.

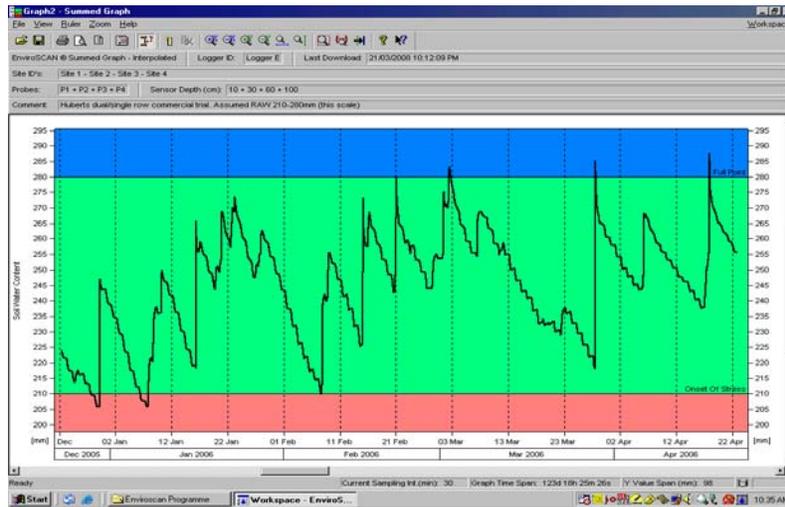


Figure 5 EnviroSCAN water balance 2005-06(30 minute interval)

In 2007 and 2008 the introduction of WaterSense enabled comparison of a recommended schedule and the field monitored water balance. The introduction of WaterSense also provided an improved rainfall and irrigation recording system. For this case study, WaterSense data was converted from a representation of deficit to represent a positive value similar to that represented by EnviroSCAN.

There was relatively good correlation of data from both systems when soil volume differences are taken into account. EnviroSCAN monitored to a 1m depth and WaterSense calculated to total soil profile depth which in this instance was 1.6m.

Graphic presentations (Figure 6 and 7) show daily water balance relationship – red shaded area indicates range of EnviroSCAN RAW and blue shaded area indicates range of WaterSense RAW.

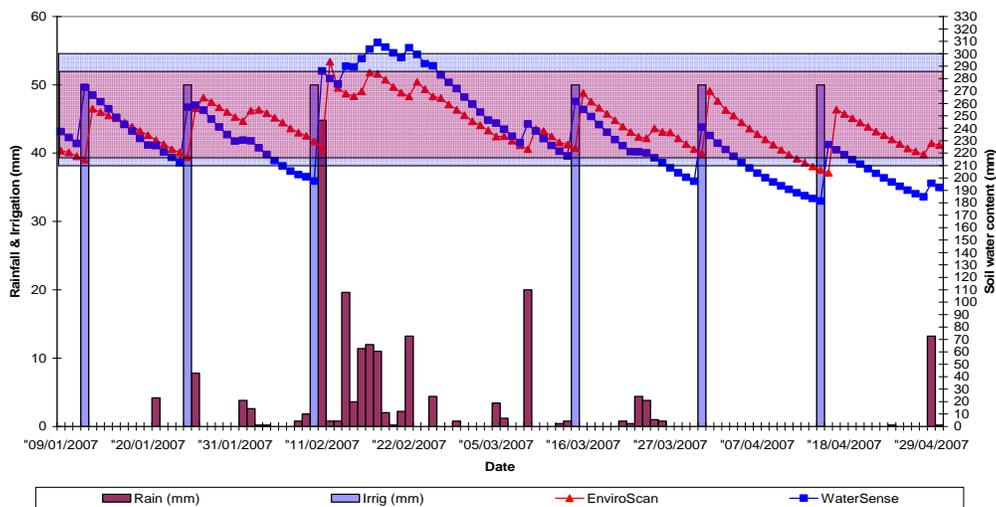


Figure 6 EnviroSCAN and WaterSense water balance, rainfall and irrigation 2nd ratoon 2007 crop.

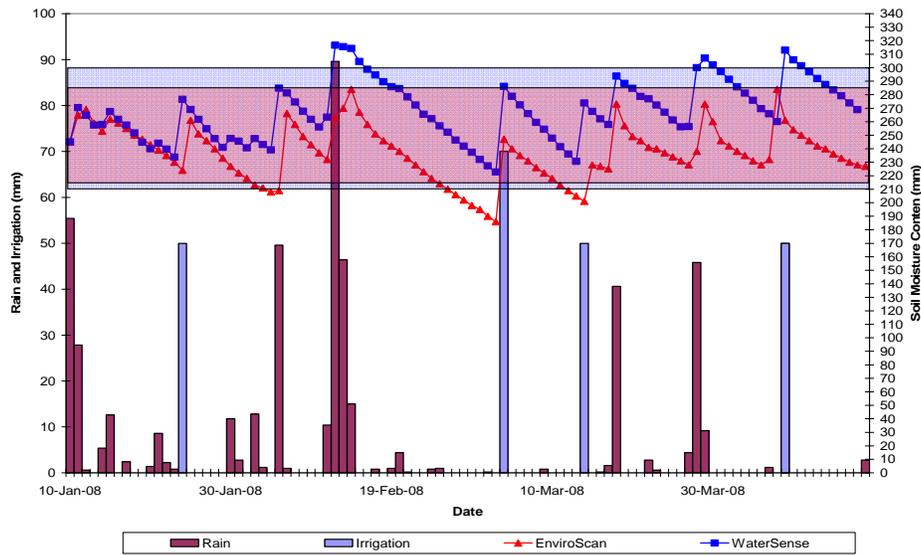


Figure 7 EnviroSCAN and WaterSense water balance, rainfall and irrigation 3rd ratoon 2008 crop.

Rain, Irrigation and Crop Factors

At Bundaberg, irrigation systems are often designed to supplement rainfall and as such, productivity opportunities may not always be fully realised. In this case study, the intensive monitoring program provided support for the development of irrigation management strategies and identified instances of lost opportunity.

There were periods that crop stress may have been avoided; rainfall patterns varied from year to year as did crop harvest dates. Comparison of the peak demand) water balance (January to March for each crop in the study (Figure 8) shows that soil moisture varied considerably from crop to crop but generally remained within the readily available moisture range during the peak summer growth period.

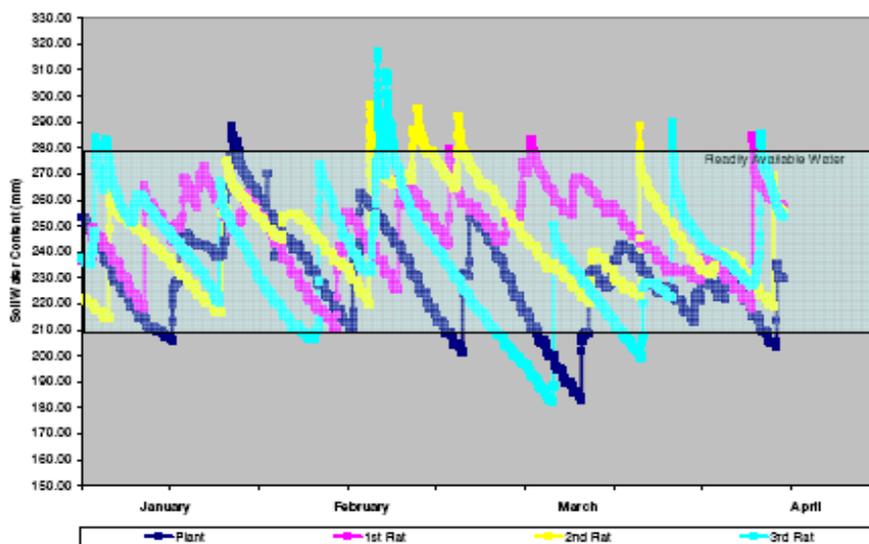


Figure 8 Comparison of daily water balance 2005-2008

EnviroSCAN monitored field capacity, mean moisture levels and RAW deficits are shown in Table 5. Mean levels represent water availability over the whole of the crop year. Levels were lowest in the plant crop and highest in the 1st and 2nd ratoon crops.

Table 5 Moisture/yield relationship 2005-2008

Year	2005	2006	2007	2008
Field capacity EnviroSCAN	280	280	280	280
Mean moisture (mm)	225	256	254	230
Mean Deficit	55	24	34	44
Deficit (% of RAW)	78	34	37	71

Crop age at harvest varied from year to year, the oldest being 2006 at 427 days and the youngest 2007 at 272 days (Table 6). Irrigation volumes also varied according to amount and timing of rainfall events and availability of allocated irrigation supplies.

Table 6 Crop age/irrigation, rain and rainfall efficiency 2005-2008 (sourced from WaterSense records)

Crop Year	Harvest Date	Crop Days	Total Rain ML/ha	Total Irrig ML/ha	Total Runoff ML/ha	Total Drain ML/ha	Effective rain/crop ML/ha
2005	Aug-05	364	8.10	4.0	0.33	0.85	6.92
2006	Nov-06	427	9.70	2.5	0.16	0.86	8.68
2007	Jul-07	272	5.33	3.5	0.45	0.00	5.28
2008	Aug-08	365	12.65	1.90	0.78	0.93	10.94

Harvest dates may vary crop opportunities and lead to ineffectual utilisation of some seasonal climatic events especially rainfall (Figure 9). In these situations visual observation of crop reaction to climatic conditions and estimation of soil moisture/plant water use relationships are often inadequate.

Given the impact of the late harvest in 2006, November 2006 rain would have been relatively ineffective for the 2007 crop as it occurred when the ratoon was in its initial development stage and unable to utilise substantial rainfall. A significant rainfall deficit also occurred from February – March 2007 resulting in a need for prolonged irrigation which is most likely reflected in the 2007 yield.

WaterSense was developed to aid water use management on a paddock scale because the variable harvest circumstances experienced in this trial regularly occur as a result of harvesting limitations during the crushing season.

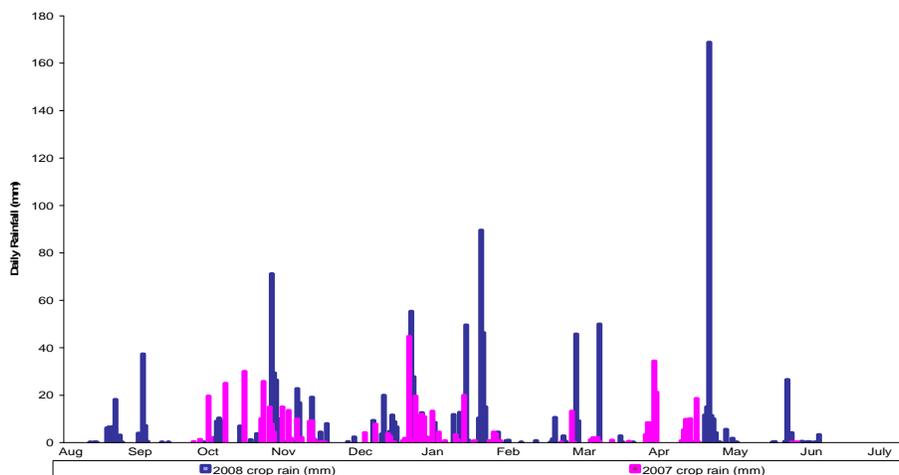


Figure 9 Crop rainfall pattern 2007 &, 2008 (sourced from WaterSense records)

Efficiency

Several agronomic and management influences are apparent in this study:

- monitoring activities using EnviroSCAN and WaterSense enhanced the farmer's capacity to adjust irrigation timing to account for daily rainfall and climatic fluctuations;
- this was aided by the use of a precision irrigation system (low pressure overhead boom) that provided a high level of distribution uniformity (DU) and an ability to adjust the volume applied to match the schedule recommended;
- 1.8m row spacing ensured that the potential for compaction close to the cane row was low;
- irrigation application efficiency was generally good with no application appearing to significantly exceed the soil water holding capacity (refer previous examples);
- requirement efficiency (irrigation water available for crop growth) as demonstrated by the detailed water balance in Figure 10 was also good with variation in the overall deficit/surplus limited to $-25 + 50$ mm;
- Yields (tc/ha) were above district average which indicates good management of seasonal climatic influences.

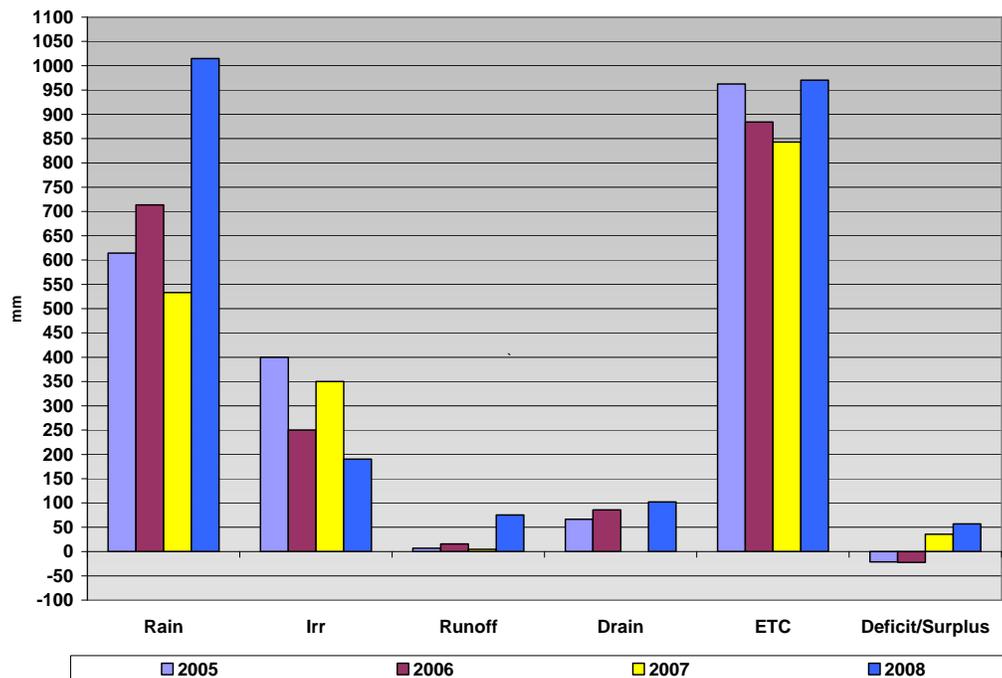


Figure 10 Full water balance 2005 - 2008

A water use index has been used at Bundaberg for many years to gauge the overall performance of irrigated farming enterprises. This index is known as Crop Water Index (CWI) which is a Farm Total Water Use Index that compares tonnes of cane per hectare to ML of effective rainfall + gross irrigation per hectare.

CWI for this study was above district average (Table 7) which demonstrates the potential to maximise efficiency and crop yield with a packaged farming system that includes change linked to precision application methods and irrigation management supported by monitoring and planning tools.

Table 7 Details of rain, irrigation, yield and efficiency for 1.8m trial plots 2005-2008

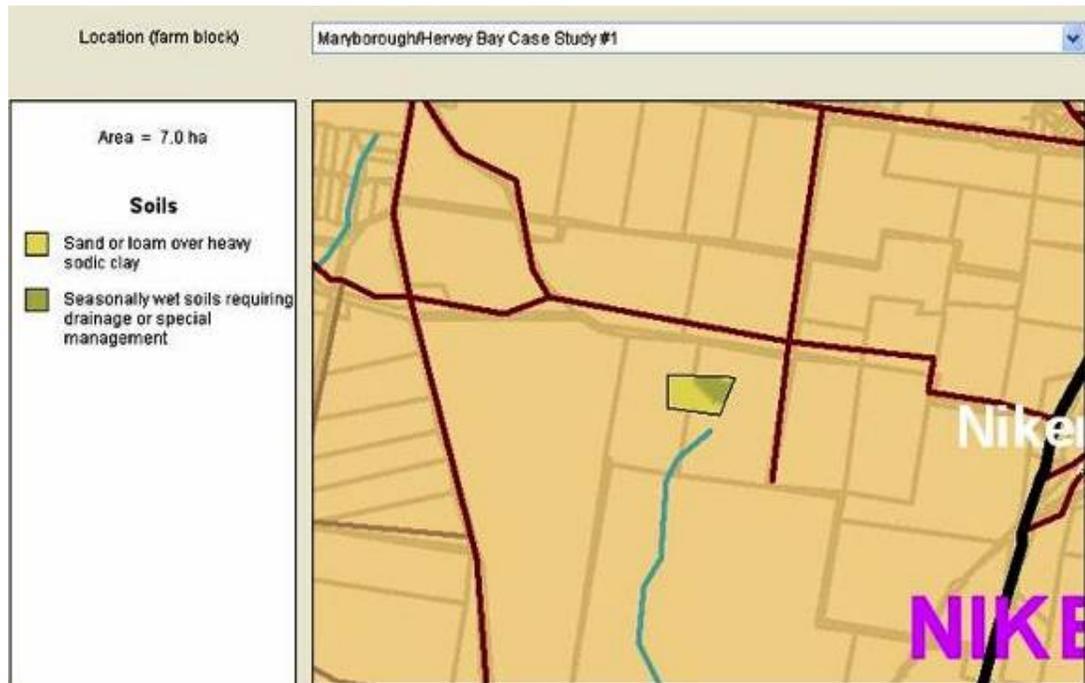
Year	Rainfall ML/ha	Eff Rain ML/ha	Irrigation ML/ha	Irrigation + Eff rain ML/ha	Yield Tc/ha	CWI tc/ML
2005	8.10	6.92	4.00	10.92	125	11.44
2006	9.70	8.68	2.50	11.18	156	13.95
2007	5.33	5.28	3.50	8.78	94	10.70
2008	12.65	10.94	1.90	12.84	104	9.13
Mean	8.94	7.95	2.97	10.93	118.9	11.30

Maryborough

Case Study # 1

Location:

Nikenbah via Hervey Bay



Soil and Soil Water Content:

Specific soil mapping data was not available for this case study site, however, based on observation of the soil profile during installation of monitoring probes the soil appeared similar to sand or loam over heavy sodic clay soils located in the Bundaberg area.

The site also had areas of shallow underlying rock which posed difficulties with installation of EnviroSCAN monitoring tubes and subsequently monitoring was limited to a depth of 60cm.

A shallow profile soil – Isis – Yellow chromosol – 0.03 to 0.1m grey sandy loam over bleached A2 horizon (0.3 to 0.7m) over acid to neutral yellow light to medium clay was applied to the WaterSense irrigation scheduling.

The select depth capability of WaterSense was used to schedule irrigation based on the limited soil depth encountered in parts of the site. Scheduling was based on 0-80cm.

Irrigation method

This case study site is irrigated by a centre pivot irrigator. Prior to the introduction of WaterSense scheduling a strategy based on historical daily water use data was in place which resulted in periods of crop stress or over watering and water logging.

Farming Method

At the site, sugarcane is produced with dual row planting on 2m wheel spacing with surface mulch provided by green cane trash blanket. Fertiliser is applied behind coulters to incorporate the product in the soil below the trash. No other tillage operations are conducted and weeds are managed with an herbicide program.

Case study time frame

The case study reviewed production of the 2008 crop.

Rainfall and Irrigation

Harvest date, crop age, calculation of gross and effective rain and irrigation records were accessed from records contained in the WaterSense program (Table 1).

Table 1 Crop information, rain, irrigation and effective rain 2007-08

Crop Year	Harvest Date	Crop Days	Total Rain ML	Irrigation ML/ha	Runoff & Drain ML	Effective Rain ML
2008	Sep - 08	357	14.57	2.2	4.15	10.42

Irrigation scheduling options

This case study set out to review existing scheduling practice and develop suitable amendments to improve its effectiveness.

The irrigation scheduled was initially recorded by WaterSense prior to amendments and the final outcome was confirmed by EnviroSCAN. EnviroSCAN was not used throughout the study due to unavailability of equipment early in the season.

In view of the shallow soil profile, WaterSense was operated to a specific soil depth (0-80cm).

The simulated schedule for December 2007 (Figure 1) indicates inappropriate timing and inadequate amounts of irrigation to maintain sufficient soil moisture for good growth during this critical month.

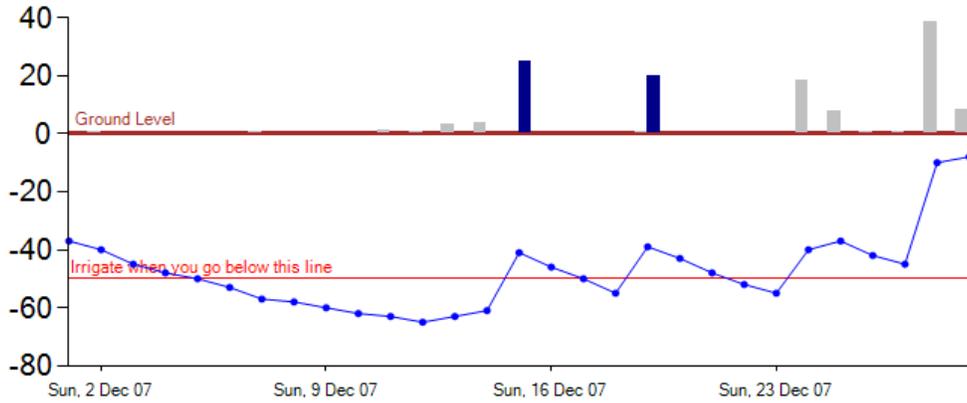


Figure 1 **December 2007**

Rainfall during January and February (Figure 2 and 3) meant that there was a low requirement for irrigation

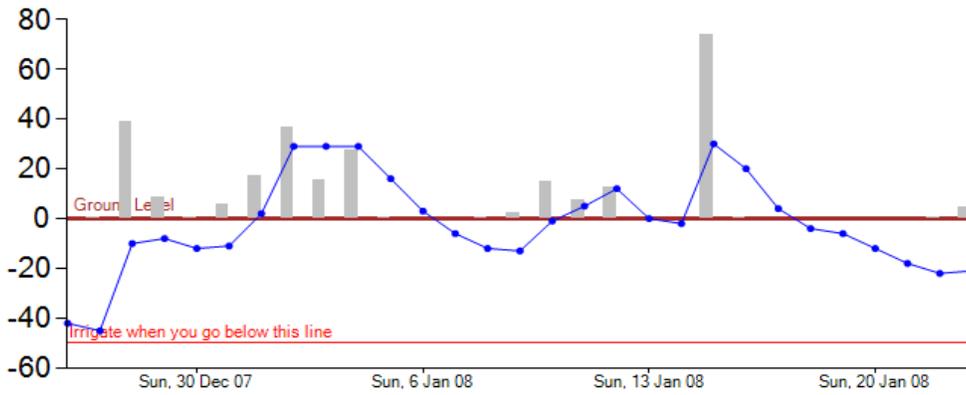


Figure 2 **January 2008**

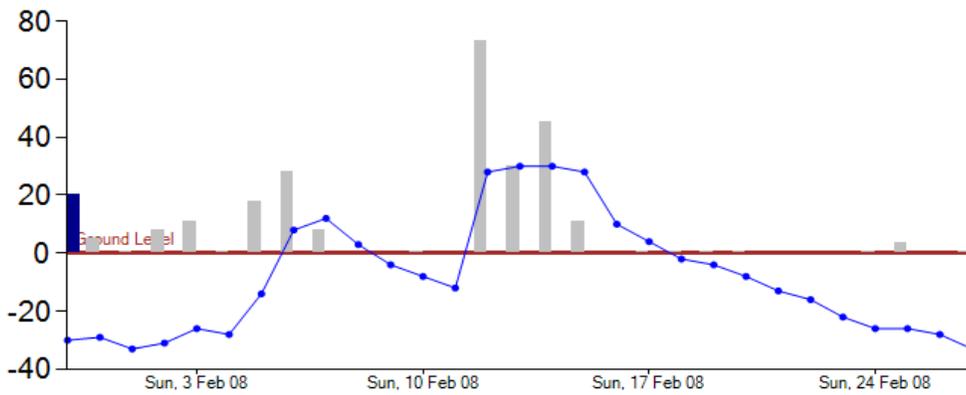


Figure 3 **February 2008**

A period of low rainfall at the end of February and March 2008 once again increased the demand for irrigation. Following a review of the previous schedule illustrated by WaterSense, the schedule was amended from irrigation every 5 days (Figure 1) in December with the soil profile being

sustained at substantial deficit to several frequent (2 day) applications to raise soil moisture and then an irrigation strategy based on daily crop usage as determined by WaterSense assessment of daily rain, irrigation and evapotranspiration (Figure 4).

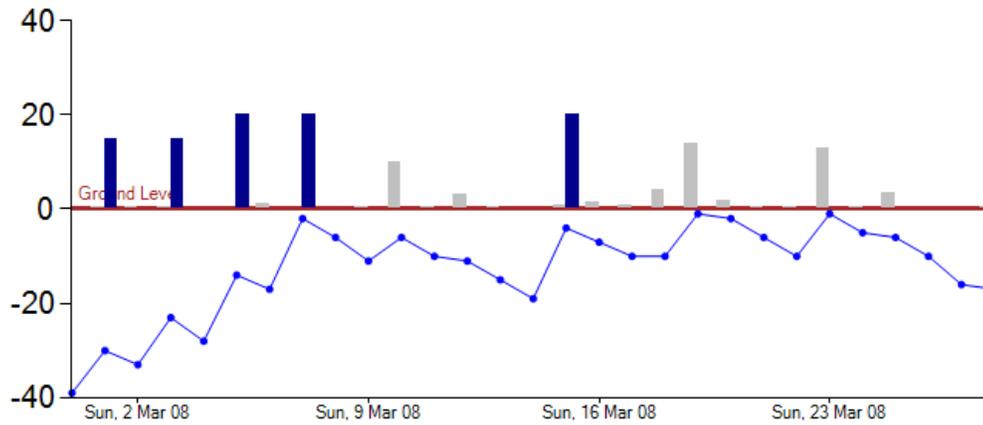


Figure 4 Amended scheduling program

This WaterSense scheduling was retained for the remainder of the season. Figure 5 illustrates the WaterSense rain and irrigation schedule for April 2008.

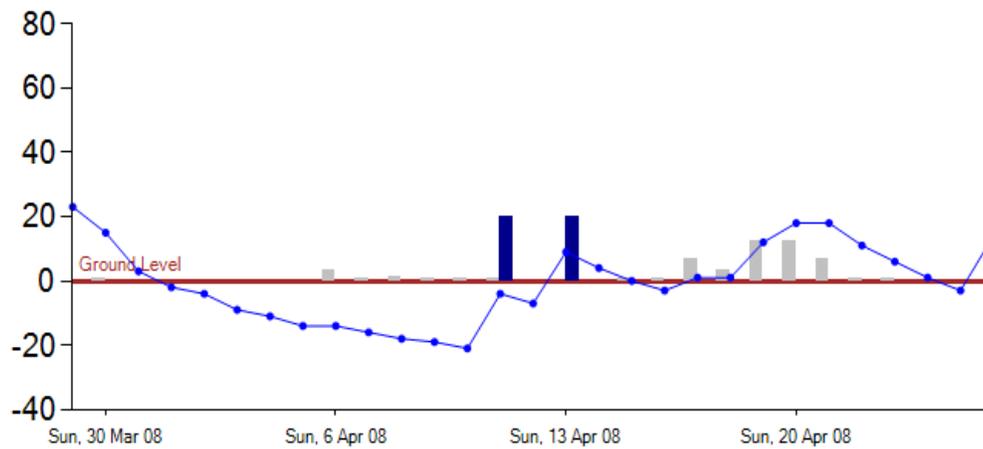
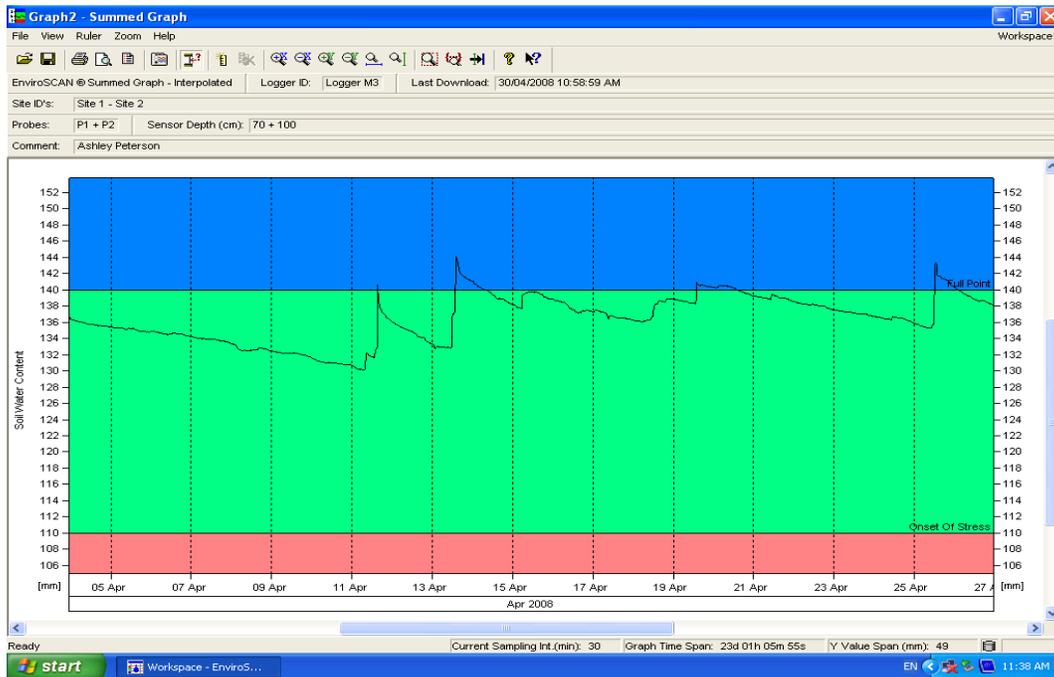


Figure 5 April 2008

Monitoring

During March 2008 EnviroSCAN equipment was installed to monitor the validity of the irrigation schedule recommended by WaterSense.

The outcomes of this monitoring are shown in Figure 6. This data indicates the moisture change determined by the EnviroSCAN for the April period shown in Figure 5 compares well with the adopted WaterSense schedule.



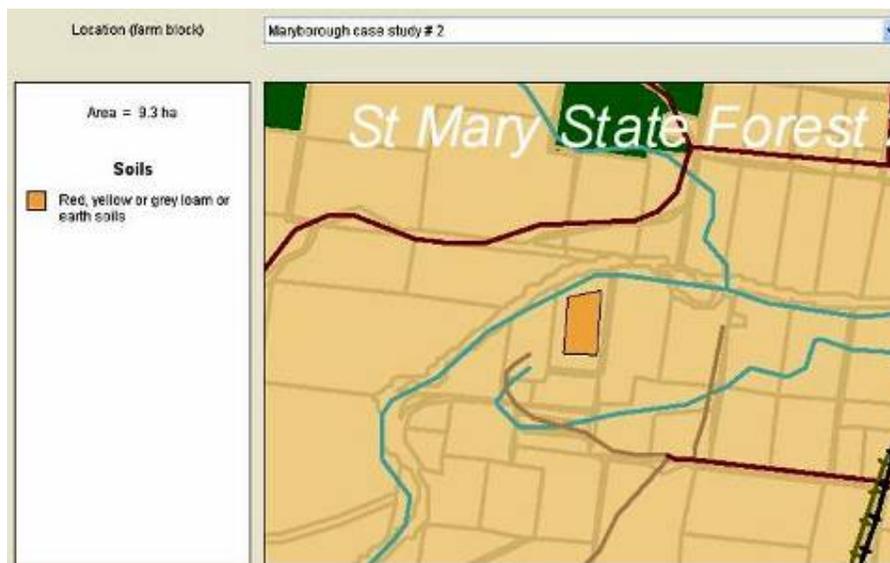
Outcome

The grower involved in this activity has now expressed a high level of satisfaction with WaterSense and indicated that he would find it very difficult to operate his centre pivot irrigators without the aid of WaterSense.

Maryborough

Case Study # 2

Location:
Tiaro



Soil and Soil Water Content:

Specific soil mapping data was not available for this case study site, however, based on observation of the soil profile during installation of monitoring probes the soil appeared similar to black/brown clay loam located in the Bundaberg area.

Based on Bundaberg region soil mapping Zund et.al, DNR 1998

Otoo – Red Dermosol – 0.25 to 0.45m black to brown fine sandy clay loam over yellow to brown light clay over red light to medium clay to 1.5m with Plant Available Water Content (PAWC) - 100mm and Readily Available Water Content (RAWC) - 50 -70mm was applied to the WaterSense irrigation scheduling.

EnviroSCAN records to 1 metre depth at the site indicate a probable soil water full point of approx. 270- 280mm/m of soil.

WaterSense irrigation scheduling for the site is based on root extraction to a soil profile depth of 1.6m which therefore necessitates that higher maximum soil water content is applied. PAWC applied to WaterSense in this case study is 153mm.

Irrigation method

This case study site was a green field development that when complete will be irrigated by a centre pivot irrigator. During the study period the irrigation system was not commissioned for use which provided an opportunity to evaluate the outputs of WaterSense against EnviroSCAN when the affects of long term cultivation activities were not a restricting factor.

Farming Method

The study site was first planted with dual row sugarcane on 2m wheel spacing in November 2008.

Case study time frame

The case study reviewed production of the 2009 crop from January to April.

Harvest date, crop age, calculation of gross and effective rain and irrigation records accessed from records contained in the WaterSense program are shown in Table 1.

Table 1 **Crop information, rain, irrigation and effective rain 2007-08**

Crop Year	Planting Date	Crop Days To date	Total Rain ML	Irrigation ML/ha	Runoff & Drain ML	Effective Rain ML
2009	Nov - 08	237	8.06	0	0.52	7.54

Irrigation scheduling options

No irrigation was applied to the site, so in this instance the study became an opportunity to compare the effectiveness of the WaterSense technology with monitored outcomes. As previously outlined the site was green field and as such the soil structural constraints that tend to develop over time in mechanised sugar cane farming were not expected to impact on water penetration and soil water holding capability.

Rainfall and Simulated soil moisture

Rainfall recorded at the Tiaro site is shown in Figure 1. This data was then applied to WaterSense to simulate daily soil moisture (Figure 2). The importance of this site (Tiaro) relates to its proximity to the contributing weather station (Maryborough) which is approximately 20 km north. While the rainfall from the Maryborough weather station was not relevant to the WaterSense simulation at Tiaro all other data relating to evapotranspiration appears to be accurate enough for WaterSense to be reliable over a reasonable distance from the point of data collection. This will no doubt expand the scope of the product in the future.

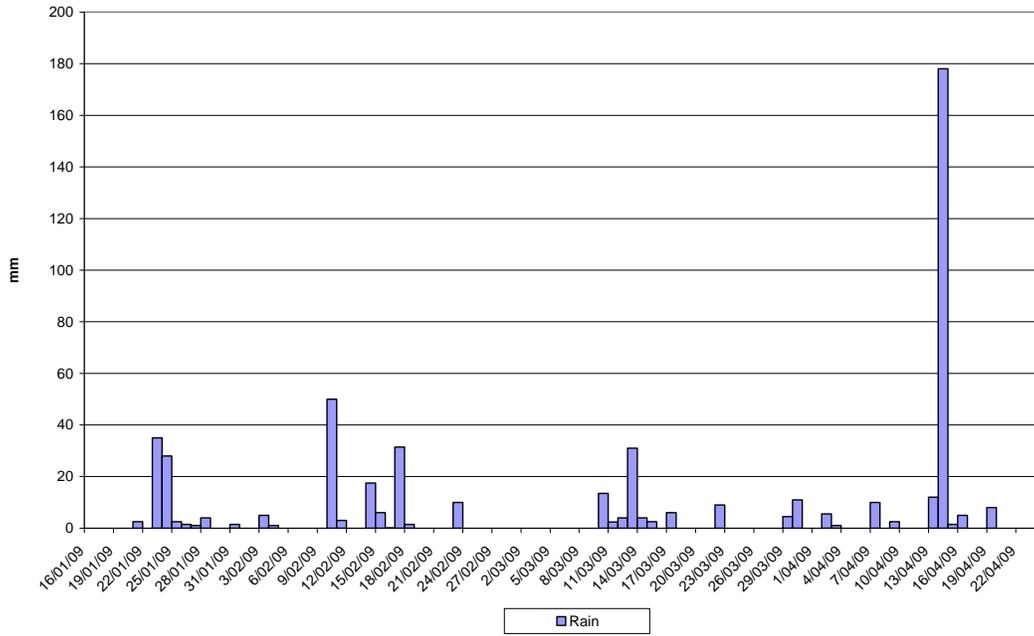
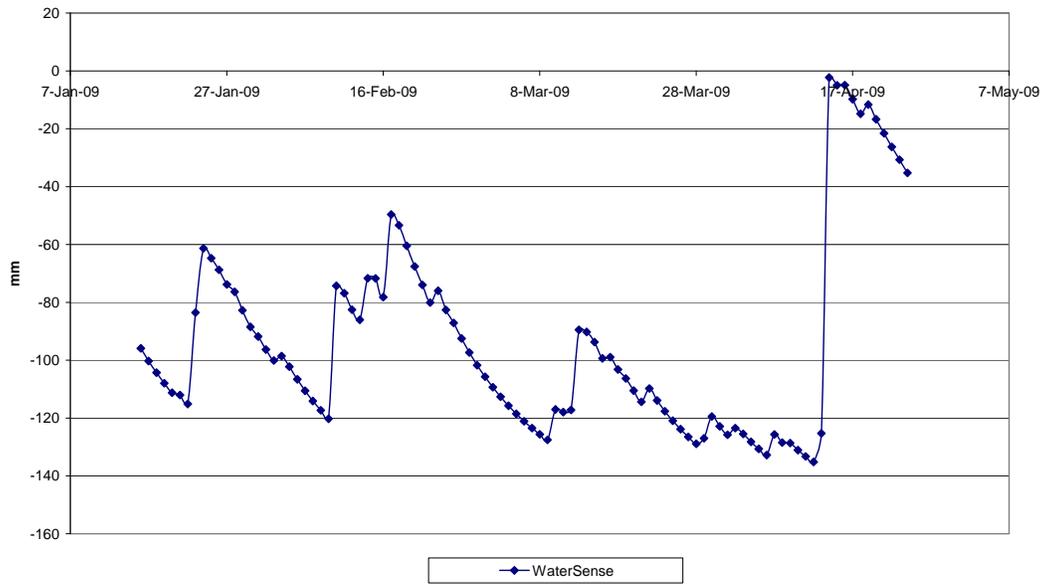


Figure 1 Rain - Jan to April 2009



Monitoring

The outcomes of EnviroSCAN monitoring are shown in Figure 3.

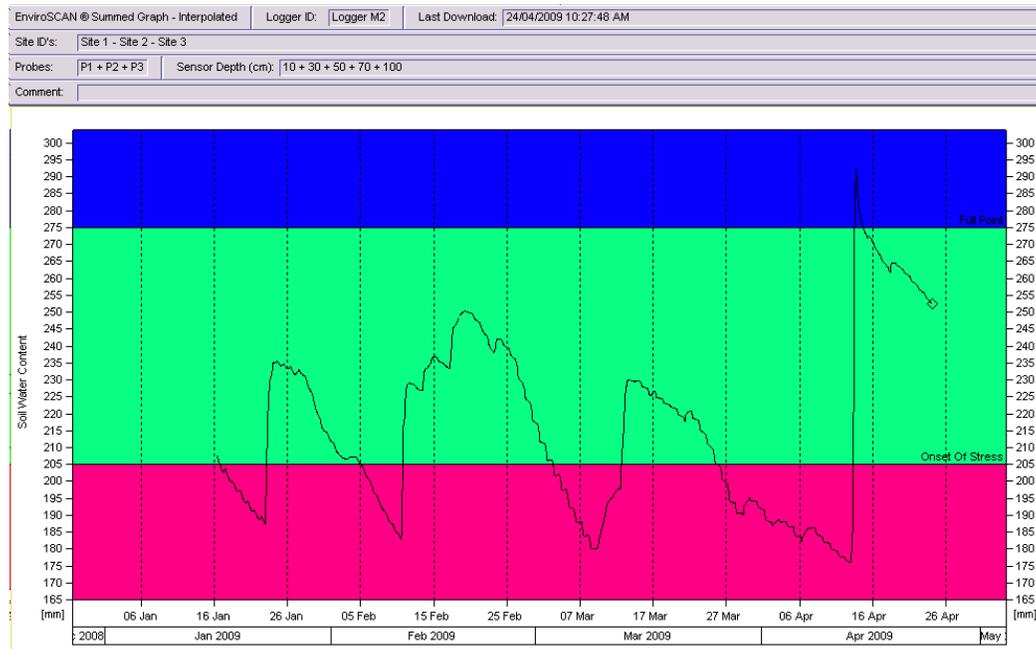


Figure 3 EnviroSCAN – Jan to April 2009

Outcome

The data indicates that the daily moisture change determined by the EnviroSCAN from January to April has a high level of correlation with the daily WaterSense simulated deficits over the same period. The main difference is the volumetric interpretation relating to different soil profile depths; EnviroSCAN to 1m and WaterSense to 1.6m in this instance. EnviroSCAN indicates that soil water varied in range of approximately 100mm (175 up to 275mm) and WaterSense deficit varied by 135mm (0 down to 135mm).

This case Study provided a unique opportunity to compare the monitoring and simulation of daily climatic and plant influences in an environment where crop water use was unlikely to be influenced by external factors like soil compaction and poor drainage etc.

The outcome of the monitored and simulated in this situation is very comparable which highlights the reliability of WaterSense to deliver effective irrigation scheduling. However, as the program been shown to most reliable where external factors were not an apparent issue, the need for factors like volumes of irrigation applied and any known soil factors to be accurately reflected in the inputs to the program becomes more important.

APPENDIX 2 – ADVISORY NOTES

Bundaberg Sugarcane Irrigation Report 9 th December 2008			
Rainfall report from automatic weather stations (AWS)			
Rainfall - most recent 12 days			
Date	Bing	FMD	BSES
Nov 26	0	0	0
27	0	0.4	0.4
29	5.6	3.8	6
30	0	6.4	6.6
Dec 1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	21.6	27	22.2
8	32.4	25.8	43.8
Total Rainfall – for crop so far			
Crop age	Bing	FMD	BSES
100 days	240	210	310
Crop report		WaterSense	
Current Av. crop canopy%	Daily crop water demand mm/day	SOIL MOISTURE & IRRIGATION INDICATOR	
70%	7.0	Millaquin (BSES)	Deficit % of RAW
	6.5	Red Volcanic	6
	6.0	Red Forest	7
	5.5	Grey Forest	0
	5.0	Sandy Loam	0
	4.5	Fairymead	
	4.0	Alluvial	29
	3.5	Red Forest	0
	3.0	Grey Forest	0
	2.5	Sandy Loam	0
	2.0	Bingera	
		Red Volcanic	6
		Red Forest	0
		Grey Forest	0
			Commence Irrigation (days)
			15
			13
			8
			7
			18
			13
			8
			6
			14
			13
			8

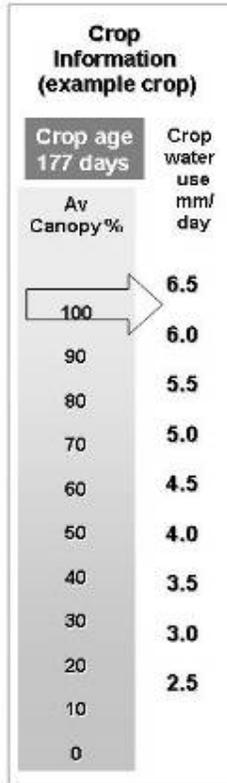
Example based on a GCTB ratoon harvested early September 2008

RAINFALL REPORT (mm)

Based on automatic weather stations

Date	Bing	FMD	BSES
Feb			
23	0	0	0
22	13.6	0	0
21	0.4	2	1.6
20	0	0	0
19	0	0	0
18	16.4	5	6.4
17	24.2	59.4	60.6
16	5.4	0	0
15	0	0	0
14	18.2	58.8	65.6
13	58.4	52.6	62.8
Total	620	610	750

Rain to date: 1 Sep 08 – 24 Feb 09



Irrigation report - 24 Feb 09

WaterSense SOIL MOISTURE INDICATOR & SCHEDULING GUIDE

	Deficit mm	Commence Irrigation (days)
Millaquin		
Red Volcanic	20	4
Red Forest	20	3
Grey Forest	10	3
Sandy Loam	10	2
Fairymead		
Alluvia	20	5
Red Forest	20	3
Grey Forest	10	3
Sand	10	2
Bingera		
Red Volcanic	10	6
Red Forest	10	4
Grey Forest	5	4

Example crop – Harvested 1st Sep 08

APPENDIX 3 - OPERATOR'S MANUAL

See separate PDF file.

APPENDIX 4 - COMMUNICATION VIA INDUSTRY PUBLICATIONS AND RADIO INTERVIEWS



Irrigation

Regional water management with WaterSense

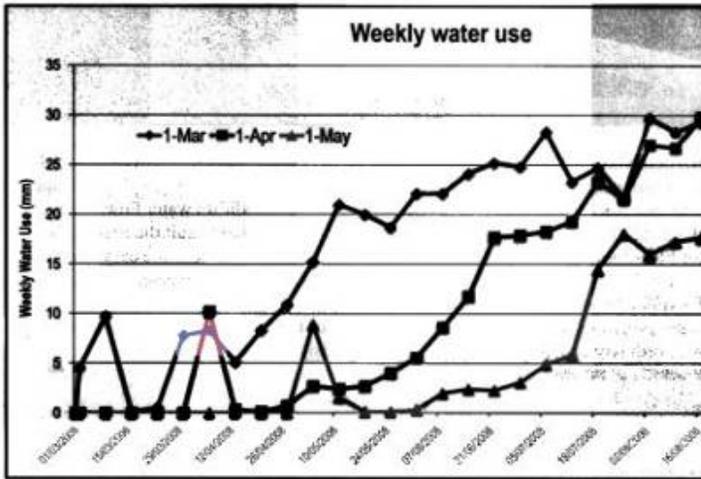
By Toni Anderson

In irrigation management there are three main things to consider; the right time, the right amount and the right place.

Through the WaterSense program the industry is trying to provide a tool that can give growers accurate information about the first two aspects of irrigation management – right time and right amount.

Throughout the state there are various WaterSense trials looking at the acceptance and uptake of the program through different delivery mechanisms.

The current WaterSense research and development trial is being funded through the SRDC and is supported by the Rural Water Use Efficiency Project. In the Burdekin, northern and southern regions three different group delivery methods are being trialed.



In young crops, water use peaks after irrigations due to evaporation losses combined with plant water extractions.

Week Ending	Planting Date		
	01-Mar	01-Apr	01-May
01-Mar-08	0	0	0
02-Mar-08	4.5	0	0
09-Mar-08	9.7	0	0
16-Mar-08	0.1	0	0
23-Mar-08	0.5	0	0
30-Mar-08	7.8	0	0
06-Apr-08	8.3	10.2	0
13-Apr-08	5.1	0.3	0
20-Apr-08	8.3	0.1	0
27-Apr-08	10.9	0.7	0
04-May-08	15.2	2.7	8.9
11-May-08	21	2.4	1.6
18-May-08	20	2.7	0.1
25-May-08	18.7	4	0.1
01-Jun-08	22.1	5.6	0.3
08-Jun-08	22.1	8.6	2
15-Jun-08	24.1	11.7	2.4
22-Jun-08	25.2	17.7	2.3
29-Jun-08	24.8	17.9	3.1
06-Jul-08	28.3	18.3	4.9
13-Jul-08	23.3	19.3	5.8
20-Jul-08	24.7	23.3	14.5
27-Jul-08	21.7	21.6	18.1
03-Aug-08	29.7	27	16
10-Aug-08	28.3	26.7	17.3
17-Aug-08	29.3	29.8	17.7

Table 1 - Example of McDesme planting data

In the south, road side signs are delivering regional crop water use information. These signs have been used for a number of years and in the last couple of years the information has been refined by the use of WaterSense.

In the northern irrigation district of the Tablelands WaterSense information is being delivered via text message.

These are providing growers with quick and simple messages to understand about crop water use and scheduling advice.

This service has been active for a season now with growers receiving information on a weekly basis.

The Burdekin is the most recent region to start a group water management information service. Three productivity regions have been selected - McDesme, Millaroo and Dalbeg.

At the last two rounds of shed meetings, two mantras of water management have been discussed; right time and right amount. As a result of these meetings, a regional crop water use email has been developed.

tipsa AUSTRALIA office **BANDAMA 2000**

DRAG IRRIGATION HOSE

- Improved rubber compound
- Low pressure loss
- All sizes available at our new warehouse
- Shipment within the week
- Sizes: 2 1/4", 3", 3 1/2", 4", 4 1/2" and 5"
- Mining hose also up to 8"
- Lengths: 150 and 200 metres
- Delivery anywhere in Australia & New Zealand

CONTACT TIPSA OFFICE IN AUSTRALIA:
 TEL: (02) 9517 9995 / (02) 9684 1688
 FAX: (02) 9517 9992
 EMAIL: tipsa.sydney@tipsa.com

PLEASE ENQUIRE NOW!!!

To better support our distributors, Tipsa currently stocks all types of hoses and accessories in Australia



Irrigation



Crop water use information will be provided on a weekly basis for various planting dates and as the season progresses, ratooning dates. Information is provided as weekly totals from Monday to Sunday. Table 1 (left) is an example of the McDesme planting data.

When property scale information is used in addition to this data it can be used to schedule irrigations, predict future irrigations and set accurate irrigation application targets.

All of these applications can lead to effective use of irrigation water resulting in an increase in crop production and profitability.

The WaterSense program calculates crop water use with localised weather data provided through CSIRO and SILO. WaterSense has been developed after extensive research and testing across the state with funding from CSIRO, SRDC and the CRC for Irrigation Futures.

For more information on the WaterSense program please contact your local RWUE sugar program contact. ■

Don't take risks buying irrigation hose

Article supplied by Angus Flexible Pipelines

Irrigating crops at any time day or night with complete confidence requires a hose you can rely on. Every so often an alternative rubber Irrigation hose comes along, which on the face of it looks like the one you use, offers high performance but at a cut price.

We have all seen these deals, but as with most things, you get what you pay for. If you are looking for long and dependable service with reliable water delivery at low cost, you must think carefully before considering a change. If you hit trouble you may find there is no one around willing to help you and your cut price hose becomes an expensive liability.

The ability of Angus Premium Hi-Flow to deliver reliable and lasting irrigation service is the difference between reality and the claims for other manufacturers' rubber hoses. ■

RWUE sugar program contacts

Joseph Evans	Project Manager and Coordinator	Ph: 07 3864 6444 joseph_evans@canegrowers.com.au
Toni Anderson	Extension Leader and Burdekin region	Ph: 07 4783 8611 or 0427 655 681 tanderson@bSES.org.au
Neil Judd	North region	Ph: 07 4064 3458 or 0439 537 823 njudd@bSES.org.au
Maurie Haines	Bundaberg region	Ph: 07 4151 2555 or 0427 589 054 mhaines@bSES.org.au
Sandra Webb	Isis & Maryborough region	Ph: 07 4126 3979 or 0408 700 585 swebb@bSES.org.au



RWUE Sugar is a partnership between CANEGROWERS, BSES and the Queensland Government Department of Natural Resources and Water.

Energy Savings

Save time and money on you Drag Irrigation Hose Operations. **ANGUS PREMIUM HI-FLOW**, with its high diametral swell delivering reduced pressure loss, offers the lowest possible energy costs for drag irrigation.

But you also get a lot more:

- Superior Ozone and UV resistance.
- Unrivalled bend diameter to minimise trackway widths.
- Robust, thick hard rubber cover for proven cut and abrasion resistance.
- No snaking, no shrinkage
- Unequalled drape and flexibility.
- Up to 315 m continuous lengths available.
- 100% factory inspected and tested.
- A reliable full 10 year factory backed warranty.

No other manufacturer can offer such a complete package of outstanding performance, long life and customer service.

With all this and more, Angus Premium Hi-Flow is the most cost effective hose money can buy.

BS EN ISO 9001 : 2000

SOLD GLOBALLY, SERVICED LOCALLY

Contact your dealer for more details



Rural water use efficiency



Big water savings for cane growers now online

By Gordon Collie

Big water savings through more efficient irrigation scheduling are now available to all cane growers through the innovative web-based management tool, WaterSense.

The system has been developed and refined over the past three years and is being rolled out by Rural Water Use Efficiency extension officers. Producers are already using the program in the Bundaberg-Maryborough, Mackay, Burdekin and Atherton Tablelands districts.

The system matches individual cane block records entered to the database with daily rainfall and temperature recorded at the nearest automated weather station to offer real time advice on when to start the irrigation pumps.

The computer program was developed by CSIRO scientists in Townsville with the SRDC funding field testing, initially in the Bundaberg and Ord River regions.

Bundaberg RWUE officer Maurie Haines has been involved with the project from the outset and presented a joint paper at a national irrigation conference in Melbourne in May.

"This program offers significant savings on irrigation water without sacrificing cane production. It also has the benefit of minimising water runoff and nutrient loss," Mr Haines said.

"It's certainly a very useful tool to stretch our available water and crop yield hasn't suffered. We are consistently above mill average," said Gavin Berry.

Growers create their own farm profile block by block, taking account of different soil types. With planting and harvesting dates for each block entered, the program calculates water needs

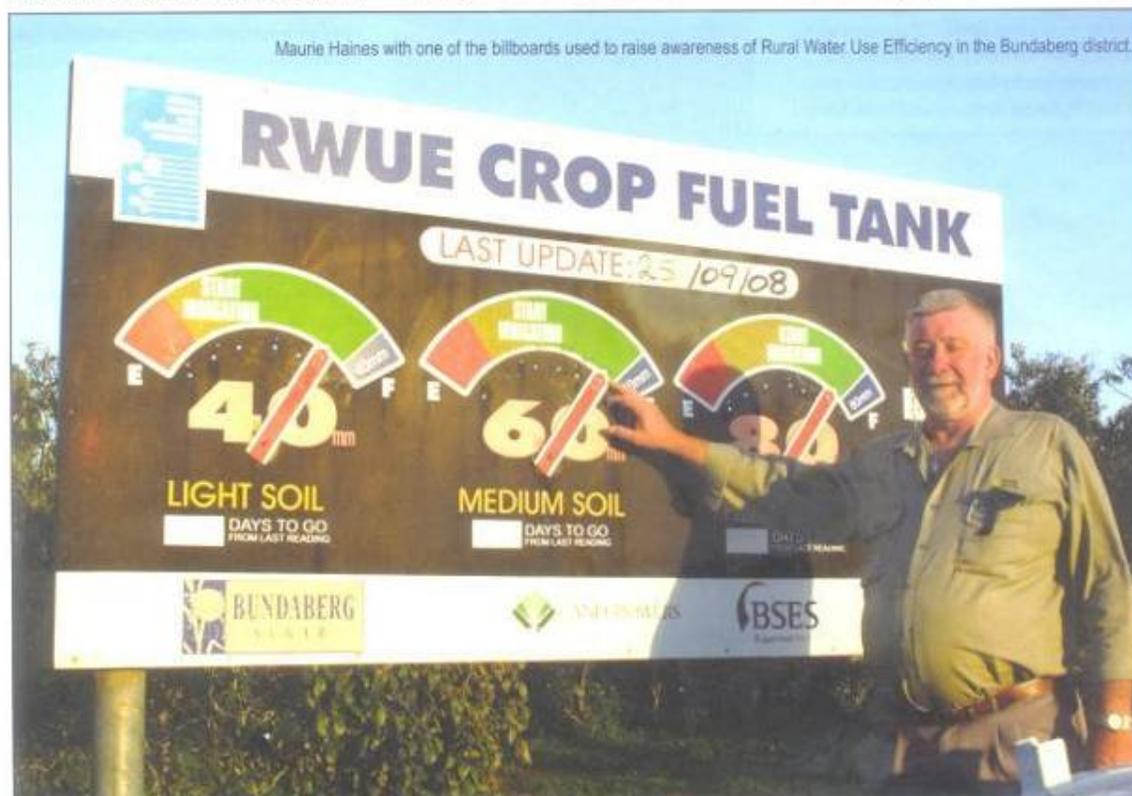
according to the stage of growth and weather conditions.

The program can be customised to reflect irrigation water availability or desired target yields. It can work at different soil depths to make use of available deep moisture reserves.

"Once the science was developed, we worked closely with a small team of growers to design a program which was user friendly," Mr Haines said.

Because the system is web-based, there is no need to download any software. Data stored on line is protected by a password.

Mr Haines said accumulated data would provide a valuable record of farm performance over time. Information such as how planting dates impacted on water use could aid decision making. He said there was potential to set up automated weather stations on-farm to provide more accurate information to the WaterSense program. ▶▶



Maurie Haines with one of the billboards used to raise awareness of Rural Water Use Efficiency in the Bundaberg district.

Rural water use efficiency



About 18 properties between Bundaberg and Maryborough are now using WaterSense and more growers are coming on-line state-wide.

Mr Haines uses WaterSense data to update public billboards around the district promoting water use efficiency. The DPI Bundaberg Research Station has trialled WaterSense on its commercial cane crop for the past three years. Station Manager Gavin Berry said water savings of about 30% were being achieved.

"It's certainly a very useful tool to stretch our available water and crop yield hasn't suffered. We are consistently above mill average," Mr Berry said.

"It's as much about telling you when you shouldn't water as when you should. Some of our black soils can get too wet."

Mr Berry said the station had developed its own storages to supplement the regional scheme supply. Irrigation runoff is also captured and recycled with gauges fitted to meter the water used.

"You need to be disciplined and measure the amount of irrigation you are putting on to get accurate results from the program," Mr Berry said.

Coral Zunker was also an early adopter of WaterSense as business manager for a large family canegrowing and harvesting enterprise based at Qunaba.

Her husband Joe and sons Richard and Craig will grow about 35,000 tonnes this year on red soil in Burnett River country and grey loams in the Bucca district on the Kolan.

"We had a lot of input into the development of the program. The scientists came and visited us and we told them what we wanted. It's very different now to the original version," Mrs Zunker said.

She has entered farm data using mill block numbers so crop performance information can be correlated with water use decisions.



Coral Zunker checks the WaterSense data for the Bundaberg family farming enterprise.



DPI Bundaberg Research Station Manager Gavin Berry checks the meter installed on the tailwater reticulation system.

"We initially used the program for our red soils, but this year we have been feeding in data from the Bucca farms which are totally different," Mrs Zunker said.

"It has really given us a better understanding of our soil moisture levels.

"It's a useful decision making tool, especially when to start irrigating after a rain event. With water restrictions applying, it also helps manage remaining allocation. We know that some blocks need less water than others." ■

RWUE sugar program contacts

Joseph Evans	Project Manager and Coordinator	Ph: 07 3864 6444 joseph_evans@canegrowers.com.au
Toni Anderson	Extension Leader and Burdekin region	Ph: 07 4763 8611 or 0427 655 681 tanderson@bses.org.au
Joe Muscat	Central region	Ph: 07 4963 6808 or 0429 377162 jmuscat@bses.org.au
Maurie Haines	Bundaberg region	Ph: 07 4151 2555 or 0427 589 054 mhaines@bses.org.au
Sandra Webb	Isis & Maryborough region	Ph: 07 4126 3979 or 0408 700 585 swebb@bses.org.au

RWUE Sugar is a partnership between CANEGROWERS, BSES and the Queensland Government Department of Natural Resources and Water.

Queensland ABC Rural Report

Monday, December 22, 2008

Nathalie Fernbach; Scott Lamond, Townsville

Irrigation tool makes sense

A new web based tool is giving cane farmers a chance to be more water efficient.

After five years of trials the CSIRO, the SRDC and industry stakeholders have developed "WaterSense" which gives paddock by paddock calculations of irrigation requirements.

WaterSense takes into account localised rainfall, evaporation, the size and maturity of the cane crop and then gives real time advise on what needs to be done and when.

Bundaberg Rural Water Use Efficiency Officer Maurie Haines says it can only be used in sugar cane at the moment.

"It's readily available through sugar extension officers across Queensland," he says.

"You access the product through the web, so there's no software required, it's all stored on a CSIRO server."

Mr Haines says when growers access the web tool they can add their own information for almost immediate irrigation scheduling advise.

BSES Senior Extension Officer Tony Linedale says the tool is perfect for regions where water is in low supply and also expensive.

"Over five years of working with this product we've also found it allows us to evaluate and assess our irrigation plans," he says.

"It's immediate, fast and low cost."

Mr Haines says the tool is a calculator of climatic impact on the crop.

"It gives the opportunity to apply the right amount of water at the right time and it helps minimise runoff and maximise productivity," he says.

"We're now able to tune the irrigation to the best benefit of rainfall and irrigation."

APPENDIX 5 - COMMERCIAL ASSESSMENT

Executive summary

WaterSense is a web-based sugarcane irrigation scheduling and planning tool that allows the user to optimise irrigation inputs over multiple fields and enhance potential yields while limiting offsite impacts. WaterSense was developed by participative projects involving growers, CSIRO, CRC for Irrigation Futures, BSES Limited, SRDC, Bundaberg Sugar Services Limited and other industry service organisations.

The principal market for WaterSense is the three main irrigation regions – southern, central and Burdekin. User groups have indicated that the number of individuals wanting to use WaterSense directly is limited, but all areas are keen to have district irrigation advice, produced from WaterSense, made available. Letters of support for WaterSense have been received from Pioneer Cane Growers Organisation Limited and Bundaberg CANEGROWERS Ltd.

The marketing approach that appears most likely to succeed is for an industry-wide organisation such as BSES Limited or CANEGROWERS to arrange a project with CSIRO to provide the service. District information on irrigation requirements could then be made available to customers of the organisation providing the service. Where individuals want access to WaterSense directly, this could be made available for a fee. It is likely that over time the numbers using the service directly would increase. Customers who have indicated they would want direct access are mostly larger corporate farms.

Background

Some 60% of the Australian sugarcane crop worth about \$2 billion annually relies on irrigation in some form. Rainfall contributes substantially to crop water requirements in all regions. Scheduling irrigations appropriately with the rainfall is a difficult management problem for growers. WaterSense was developed to help growers optimise irrigation management under these conditions.

Initially, growers in the Bundaberg-Isis region were involved in a research project where the crop modelling skills of a research team were compared to the skills of cooperating growers in getting the highest sugarcane yield out of variable and limited water allocations (Inman-Bamber *et al.*, 2005). After three years of on-farm experimentation, a web service called 'Cane Optimiser' was provided.

At the same time as Cane Optimiser was being developed in Bundaberg, a participatory style of research project in the Ord River Irrigation scheme developed a web service called Water Balance. Water Balance demonstrated how potential yields could be achieved by irrigating at safe deficits of 40 to 60 mm.

WaterSense was developed as a hybrid of both models. WaterSense combined the elements of the simple water balance for Ord growers with the optimising algorithms of Cane Optimiser (Inman-Bamber *et al.*, 2006).

WaterSense schedules irrigation to avoid unnecessary water stress in areas with limited irrigation supplies by using the least amount of irrigation water as well as offering the opportunity to deficit irrigate and utilise water stored at depth in the soil.

The WaterSense system matches individual cane block records entered to the database with daily rainfall and temperature recorded at the nearest automated weather station to offer real time advice on when to start irrigation. Growers create their own farm profile block by block, taking account of different soil types. With planting and harvesting dates for each block entered, the program calculates water needs according to the stage of growth and weather conditions. The program can be customised to reflect irrigation water availability or desired target yields. It can work with different soil depths to make use of available deep moisture reserves.

Since the product was developed in 2006, WaterSense has been evaluated with pilot groups at Bundaberg-Maryborough, Mackay, Burdekin and the Atherton Tablelands.

WaterSense – the product

The WaterSense web site resides in the CSIRO network. The web address is www.clw.csiro.au/watersense/pages/main.aspx. The site is maintained by CSIRO and contains links to sites such as SILO weather data. Any commercial service based on WaterSense would need an Agreement with CSIRO and fund their involvement.

A grower accessing this product obtains a user name and password and is able to set up a farm(s) within the web site. The farm may contain a number of blocks with different soil types; date planted or ratooned, variety and trash management. The grower also selects whether water is limited or the soil water deficit to irrigate at if water is not limited. Rainfall and irrigation data is entered for each block.

Information is presented as a series of graphs showing input data such as rainfall and irrigation, and an irrigation predictor showing a daily water balance. The raw data behind the graphs may also be displayed.

The product is also being used by extension officers to produce information for district irrigation advice. Crop water use information is made available through text messages, roadside signs and industry newsletters.

The Market for WaterSense

In 2008 about 2800 farms produced 20 million tonnes of sugarcane (65% of the Queensland sugarcane crop) from 230,000 ha that was irrigated to varying extents. All these are potential users of WaterSense.

The most intensive irrigation was in irrigation areas with reticulated water from dams. These include the Burdekin, Bundaberg-Isis, Atherton Tablelands and parts of Proserpine, Mackay, Plane Creek and Maryborough. Farms in these areas outside of the irrigation schemes generally have limited water sourced from streams, farm dams or groundwater.

Some of the irrigation schemes also had restricted irrigation supplies in recent years due to drought conditions.

The principal market for WaterSense is the three main irrigation regions – southern, central and Burdekin. User groups have indicated that the number of individuals wanting to use WaterSense directly is limited, but all areas are keen to have district irrigation advice produced from WaterSense made available. Letters of support for WaterSense have been received from Pioneer Cane Growers Organisation Limited and Bundaberg CANEGROWERS Ltd.

The marketing approach that appears most likely to succeed is for an industry-wide organisation such as BSES Limited or CANEGROWERS to arrange a project with CSIRO to provide the service. District information on irrigation requirements could then be made available to customers of the organisation providing the service. Where individuals want access to WaterSense directly, this could be made available for a fee. It is likely that over time the numbers using the service directly would increase. Customers who have indicated they would want direct access are mostly larger corporate farms.

At present there is no direct competition in the marketplace as there are no other products offering this degree of sophistication. The main alternatives are soil moisture monitoring devices which are normally site specific within a field. WaterSense has been compared with devices such as Enviroscan and gives similar results without the need to have probes throughout the paddock.

The market niche for WaterSense is to provide real time information on crop water use to enable growers to optimise crops where irrigation water is limited and to reduce the water applied where irrigation water is adequate. The product also has environmental benefits in that it reduces deep drainage and run-off in fully irrigated situations. It also has the potential to make irrigation more energy efficient by reducing pumping energy requirements.

The demand for WaterSense is expected to increase as the community embraces climate change and the associated incentives and legislation.

Strengths and Opportunities for WaterSense

- WaterSense uses the current international standard measurement for evaporation, the Penman Monteith equation, to calculate crop water usage replacing the outdated Class A pan system.
- WaterSense has the advantage over soil moisture monitoring systems that it is not site specific (position of the probe) and therefore handles block variability better and allows easier management.
- All growers involved with the pilot project at Bundaberg find WaterSense useful and want the service to continue.
- WaterSense is an excellent tool to calculate crop water use on a district wide basis to text to growers to help them manage irrigation.
- Parameters such as biomass accumulation and soil depth can be adjusted in WaterSense to give more accurate results for certain situations.

Weaknesses and Threats for WaterSense

- There is some grower resistance to computer based programs.
- Accurate use of WaterSense requires growers to have a degree of knowledge regarding the quantity of irrigation water applied, soil type, depth of soil profile, soil water holding capacity and appropriate predicted deficits. This is not always fully understood.
- Some growers find WaterSense a difficult product to master if it is not used regularly. Grower use of WaterSense is sporadic often with lengthy periods of inactivity coinciding with lack of irrigation activity on farm. During this period, growers do not access or update the product. As a result, they forget how to access and use the product, interest wanes and they lose the desire to proceed further.
- In some areas, such as Mackay, soil types need to be calibrated for the model.
- The website requires resources inside CSIRO to keep it running. This requires time allocation by CSIRO staff as well as equipment such as computers and links to SILO. In going forward, a formal agreement with SILO to access weather data will need to be progressed. These activities need to be resourced and the system would not be able to operate, in its current form, without them.

Budgets and pricing

CSIRO estimate an annual cost of \$50,000 to \$100,000 per annum to host and service WaterSense. This includes:

- Resources to keep WaterSense running (computers, links to SILO weather data, system crashes) inside CSIRO, i.e. maintain the current arrangement
- Training and support of regional staff using and promoting WaterSense including travel to each region
- Soils data set improvement for each region. A small amount of improvement e.g. new soils being added for a region, would be able to be catered for but the budget does not allow for significant changes (this would require additional funding).
- Time allocations for CSIRO staff.

To fund this, the following option is recommended:

- An industry wide organisation(s) (e.g. BSES and/or CANEGROWERS) contribute 50% of the funds and coordinate the overall distribution and servicing of WaterSense. Decisions whether or not to charge for access to WaterSense by individual growers would be made in consultation with the region. Regions may see it as a way of recouping some of the annual outlay to maintain the system.
- The three major irrigation regions – Southern, Central and Burdekin contribute the remaining 50% of the cash as distribution agents for WaterSense.
 - Within a region, the local industry contributes approximately one third of the remaining funds. The local industry stakeholders, as a collective, decide how much each will contribute. Local staff to be identified and become WaterSense champions. These people would then interact with the farmers in a manner most appropriate to their region.
 - Each region's contribution would go toward CSIRO time to provide training and ongoing support for WaterSense. While support would be negotiated to suit specific needs – this could be made up of visits to the region, meetings with

growers, face-to-face training with staff, troubleshooting, etc. This is expected to be 10% of a scientist's time per region.

This scenario fits with feedback from the user groups that WaterSense is most valued as a tool to make and update district-wide recommendations.

References

Inman-Bamber, N.G., Attard, S.J., Baillie, C., Lawson, D. and Simpson, L. (2005). A web-based system for planning use of limited irrigation water in sugarcane. *Proc. Aust. Soc. Sugar Cane Technol.*, 27, 170-181.

Inman-Bamber, N.G., Webb, W.A. and Verrall, S.A. (2006). Participatory irrigation research and scheduling in the Ord: R&D. *Proc. Aust. Soc. Sugar Cane Technol.*, 28, 155-163.

**APPENDIX 6 - ENHANCING IRRIGATION MANAGEMENT PLANNING WITH
ENVIROSCAN AND WATERSENSE**

See separate PDF file.

APPENDIX 7 – BURDEKIN EMAIL

How much Water is your Crop Using?

Information tailored to the McDesme Region

Below is the following:

- o Table outlining the weekly water use for crops planted on March 1 2008, April 1 2008 and May 1 2008,
- o Table outlining the weekly water use for Crops ratooned on the 1st of July, August, September, October and November 2008,
- o Table summarizing Rainfall, and
- o Graph comparing the weekly water use.

Table 1: Weekly Water Use (mm) for all 100% Crop Cover

Week Ending	100% Crop Cover
25-Jan-09	36.2
1-Feb-09	27.1
8-Feb-09	22.5
15-Feb-09	33.7

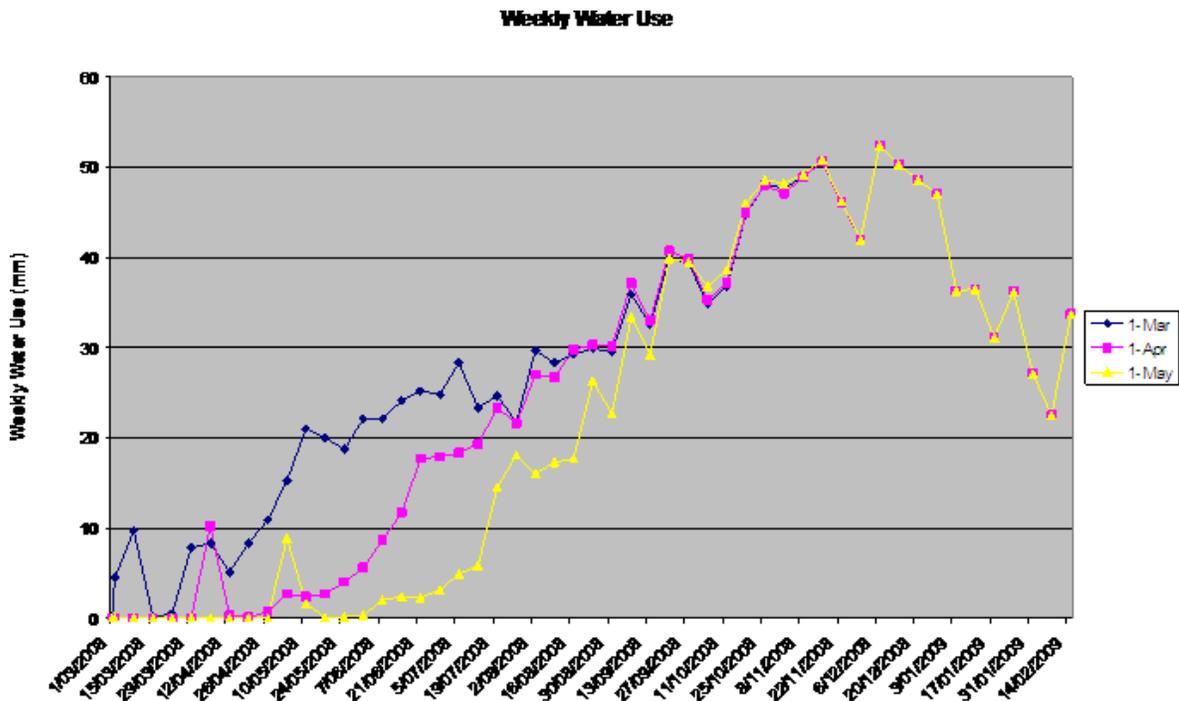


Figure1: Total plant cane crop water use (mm) for each week.

Table 2: Weekly Water Use for Ratoons

Week Ending	Ratoon Date		
	1-Sep 99% Crop Cover	1-Oct 99% Crop Cover	1-Nov 96% Crop Cover
25-Jan-09	36.5	37.3	38.4
1-Feb-09	27.3	22.6	29.5
8-Feb-09	22.6	22.9	24
15-Feb-09	33.7	34	35

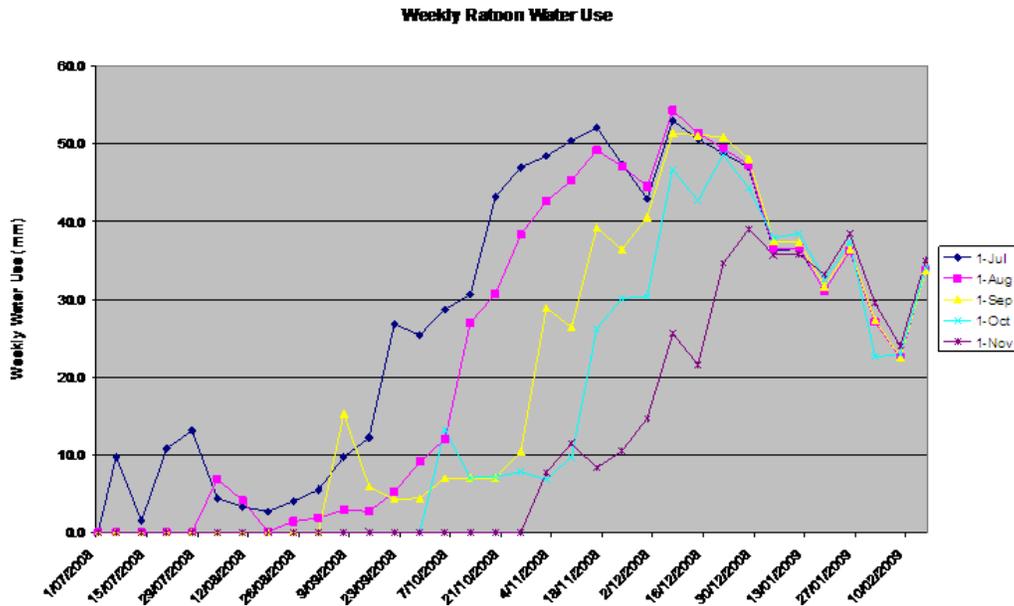


Figure 2: Total ratoon cane crop water use (mm) for each week.

Table 3: Weekly Rainfall totals

Week ending	Rainfall (mm)
2-Mar	22.8
9-Mar	0.5
23-Mar	0.2
30-Mar	45.2
18-May	0.1
25-May	0.1
1-Jun	0.4
8-Jun	0.3
15-Jun	2.4
6-Jul	0.1
13-Jul	0.7
20-Jul	20.5
27-Jul	76.7
3-Aug	0.2
10-Aug	0.4
7-Sep	1.3
14-Sep	1.7
28-Sep	5.1
5-Oct	0.1
19-Oct	1.8
2-Nov	0.7
9-Nov	2.9
23-Nov	18.7
30-Nov	15.3
7-Dec	7.9
14-Dec	2
21-Dec	30
28-Dec	0.8
4-Jan	260.8
11-Jan	4
18-Jan	176
25-Jan	93.6
1-Feb	161.1
8-Feb	501.2
15-Feb	120.9

Note: In young crops water use peaks after irrigations due to evaporation losses combined with plant water extractions.

Table 4: Generic Readily Available Water for the Burdekin

Soil Type	Readily Available Water (mm) (RAW)
Cracking Clay	90-100
Clay Loam	80-90
Loam	70-80
Sandy Loam	50-60
Loamy Sand	30-40
Sodic Clay	40-90

Irrigation applied based on a 55mm refill point:

<p>1 March Plant:</p> <p>1st Irrigation: 1 March 2nd Irrigation: 8 May 3rd Irrigation: 27 May 4th Irrigation: 14 June 5th Irrigation: 29 June 6th Irrigation: 14 July 7th Irrigation: 9 August 8th Irrigation: 22 August 9th Irrigation: 3 September 10th Irrigation: 15 September 11th Irrigation: 25 September 12th Irrigation: 5 October 13th Irrigation: 14 October 14th Irrigation: 23 October 15th Irrigation: 30 October 16th Irrigation: 7 November 17th Irrigation: 14 November 18th Irrigation: 30 November 19th Irrigation: 9 December 20th Irrigation: 21 December</p> <p>Predicted Next Irrigation: 1 March</p>	<p>1 April Plant:</p> <p>1st Irrigation: 1 April 2nd Irrigation: 20 June 3rd Irrigation: 11 July 4th Irrigation: 10 August 5th Irrigation: 22 August 6th Irrigation: 3 September 7th Irrigation: 15 September 8th Irrigation: 25 September 9th Irrigation: 4 October 10th Irrigation: 14 October 11th Irrigation: 23 October 12th Irrigation: 30 October 13th Irrigation: 7 November 14th Irrigation: 16 November 15th Irrigation: 30 November 16th Irrigation: 9 December 17th Irrigation: 21 December</p> <p>Predicted Next Irrigation: 1 March</p>
--	---

1 May Plant:

1 st Irrigation:	1 May
2 nd Irrigation:	18 August
3 rd Irrigation:	2 September
4 th Irrigation:	16 September
5 th Irrigation:	26 September
6 th Irrigation:	4 October
7 th Irrigation:	13 October
8 th Irrigation:	22 October
9 th Irrigation:	29 October
10 th Irrigation:	6 November
11 th Irrigation:	15 November
12 th Irrigation:	26 November
13 th Irrigation:	8 December
14 th Irrigation:	20 December

Predicted Next Irrigation: 1 March

1 July Ratoon:

1 st Irrigation:	1 July
2 nd Irrigation:	17 September
3 rd Irrigation:	2 October
4 th Irrigation:	12 October
5 th Irrigation:	22 October
6 th Irrigation:	29 October
7 th Irrigation:	6 November
8 th Irrigation:	15 November
9 th Irrigation:	25 November
10 th Irrigation:	7 December
11 th Irrigation:	19 December

Predicted Next Irrigation: 1 March

1 May Plant:

1 st Irrigation:	1 May
2 nd Irrigation:	18 August
3 rd Irrigation:	2 September
4 th Irrigation:	16 September
5 th Irrigation:	26 September
6 th Irrigation:	4 October
7 th Irrigation:	13 October
8 th Irrigation:	22 October
9 th Irrigation:	29 October
10 th Irrigation:	6 November
11 th Irrigation:	15 November
12 th Irrigation:	26 November
13 th Irrigation:	8 December
14 th Irrigation:	20 December

Predicted Next Irrigation: 1 March

1 July Ratoon:

1 st Irrigation:	1 July
2 nd Irrigation:	17 September
3 rd Irrigation:	2 October
4 th Irrigation:	12 October
5 th Irrigation:	22 October
6 th Irrigation:	29 October
7 th Irrigation:	6 November
8 th Irrigation:	15 November
9 th Irrigation:	25 November
10 th Irrigation:	7 December
11 th Irrigation:	19 December

Predicted Next Irrigation: 1 March

1 August Ratoon (not a realistic time to harvest, however included for consistency):

100% moisture at harvest due to rain.

1 st Irrigation:	8 October
2 nd Irrigation:	18 October
3 rd Irrigation:	28 October
4 th Irrigation:	6 November
5 th Irrigation:	15 November
6 th Irrigation:	25 November
7 th Irrigation:	7 December
8 th Irrigation:	19 December

Predicted Next Irrigation: 1 March

1 September Ratoon

1 st Irrigation:	1 September
2 nd Irrigation:	28 October
3 rd Irrigation:	12 November
4 th Irrigation:	25 November
5 th Irrigation:	7 December
6 th Irrigation:	19 December

Predicted Next Irrigation: 1 March

1 September Ratoon

1 st Irrigation:	1 September
2 nd Irrigation:	28 October
3 rd Irrigation:	12 November
4 th Irrigation:	25 November
5 th Irrigation:	7 December
6 th Irrigation:	19 December

Predicted Next Irrigation: 1 March

1 October Ratoon

1 st Irrigation:	1 October
2 nd Irrigation:	14 November
3 rd Irrigation:	4 December
4 th Irrigation:	17 December

Predicted Next Irrigation: 1 March

1 November Ratoon

1 st Irrigation:	1 November
2 nd Irrigation:	22 December

Predicted Next Irrigation: 1 March

These predicted irrigations are calculated from information up to 15 February.

Note: As we get closer to the irrigation date these predictions will become more accurate. This information is produced through the CSIRO's WaterSense program. Calculations and predictions can be customised and provided automatically through WaterSense for any grower who wishes to use the program. WaterSense uses localised weather data along with crop factors to calculate the crop water use.

Toni Anderson

Natural Resources and Production Extension Officer

BSES Limited

Street address: Bruce Hwy, Brandon

Postal address: PO Box 117, Ayr 4807

Phone: 07 4783 8611 Fax: 07 4782 5487

Mobile: 0427 655 681

Email: tanderson@bses.org.au