2.3 Irrigation decision support tools

Lance Pendergast
DAFF Queensland

David Wigginton
DW Consulting Services

Key points

- Complex irrigation management decision making can be assisted by a number of decision support tools.
- Tools exist for a range of tasks such as scenario planning, water budgeting, irrigation scheduling and performance evaluation.
- A range of free and commercial tools that are most relevant to cotton and grain irrigators are summarised.

Growing the best irrigated crops often requires difficult and complex decision making. Thankfully, as the prevalence, flexibility and power of computing technologies and the internet have increased, so too has the range of tools designed to help irrigators source information and make management decisions.

A number of these tools have been identified in this chapter to provide an indication of what the different tools do and how they might apply to your particular situation. Because of the vast number of tools available, the descriptions in this chapter are generally quite brief, although the website links listed under each heading usually provide greater detail and may also include examples and tutorials of the tools in use.

It should be noted that technological tools such as these evolve over time and new tools can become available on a much more regular basis than can be adequately captured in a publication such as this. For this reason, readers are encouraged to search for new tools on the internet that meet your particular requirements and to refer to the specific websites listed within this chapter for the most up to date information on existing tools.

It should also be noted that the tools in this chapter have been identified because of their usefulness in irrigation management. This is by no means an exhaustive list and neither does it cover the wide range of other crop management tools that may not be specifically related to irrigation management.

CottASSIST

www.cottassist.cottoncrc.org.au

CottASSIST is a group of web tools designed to integrate the latest cotton research to assist with cotton management decisions. Developed by CSIRO Plant Industry, the Cotton Catchment Communities CRC and the Cotton Research and Development Corporation (CRDC), the CottASSIST tools include applications that can assist with irrigation scheduling, water quality and climate analysis. Whilst a summary of these irrigation related tools is included below, a number of other tools are also available on the CottASSIST website.

Day degree calculator

The Day Degree Calculator provides a measure of expected crop development based on daily minimum and maximum temperatures. These values can identify the degree of progress towards a developmental stage (e.g. first square), which is valuable information when scheduling irrigations (see WATERpak Chapter 3.2).

Crop Development Tool

The Crop Development Tool allows users to track the development of their crops and compare to known potential development rates in order to manage vegetative and reproductive growth. The Crop Development Tool is also based on the concept of day degrees and is also useful for irrigation scheduling (see WATERpak Chater 3.2) as well as the management of crop growth regulators.

Last Effective Flower Tool (LEFT)

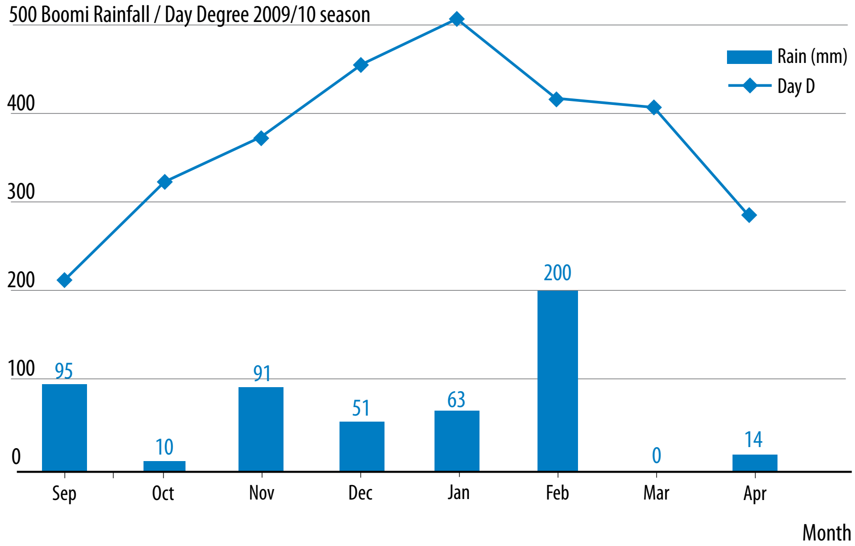
The Last Effective Flower Tool is useful for determining the target date for crop cut-out and to help schedule the last irrigation (see WATERpak Chapter 3.2). The Last Effective Flower Tool uses temperature data and day degree targets from the SILO climate service to determine the boll period (flower to open boll) and square period (square to flower) to estimate the date of the last effective flower in a season that will contribute to a harvestable boll.

Seasonal Climate Analysis

Climate variability challenges all aspects of farming in Australia and the Seasonal Climate Analysis tool can help to analyse seasonal variability or regional influences on crop performance by comparing rainfall, day degrees, number of cold and hot days with long term averages and probabilities.

The tool can be useful to obtain data for an individual season or to look at historical patterns as indicated in Figure 2.3.1.

Figure 2.3.1 - Data generated by the Seasonal Climate Analysis tool can be easily graphed.



Water Quality Calculator

For many irrigators, water quality can vary and may sometimes be poor. The use of poor quality water has the potential to impact yield and soil structure. The Water Quality Calculator helps determine the resultant water salinity (EC), Sodium Adsorption Ratio (SAR) and pH from mixing water from different sources and highlights the potential impact that this water quality may have on cotton yield.

CottBase

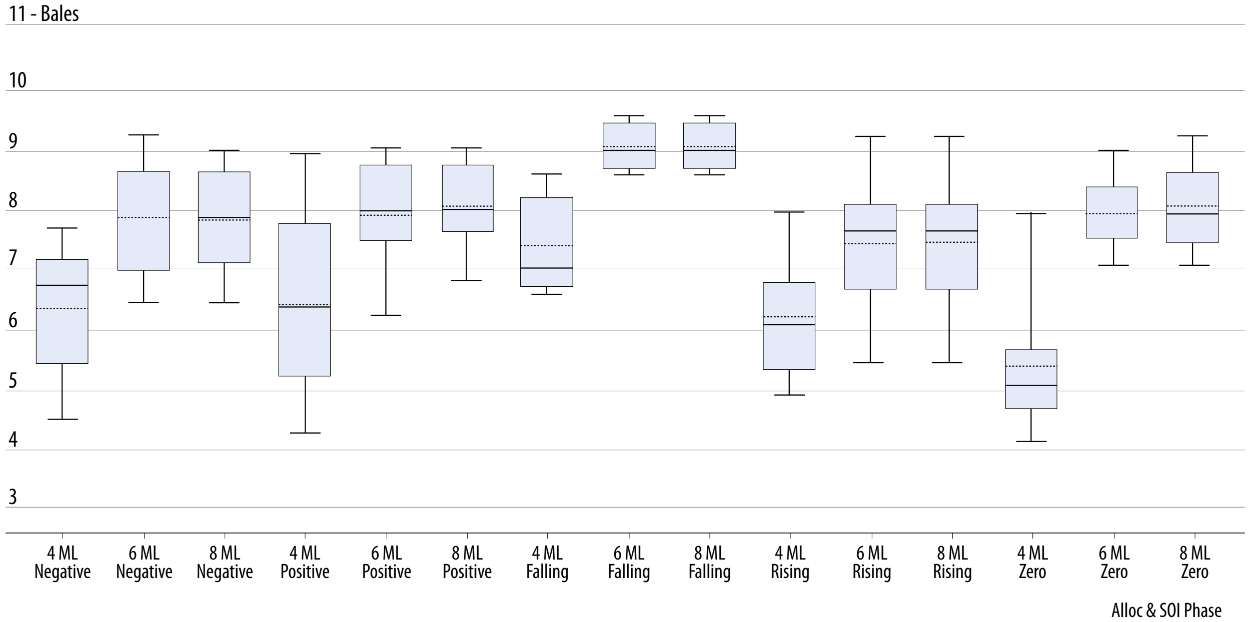
http://cottassist.cottoncrc.org.au/CottBASE/

CottBASE predicts potential crop outcomes based on crop modelling (OZCOT) and historical climate records to enable irrigators to manage risk and make improved management decisions. Variables such as plant available water content, initial soil moisture, seasonal SOI outlook, variety, sowing date, nitrogen, irrigation water availability and timing of irrigation events can be modified to make predictions for individual circumstances.

Each simulation can provide valuable data to support management decisions. For example, in WATERpak Chapters 1.2 and 3.2, CottBASE is used to predict the yield for different available irrigation water scenarios. Similarly, Figure 2.3.2 demonstrates how CottBASE can be used to investigate how the likely seasonal weather conditions (depending upon the current SOI) will impact upon yield for different amounts of available irrigation water. In this scenario, if the SOI were falling there would be less risk in allocating only 4 ML/ha of irrigation water than if the SOI were zero, where the predicted yield is lower. Such information is very valuable in determining the risks involved in different management options.

OZCOT is a cotton crop simulation model developed by CSIRO Plant Industry. The model is based on experimental research of cotton growth and development and is regularly updated with information from ongoing trials. Whilst OZCOT is not typically employed directly on-farms, it underpins a number of other tools such as CottBASE, Hydrologic, VARIWise and others.

Figure 2.3.2 – Using CottBASE to predict the effect of SOI and irrigation allocation on cotton yield.



CropWaterUse

cropwateruse.dpi.qld.gov.au

As the name suggests, the CropWaterUse tool determines seasonal crop water requirements (See WATERpak Chapter 2.1) based on historical climate data. The location, planting date and crop type can be specified to reflect a series of specific scenarios of interest. The tool will then provide reports which can show the amount of total water and irrigation required in wet, dry and average seasons, and how this varies for different planting dates or crop types.

This can be useful to help determine planting dates based on predicted water use or to determine which crop might be the best option when water is limited. Also, this data may be useful when growing unfamiliar crops where the seasonal water use for a particular location has not been experienced.

Figure 2.3.3 shows a CropWaterUse report which illustrates how the tool can be used to compare the irrigation requirements of cotton, sorghum and corn at Dalby. The number of irrigations required will be determined by the refill point the user enters into the model. A video tutorial is also available.

Figure 2.3.3 – An example CropWaterUse report showing the historical range of rainfall, water use and irrigation required for corn, sorghum and cotton crops at Dalby. More detail available from the source.

CropWaterUse

Report Compiled By:
Simon Vriesema
simon.vriesema@deedi.qld.gov.au

Summary

Project: Dalby Summer Crops
Analysis Period: *1957 to 2008*

Assumptions
RainEff: 75% Irri.Eff: 75% Irri.Def: 75 mm

Crop: Corn **Plant Date:** *01 October*
Location: *Dalby* **Pattern:** *Dalby Early Corn*
Total Days: *105*

	Init.	Dev.	Mid.	Late
Days	20	30	30	25
Kc. Val	0.4	1.2		0.5

	Minimum	Maximum	Average	Standard Deviation
Effective Rainfall (mm)	60	370	199	62
Water Use/ETc (mm)	421	573	491	33
Applied Irrigation (mm)	128	684	388	110
Number of Irrigations	1	5	3	1

Crop: Cotton **Plant Date:** *01 October*
Location: *Dalby* **Pattern:** *Dalby Early Cotton*
Total Days: *190*

	Init.	Dev.	Mid.	Late
Days	30	50	70	40
Kc. Val	0.4	1.25		0.5

	Minimum	Maximum	Average	Standard Deviation
Effective Rainfall (mm)	143	573	336	94
Water Use/ETc (mm)	807	1009	922	53
Applied Irrigation (mm)	315	1155	780	169
Number of Irrigations	1	11	7	2

Crop: Sorghum **Plant Date:** *15 December*
Location: *Dalby* **Pattern:** *Dalby Late Sorghum*
Total Days: *130*

	Init.	Dev.	Mid.	Late
Days	20	35	45	30
Kc. Val	0.4	1.2		0.5

	Minimum	Maximum	Average	Standard Deviation
Effective Rainfall (mm)	55	444	207	75
Water Use/ETc (mm)	467	633	560	38
Applied Irrigation (mm)	129	770	471	136
Number of Irrigations	2	9	6	2

Thursday, 19 November 2009 *Summary* **Page 1 of 1**

Note that CropWaterUse uses historical weather data and is intended to predict typical water use patterns, and is not designed for use as an irrigation scheduling tool, which would require daily real-time data. However WaterSched provides irrigation scheduling functionality and is described below.

WaterSched2

http://watersched.deedi.qld.gov.au/

WaterSched2 provides irrigation scheduling and economic reporting functionality based on crop evapotranspiration. WaterSched2 achieves this by determining a daily soil moisture balance, as described in WATERpak Chapter 2.1, by taking into account daily weather, crop growth stage and irrigation applications. Actual soil moisture data can also be used by WaterSched2 to ensure the calculated soil moisture equals the actual readings.

The tool provides pre-defined crop types, varieties and soil profiles, but also allows the user to enter their own data. Similarly, real-time local weather data provided by SILO can be downloaded or users can choose to enter their own location based data. WaterSched2 can be used to manage multiple farms, fields and crops, which makes it applicable to operations of all sizes.

A range of reports are generated including irrigation date recommendations, daily soil water balance graphs, current/forecast yield estimates and seasonal report summaries. An example end of season summary report is provided in Figure 2.3.4. This report shows a number of irrigation performance benchmarks that have been calculated as well as the seasonal soil moisture balance. The soil moisture balance can be used throughout the season to determine appropriate irrigation times. A video tutorial is also available.

IrriSat

http://www.irrigateway.net/Projects/IrriSat/

IrriSat is a low cost irrigation scheduling tool which, like WaterSched2, is based on evapotranspiration data. However, where most tools that determine a soil moisture balance use a user defined crop growth pattern to determine ET_c, IrriSat uses satellite imagery to determine the actual level of crop growth. This means that the soil moisture balance more accurately represents the true conditions in each field.

The tool uses this information, along with ET data from a local weather station, to determine daily crop water use. Irrigation scheduling advice is then provided to users via SMS message on their phone or through a website interface. More information is available online along with a video describing the tool.

Water and the Land

http://www.bom.gov.au/watl/

Weather and climate information is extremely important for successful crop production. Knowledge regarding past and recent events, coupled with future predictions, helps when planning production strategies and is critical for tactical decision making. The Water and the Land website (WATL), provided by the Bureau of Meteorology (BOM), delivers a range of information that assists growers achieve this.

This website is designed to bring together a wide range of BOM services that are relevant for primary producers and natural resource managers. Different types of information are accessible from this single location and are presented in a manner that is relevant to individual circumstances.

The types of information available include:

- historical rainfall records and forecast expectations out to 8 days;
- recent and average evapotranspiration data as well as maps of monthly or annual evaporation;
- temperature information including recent temperatures, 3 month temperature outlook and frost potential;
- southern oscillation index (SOI) data and forecasts; and,
- a range of other weather and climate data.

Irrimate

www.irrimate.com.au

Irrimate™ is a commercial surface irrigation evaluation package that provides for measurement of individual surface irrigation events, evaluation of the performance of that event and determination of the combination of management parameters that would lead to optimised performance.

The service allows combinations of siphon flow rate, irrigation run time, row length and field slope to be trialled on a computer to determine their effect on performance without the cost and hassle of trialling each combination in the field. The surface irrigation performance evaluation process is outlined in some detail in WATERpak Chapter 5.3.

Figure 2.3.4 – An example end of season summary report from WaterSched2

WaterSched2

Report Compiled By:
Graham Harris
graham.harris@deedi.qld.gov.au

End of Season Summary

Field Summary

Farm:	Wallon Park	**Plant Date:**	1/09/2009
Location:	Dalby	**Season:**	2009/2010
Field Name:	Wallon Park	**Length of Season:**	147 days / 2093 GDD
Field Size:	100 ha	**Irrigation Type:**	Surface 100%
Crop:	Late Maize	**Irrigation Trigger Deficit:**	75 mm

Water Summary

	mm	ML/ha
Total Irrigation:	400	4
Total Rainfall:	149	1.49
Total Losses:	100	1
Starting Soil Water:	178	1.78
Ending Soil Water:	30	0.3
Soil Water Change:	148	1.48
Total Water Input:	697	6.97
Net Water Supply:	597	5.97

Crop Summary

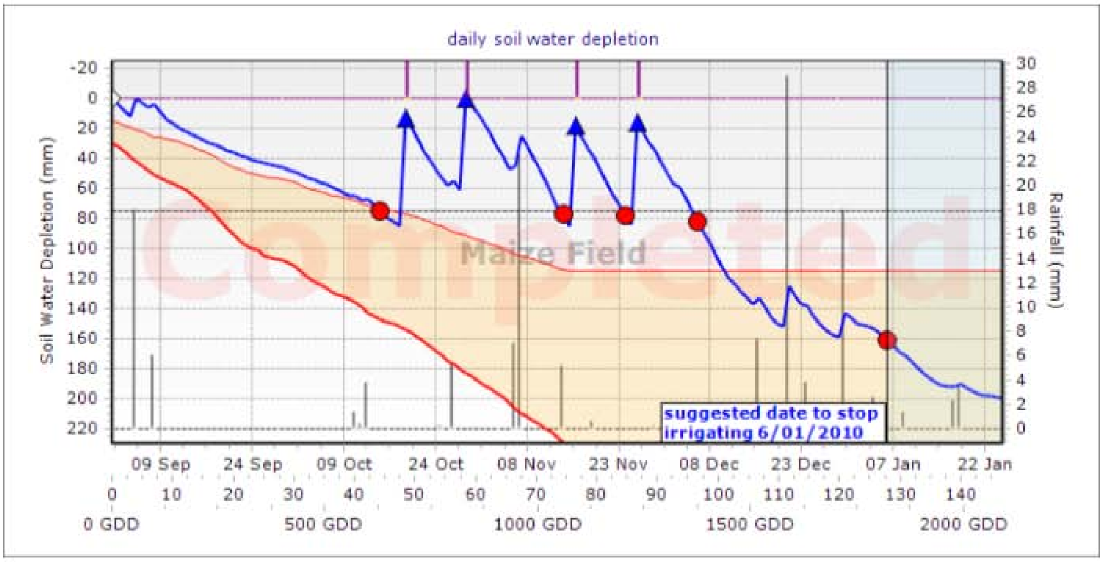
Expected Yield:	12 tonnes/ha
Predicted Yield:	10.6 tonnes/ha
Actual Yield:	10 tonnes/ha
Accumulated ETp:	657 mm
Accumulated ETc:	597 mm

Economics Summary

Price Per Unit:	$250 / tonnes
Variable Costs:	$1310 / ha
Gross Margin:	$1190 / ha

Water Use Efficiency

	Predicted	Actual	Gross Margin
Total Water Use Index TWUI	1.53 tonnes / ML	1.43 tonnes / ML	$170 / ML
Gross Production Water Use Index GPWUI	1.78 tonnes / ML	1.68 tonnes / ML	$200 / ML
Irrigation Water Use Index IWUI	2.66 tonnes / ML	2.5 tonnes / ML	$298 / ML
Crop Water Use Index CWUI	17.81 kg / mm	16.75 kg / mm	$1.99 / mm



Friday, 12 April 2013 *End of Season Field Summary* **Page 1 of 1**

WaterTrack

www.watertrack.com.au

WaterTrack™ is a commercial whole farm water balance tool. This allows all water on the farm to be accounted for so that sources of loss can be identified and the performance of different irrigation system components (and the whole farm) can be determined.

The WaterTrack suite of tools includes:

- WaterTrack Rapid which determines whole farm seasonal water use performance, with the minimum amount of input data required.
- WaterTrack Divider which requires some additional data but also allows losses to be segmented into different components of the farm irrigation system; storages, distribution system and fields.
- WaterTrack Optimiser which requires the most comprehensive input data but also provides detailed daily water use and loss in each individual component of the irrigation system and has prediction capability which aids in water budgeting.

The ability to accurately track water through every component of the farm irrigation system is extremely useful for optimising whole of farm irrigation management and supporting management and investment decisions. Further information and examples are available from the suppliers website provided above.

Knowledge Management System for Irrigation (KMSI)

http://kmsi.nceaprd.usq.edu.au

KMSI was developed by the National Centre for Engineering in Agriculture (NCEA) as a repository of tools designed for use by irrigators and/or consultants across a range of topics from irrigation performance to pumps and on-farm energy use. A number of the tools of most relevance to cotton and grain irrigators have been described below.

Note that some tools have open access, whilst others require registration. Some of the registered tools may be restricted to certain types of users and irrigators should enquire to see if access to the particular tool they are interested in is available.

EconCalc

EconCalc evaluate the costs and benefits associated with different irrigation system types and can be used for new systems as well as for system conversions. Economic performance indicators such as Net Present Value (NPV), internal rate of return (IRR) and Benefit Cost Ratio are calculated .

EnergyCalc

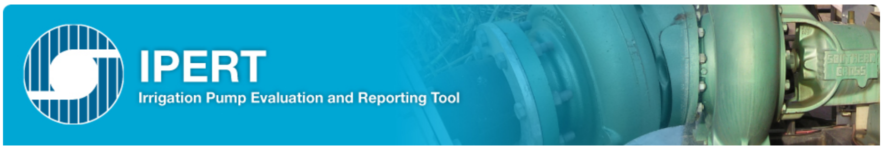
EnergyCalc can be used to assess energy use, costs and greenhouse gas emissions (GHGs) from all key on-farm processes. All energy sources are included (diesel, petrol, LPG and Electricity) so that each farming practice (tillage, spraying, irrigation, processing, etc.) can be evaluated. This can help identify potential energy cost savings and may be useful for greenhouse gas accounting. Further information is available in the online user manual.

Irrigation Performance Audit and Reporting Tool (IPART)

IPART assists in the evaluation of irrigation performance for pressurised irrigation systems (e.g. centre pivot, lateral move, drip, etc.). The tool helps to standardise the collection of infield data, calculates standard performance measures and serves as a database of performance measures so that wide scale benchmarking can be undertaken.

Registration is required to use IPART, although a public interface provides access to a summary of the performance evaluations that have been undertaken. This interface allows for basic filtering of results by irrigation system, crop type or region. This article provides a description of IPART and examples of the outputs produced.

Figure 2.3.5 – An example IPERT report showing a range of pump performance measures.



Centrifugal Electric - Report   Generated From Evaluation #429 by Graham Harris on 12/04/2013

Pump

Pump		**Motor**	
Make&Type	China	Make	WEG
Model / Size	26HBO-40	Rated Output	160 kW (HP)
Nominal RPM	450	Rated RPM	1400
Measured RPM	516	Measured RPM	1400
Pump Inlet ID	750	Drive Type	V-Belt
Pump Outlet ID	559	Speed	Fixed
Suction		**Discharge**	
Inlet Pressure (kPa) (10 kPa = 1 m)	-27.69	Outlet Pressure (kPa)	21.3
Suction Line Velocity (m/sec) if measured	4.26	Nominal Discharge Pressure (kPa)	300
Suction Gauge Fitted	No	Disc. PipeID Outlet Press. Gauge (mm)	600
Suction Pipe Length (m)	3	Pipe Material	Steel
Suction Pipe ID (mm)	750	Pipe OD & Specification (mm)	660
Pipe Material	Steel	Pressure gauge fitted	Yes
Elevation Diff. b/t water source&pump (m)	-2.8	Flow Rate (L/sec)	1081
		Nominal Flow Rate (L/sec)	944
		Elevation Diff. b/t Outlet&Inlet Pressure (m)	0

Electricity Consumption

Energy Cons. over 1 hour (kWh)	100.48	Tariff Code	64
Tariff Rate (cents/kWh) (High)	31	Tariff Rate (cents/kWh) (Low)	21

Other Logged Data

There are no new sensors recorded.

Recommendation

No recommendations have been made for this evaluation

Statistics

Calculated Performance Statistics	
Flow Rate	93.4 ML/day (1081 L/sec)
Flow Rate (Target)	82.94 ML/day (960 L/sec)
Total Dynamic Head	5.74 (m)
Total Dynamic Head (Target)	30.58 (m)
Energy/Volume	25.82 (kWh/ML)
Energy/Volume/Head	4.49 (kWh/ML/m)
Performance	
Combined / Overall Efficiency	60.57%
Motor Efficiency	92%
Pump Efficiency	70.79%
Specific Speed	
Target Specific Speed	33.91
Nominal Specific Speed	33.61
Measured Specific Speed	144.58
Pumping Cost	
Peak Cost	8 ($/ML)
Comparison Cost at $0.20 kWh	5.16 ($/ML)
Off-Peak Cost	5.42 ($/ML)
Peak Cost	1.39 ($/ML/m)
Comparison Cost at $0.20 kWh	0.9 ($/ML/m)
Off-Peak Cost	0.94 ($/ML/m)

Graph

No graphs have been generated for this evaluation

Irrigation Pump Evaluation and Reporting Tool (IPERT)

IPERT is designed to assist in the evaluation of irrigation pump performance. Such evaluation is important to ensure that pumps are operating cost effectively and at the desired pressure and flow rate. IPERT standardises the data acquisition process, calculates the relevant performance measures and generates standard recommendations. Figure 2.3.5 gives an example of an IPERT report and shows a number of the performance measures that are calculated.

Irrimate Surface Irrigation Database (ISID)

The Irrimate Surface Irrigation Database (ISID) provides benchmarks of surface irrigation management and performance and enables ongoing future data collection. Data from commercial and research surface irrigation evaluations (undertaken using the Irrimate service mentioned above) are entered into ISID and the database can be interrogated by registered users to provide aggregated performance benchmarks and trends. This data has been summarised in WATERpak Chapter 1.3.

Evaporation and Seepage Economic Ready Reckoner

http://readyreckoner.nceaprd.usq.edu.au/

The Evaporation Ready Reckoner allows users to evaluate various evaporation and seepage mitigation options for on-farm storages. The Ready Reckoner determines the volume of water savings from different technologies and calculates the economic benefit of investing in these technologies so that an investment decision can be made.

As an example, the Ready Reckoner was used to evaluate storage structural changes such as cell division and increasing wall height. The results showed that such changes could often be economically justified but that individual circumstances could change the results substantially. This illustrates the value of undertaking an analysis such as that provided by the Ready Reckoner.

OVERSched

http://www.irrigationfutures.org.au/OVERsched/OverSchedv1-0.html

OVERSched is designed to assist managers of overhead (centre pivot and lateral move (CPLM)) irrigation systems. The tool is especially useful for irrigators that are new to CPLM management, because these systems require considerably different management strategies and irrigation decisions when compared to furrow irrigation.

OVERSched is not a model but a visualisation tool which allows the user to see how soil moisture might change over time. This is important for CPLM systems because soil moisture varies across CPLM fields due to the time taken for the CPLM system to traverse the field. Irrigation applications are also smaller and more frequent than for furrow irrigation fields.

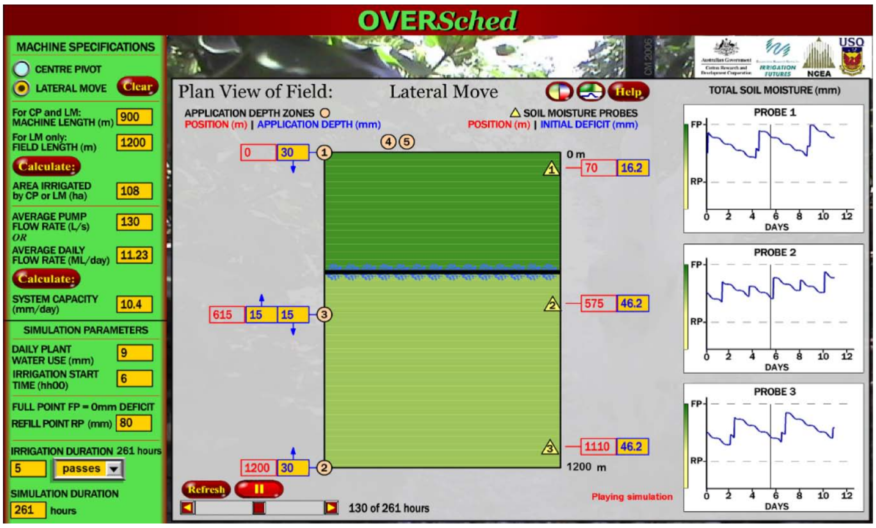
Therefore, deciding when and how much irrigation to apply following a rain event or determining the effect on soil moisture deficit at different points in the field for a range of different management strategies can be challenging and are made easier using OVERSched.

Users enter some basic machine specifications such as length and flow rate, as well as an estimate of daily plant water use. Because the tool is for visualisation only, real ET data is not used and a constant daily plant water use is assumed. It is also possible to enter the soil moisture deficit at up to three places within the field.

When entering the depth of water applied, it is possible to divide the field into a number of zones with different application depths. This is useful, for example, where a shallower application is applied under lateral moves as they approach the end of the field ready for the return run.

By evaluating the effect of different machine management strategies on soil moisture within different parts of the field, the tool can help identify the irrigation scheduling strategies that best fit your field and machine conditions and management style.

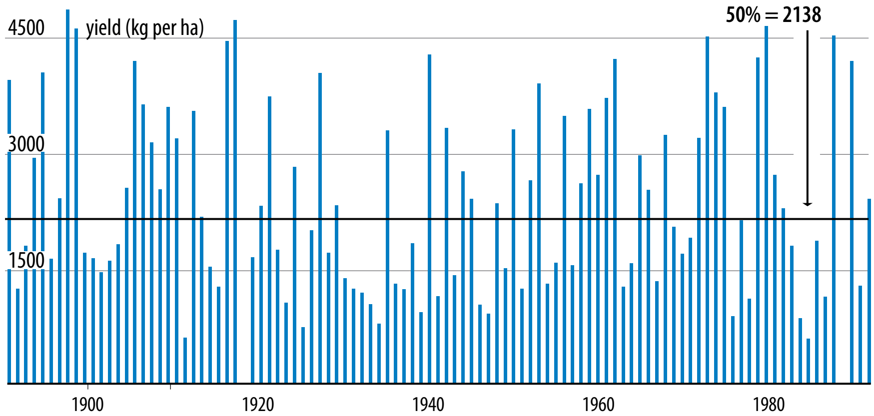
Figure 2.3.6 – An example of OVERSched showing predicted soil moisture and how this can vary over the field.



Whopper Cropper

WhopperCropper combines seasonal climate forecasting with cropping systems modelling to predict the production risk that growers face in the coming cropping season. The historical climate record is used to predict the year-to-year variability in outcomes associated with rainfed crop management options (Figure 2.3.7).

Figure 2.3.7 - Simulation results for 100 years of climate records



This helps producers to choose the best management options for the coming season. Whopper Cropper also enables price and production risk to be combined, so that the economic risk of alternative crop management options can be analysed.

Whopper Cropper enables crop management advisers to predict the likely distribution of crop yields for the upcoming season, based on starting soil conditions and knowledge of the current phase of the SOI. The Agricultural Production Systems SIMulator (APSIM) has been used to simulate a range of management options based on around 100 years of historical climate data.

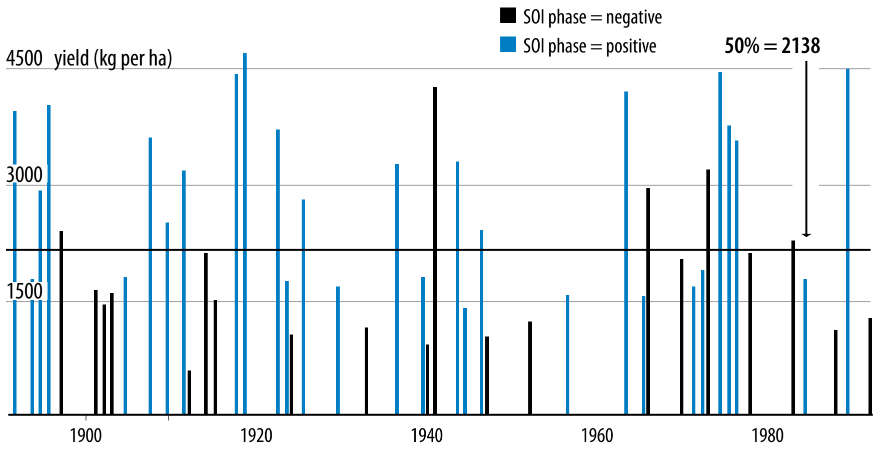
WhopperCropper contains a database of more than 600 000 pre-run APSIM simulations (currently 26 sites Clermont to Dubbo). For each site, combinations of the following options can be examined:

- 8 crops (including cotton)
- 4 soil water-holding capacities
- 3 starting soil water amounts
- 6 nitrogen fertiliser rates
- 3 crop maturities
- 5 sowing dates
- 3 row spacings
- 5 plant populations
- 2 soil fertilities
- Gross margin analysis

From this information, Whopper Cropper allows exploration of changes to management inputs that may be required under current climatic conditions. For example, the 100 year simulations of crop yields can be divided into groups of analogue years in which the SOI phase in a particular month was the same (Figure 2.3.8). Distributing simulated yields by SOI phase enables crop management advisers to discuss with farmers the best management options for the coming season.

Whopper Cropper can also determine the gross margin, which accounts for the different costs involved with different management options and also takes price into account.

Figure 2.3.8 - Analysis of simulation results using SOI phases



Further Reading

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