

Making Irrigation Pay

This Cross Sector workshop is brought to you by

FAR, Irrigation NZ and Dairy NZ

Thursday 1 October

10.00am – 2.05pm

Taratahi Agricultural Training Centre, Cornwall Road, Masterton

Programme

Time	Subject	Speakers	Time allocation
10.00	Arrive & Welcome	Andrew Curtis, CEO, INZ	15 mins
10.15	Message from Sponsor	Agmardt	10 mins
10.25	Message from Sponsor	Blair Miller, Aquaflex	10 mins
10.35	Irrigation Design		
	<ul style="list-style-type: none"> Why Good Design is Critical 	John Bright & Ian McIndoe, Aqualinc	20 mins
10.55	Irrigation Scheduling		
	<ul style="list-style-type: none"> Why Good Management is Critical 	Hamish Brown, Plant & Food Research	20 mins
11.15	Dairy Case Study – Tour of Taratahi ATC's Farm with irrigation examples	All	1 hour
12.15	Lunch		
12.50	Arable Case Study	Richard Kershaw	15 mins
1.05	Improving Your Irrigator	John Bright & Ian McIndoe, Aqualinc	
	<ul style="list-style-type: none"> What will it cost you if it's not right? 	John Bright & Ian McIndoe, Aqualinc	20 mins
	<ul style="list-style-type: none"> What should you be looking out for? 	John Bright & Ian McIndoe, Aqualinc	20 mins
1.45	Message from Sponsor	Grow Wellington & Taratahi ATC	20 mins
2.05	Close		

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Making Irrigation Pay Workshop

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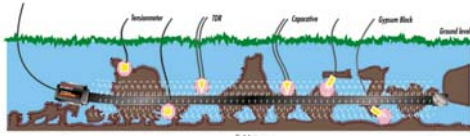
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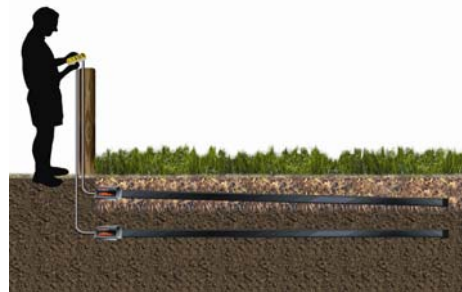
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Typical Sensor Installation

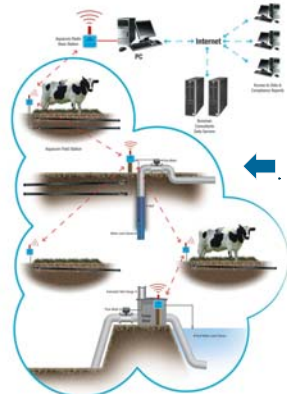


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WHY GOOD DESIGN IS CRITICAL

**Ian McIndoe
Aqualinc**



Making Irrigation Pay

Why good design is critical

Ian McIndoe
1 October 2009

How well is this designed?



Or this?



Or this?



Or this?



Or this?



Or this?



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Or this?



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Or this?



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Or this?



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Message

- You can't easily tell by just looking
- If it looks bad, it is probably very bad – hydraulics is quite forgiving
- You need to know what a system is supposed to deliver
- You need to measure things to find out if it is delivering

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Irrigation design in context

- Irrigation on most farms is NOT insurance – it is a necessary farm input
- Whole farm performance depends on irrigation
- Used to ensure high inputs give high outputs
- Water is a valuable resource – competition for it
- Constraints are becoming tighter
- Performance levels are being raised
- Efficient irrigation is a requirement, not an option

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Fundamental Concepts

- Irrigation requires efficient use of water, energy, labour and capital to provide optimal and sustainable outputs
- Efficient irrigation depends on both design and operation/management of the irrigation system
- Design sets the platform for efficient use of resources and optimal outputs

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Current situation

- Many well-designed systems
- Most can be improved
- Some major technical failures
- Required performance levels not documented
- Up-front cost-driven mentality

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Current situation (cont)

- Undergoing improvement with better technology and understanding
- Many systems constrained by unreliable and inflexible supply
- Will improve under new distribution systems
- Operating environment is changing – e.g. annual allocation limits

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Two key factors

- Correct irrigation design
 - Provides potential for efficient use
 - Does not guarantee efficient use
- Optimal use of the water
 - Impacts on production
 - Requires measurements
 - Requires monitoring

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Consequences of poor design

- Poor performance
 - Lost production
 - Cost (O&M, stress....)
- Other effects
 - Adverse environmental effects
 - Possible loss of water supply
 - Inability to demonstrate environmental responsibility

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Serious failure

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Good design :

- Considers the big picture – present and future (key is water supply)
- Is properly specified – plans and reports (according to INZ Code)
- Provides the ability to apply the right depth of water in the right place at the right time
- Applies water as uniformly as possible at the right rate
- Takes into account both capital cost and operating costs

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Good design :

- Matches irrigation method to:
 - Topography
 - Soils
 - Climate
 - Water availability
 - Crop
 - Farming practices
- Farm is designed around the irrigation system

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Basic design specs

- System capacity (l/s/ha, mm/day)
- Depth applied (mm)
- Return interval (days, hours)
- Uniformity (CU, DU, EU)
- Application rate (mm/h)
 - Intensity
 - Average application rate
- Pump pressures, flows and efficiency

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Design evaluation

- Independent check of system at design stage
- Full system evaluation when system is operating
 - Carried out according to INZ Evaluation Code
 - Checks to see if system meets design specs.

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Summary

- Consider the big picture
- Get the design right
- Design the farm around the irrigation system
- Make sure the design is properly specified according to the INZ Code
- Get the design evaluated

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Taratahi Pivot

IRRIGATION SCHEDULING

**Hamish Brown
Plant & Food Research**

Irrigation Scheduling

Hamish Brown, Dick Martin and Andrew Fletcher

Keypoints

1. Know your soil.
 - a. Available water capacity of upper soil layer
 - b. Stone content of upper soil layer
 - c. Depth to gravel layer
 - d. Root impediments (cultivation pans and compact subsoils)
2. Know your crop.
 - a. Maximum root depth (in the absence of impediments)
 - b. Root growth rate and time to reach maximum root depth
 - c. Crop cover
3. Determine key parameters for each paddock.
 - a. Available water capacity (available water to the crops root depth)
 - b. Trigger point – about 50% of available water capacity
 - c. Refill amount (how much water should be applied by irrigation)
4. Effective irrigation aims to keep soil water content (SWC):
 - a. Above trigger point so yield is not being lost
 - b. Below field capacity so drainage and leaching are not occurring
5. Schedule irrigation – either:
 - a. Use a scheduling service or
 - b. Calculate soil water content with a soil water balance or
 - c. Use a crop calculator (which provide a detailed water balance)
 - d. Measure your soil moisture content or
6. Successful water scheduling using a water balance requires accurate records of:
 - a. Rainfall – how much and when
 - b. Irrigation – how much and when
 - c. Potential evapotranspiration – from news paper, met station or use historic averages as a close approximation
7. A soil water balance can estimate when trigger point will be reached next.
 - a. $SWC_{\text{tomorrow}} = SWC_{\text{today}} + \text{rain} + \text{irrigation} - \text{drainage} - \text{evapotranspiration}$
 - b. Drainage will occur when SWC exceeds field capacity
8. Soil moisture measurements may be used to indicate how close a soil is to trigger point but consideration of root depth, soil characteristics and upcoming weather events is necessary to provide produce sensible irrigation schedules from these.

Why is irrigation scheduling important

Irrigation scheduling has a number of benefits to arable and vegetable farmers, including

- Increasing profits
- Increasing yields
- Reducing costs – labour, power
- Reducing waste – drainage, runoff
- Less leaching - better use of nutrients
- Improve groundwater quality
- Free up water allocation for more production
- Satisfying demands of regulators and government
- Improved public and consumer perception

Efficient Use of Water

To make the most efficient use of water, you need to know

- When to start irrigating
- When to stop
- How much water to apply
- When to apply it

These will vary according to your soil type, crop type, sowing date and the weather.

Yield Response to Water Stress

Crop yields generally respond to water stress in the way outlined in Figure 1. When the soil water content is close to full (field capacity) a crop will be growing at its maximum rate. As the soil dries, the roots can initially get enough water from the soil for the plant to continue growing at its maximum rate. At a certain point, called the trigger point (or stress point), the roots can no longer extract enough water, and so growth decreases. Reduced growth means lower yields. As the soil continues drying, growth continues to decrease until eventually it stops, at what is often called the wilting point or lower limit.

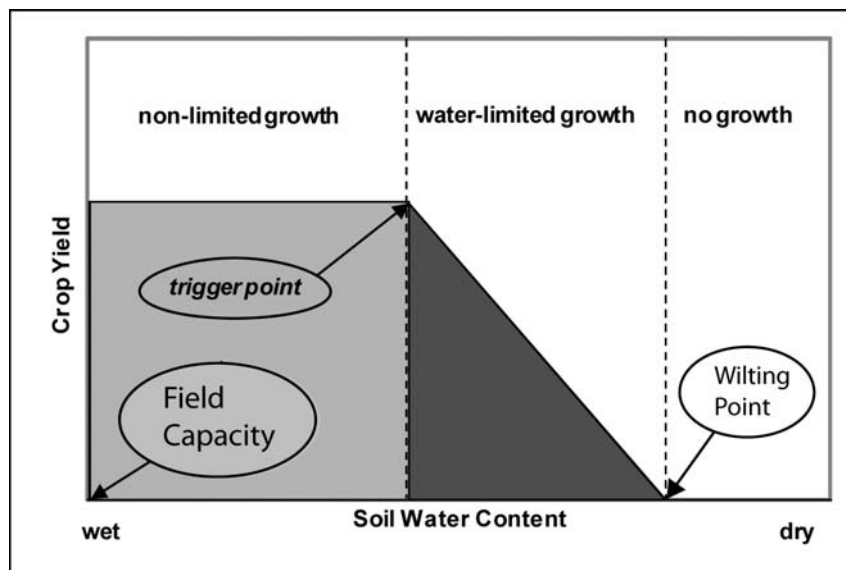


Figure 1: Diagrammatic yield responses of crops to soil moisture deficits.

If soil water content is maintained above the stress point the crop will always be growing at its optimum and achieve maximum potential yield (provided there are no other factors limiting yield such as nutrient supply). Yield will be reduced below potential whenever soil water content falls below stress point. The size of the reduction increases as soil water content falls further below the stress point and as more time is spent below stress point.

Knowing your soils

Field capacity of a soil represents its upper limit to water storage and is the soil water content that occurs when the soil has been filled to saturation and allowed to drain for a few days. Wilting point represents the lower limit for crop water extraction and is the soil water content that occurs when the growth of a crop has completely stopped due to water stress and is permanently wilted throughout the day. The trigger point occurs when SWC falls to 50% of AWC. The amount of water in a soil between field capacity and wilting point is the available water content (AWC) and the amount between field capacity and the trigger point is often called the readily available water.

A soil can be represented as layers of different materials. Most Canterbury soils have an upper layer of fine material (Silt and Clay sometimes mixed with stones) overlying a layer of gravels. The upper layer of most Canterbury soils has 160 mm of AWC per meter of soil depth (mm/m). The presence of stones in the upper layer causes AWC to decline in proportion to the volume of stones (e.g. a soil with 50% stones by volume would only hold 80 mm/m). The gravel layers under the soil only hold around 55 mm/m depth. This may vary depending on the soil texture and the coarseness of the gravel. However, the shallower the gravel layer, the less its available water capacity (Table 1).

The deeper the soil, the higher the AWC and the longer it takes to reach trigger point (Table 1). So on a shallow Lismore soil, irrigation is required at least weekly to prevent loss of yield in midsummer, whereas on a deep Templeton soil, this irrigation can be extended out to two weeks or more without yield loss.

Table 1. The available water at field capacity refill, and the necessary interval between irrigation events at different potential evapotranspiration rates (PET) on soil with different depths to gravel layer (assuming no stones in the upper layer).

Depth to gravel (m)	Available water at Field Capacity (mm to 1.6 m depth)	Refill amount from Trigger point to FC	Days from FC to TP @ 3 mm PET/day	Days from FC to TP @ 5 mm PET/day	Days from FC to TP @ 7 mm PET/day
0.2	76	38	13	6	3
0.4	97	49	16	10	5
0.6	118	59	20	12	7
0.8	139	70	23	14	9
1.0	160	80	27	16	11
1.2	192	96	32	19	14
1.4	224	112	37	22	16
1.6	256	128	43	26	18

In some situations cultivations pans or compacted subsoils will stop root penetration. This reduces root depth to the depth of the impeded layer so the presence of impeded soil layers must be known to accurately estimate crop root depth.

Knowing your crop

Crop root depth has an important influence on the AWC for a paddock. For a shallow rooted crop, such as peas, the AWC is lower than for a deep rooted crop such as autumn wheat so smaller, more frequent irrigation will be required. Thus, it is necessary to know how deep a crops roots will go and how deep they are at a given point in time if they are not at maximum rooting depth when the irrigation season starts. Maximum crop rooting depths are around 1.5 m for winter cereals, 1 m for spring cereals, first year clover and first year grass seed crops, and 0.8 m for peas. Crops can take 2 to 7 months to get to those depths, and so irrigations may need to be adjusted to account for shallower roots earlier in the crops duration. Crop root depth will stop extending if crop roots reach and impeded soil layer and this must be taken into account in calculation of crop root depth.

Table 2 shows monthly root growth rates, and also the depth to which crops roots will have grown from different sowing dates. Spring and summer crops can only access one third of the water during their first month after planting and two thirds in their second month. So AWC and TP will need to be adjusted to account for the shallower soil depth exploited by the roots of a young crop in spring and summer.

Table 2: Root depth extension rates and estimated rooting depths (m) for crops sown on four different dates.

Month	Root depth extension (m/month)	Root depth for crop sown 1 Jan	Root depth for crop sown 1 May	Root depth for crop sown 1 Aug	Root depth for crop sown 1 Oct
Jan	0.5	0.2			
Feb	0.5	1			
Mar	0.5	1.5			
Apr	0.4				
May	0.3		0.3		
June	0.2		0.5		
Jul	0.2		0.7		
Aug	0.2		0.9	0.2	
Sep	0.3		1.2	0.5	
Oct	0.4		1.6	0.9	
Nov	0.4			1.1	0.4
Dec	0.5			1.6	0.9
Jan					1.4

Crop cover influences crop water use and soil evaporation (collectively termed evapotranspiration) which is a key element of a water balance. The amount of water used by arable crops is not much affected by crop type and is well represented by potential evapotranspiration (PET) if the crop is completely covering the ground. A Crop with an

incomplete ground cover does not use as much water and an approximate rule is; a crop with 50% ground cover will lose water at 50% of PET. A bare soil will lose water at a similar rate to PET for a day or two after a rainfall event but this quickly drops to small amounts as the soil surface dries.

Determining key parameters for each paddock

By knowing a crop's rooting depth, the stone content of the upper soil and the depth to gravels the AWC can be estimated for each soil as follows:

1. Estimate the Root Depth of the crop (RD in meters) considering time since planting and the possible presence of impeded layers.
2. Calculate the AWC of the upper soil (fine soil above gravel)
 - a. Estimate the Depth to Gravel (DtG in meters, use RD if gravels do not occur within the crop's rooting depth)
 - b. Estimate the Stone Content of the top soil (SC, % stones by volume)
 - c. $AWC_{\text{upper soil}} = 160 \times DtG \times (1 - SC/100)$
3. Calculate the AWC of the gravels
 - a. $AWC_{\text{gravels}} = 55 \times (RD - DtG)$
 - b. $AWC_{\text{gravels}} = 0$ if gravels do not occur within the crop's rooting depth
4. $AWC = AWC_{\text{topsoil}} + AWC_{\text{gravels}}$

The Trigger Point (TP) and Refill Amount (RA) for each paddock can then be calculated as:

1. $TP = AWC * 0.5$
2. $RA = TP * 0.8$

This calculation of refill amount will provide enough water to take the soil from trigger point to 90% full. This will ensure no drainage occurs from irrigation and there is some capacity in the soil to absorb rainfall that may occur soon after irrigation.

Effective irrigation scheduling

So far we have covered how soil and crop factors will influence available water capacity, trigger point and refill amount. This information can then be used for irrigation scheduling. The most effective irrigation scheduling will measure or calculate SWC each day to determine when SWC will reach the trigger point. Irrigation will then be applied on this day at the refill amount. This practice will keep the SWC above trigger point so yield is maximised but maintain SWC below field capacity so to minimise the risk of drainage and subsequent leaching.

Clearly the AWC of a paddock will change as root depth increases (see above section). Autumn sown crops will have roots close to the maximum depth by the time irrigation season starts in the spring so there is no need to consider changing root depth for such crops. However, later spring and summer sown crops will still be extending their roots during depth during the irrigation season so TP and RA will increase as the season progresses. Such crops may need irrigating more frequently and in smaller amounts earlier in their growth cycle to ensure they are not water stressed. A detailed irrigation schedule should take this into account.

Measuring soil water content

There are a range of systems available for measuring soil moisture content of different paddocks. To provide reliable scheduling advice such systems must be able to give an accurate measurement of when the soil is at trigger point. None of these systems measure soil water content in mm, rather some measure of soil wetness. So it is necessary to have an appropriate calibration to calculate when the soil water content is at 50% of full. Measurements from neutron probes are easily converted to mm of soil water and these systems can provide a reliable means of irrigation scheduling. Measurements from other systems are more difficult to interpret because the translation from the units they measure to actual amounts of available water in the crops root zone are greatly influenced by soil texture, the presence of stones, the method of installation, the time since installation, the position of installation (relative to soil variability within the rest of the paddock) and the depth of installation (relative to the crops root depth). All of these things must be taken into account in determining when soil water measurements mean irrigation is required or not.

Irrigation usually requires some forward planning because the irrigation systems can't be moved into the paddock as soon as a measurement indicates trigger point has been reached. All measurement systems measure soil wetness now and the time from now until trigger deficit will depend on the PET in the coming days. Scheduling services that extrapolate SWC forward from a measured value to the trigger point using average ET for the time of year provide a useful facility for such forward planning. Owners must make this extrapolation themselves for most other standalone measurement systems.

Devices to measure soil moisture are not the single answer to effective irrigation scheduling, knowledge of the soil and crop must still be used to determine TP and RA for each crop paddock combination. Scheduling services provide this information along with soil moisture monitoring but no stand alone system can provide this.

Soil Water Balance

The principles of crop water use are well established and reliable irrigation scheduling can be achieved by predicting SWC using a water balance:

$$SWC_{\text{tomorrow}} = SWC_{\text{today}} + \text{irrigation} + \text{rainfall} - \text{evapotranspiration} - \text{drainage}$$

Evapotranspiration is a combination of crop transpiration and soil evaporation which is driven by demand for water by the atmosphere, and depends on sunlight, temperature, wind and humidity. This demand is represented by PET and these data can be obtained from personal weather stations and are also available to FAR members on the internet at the FAR website (www.far.org.nz). PET data are also published weekly in many newspapers. PET gives a good representation of the actual evapotranspiration in a water balance when the crop is well watered and fully covering the ground. When the crop has incomplete ground cover a simple correction is achieved by halving PET if crop cover is less than 50% and using the full rate of PET if crop cover is greater than 50%. A more comprehensive prediction of PET for incomplete ground cover can be achieved by

calculating transpiration at evaporation separately and such mechanisms are built into more complex scheduling tools such as crop calculators.

Monthly PET in Canterbury average ranges from 1 mm/day in June to 5 mm/day in January (Figure 2), but can be as high as 8 mm/day with hot dry nor'westerly weather, and often around 6 mm/day between Christmas and early January. The higher the PET, the faster the soil dries from field capacity to the trigger point, so that you need to irrigate more than twice as often if ET rates are 7 mm/day compared to 3mm/day.

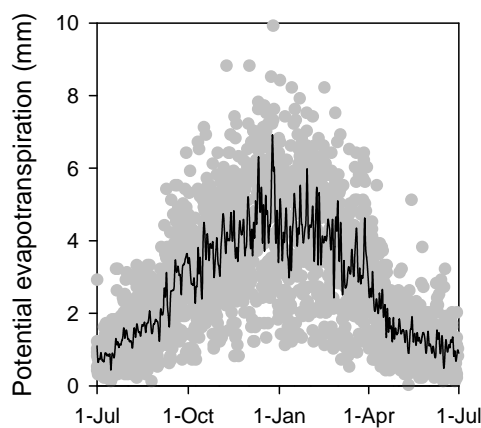


Figure 2. Average daily evapotranspiration rates (mm) for Lincoln.

Evapotranspiration will also fall below PET when the crop is not adequately supplied with water and transpiration can not meet atmospheric demand. Under optimal irrigation this should not occur so need not be accounted for. This can be simply accounted for in a water balance by limiting evapotranspiration to the minimum of PET (demand) and soil water supply. Soil water supply is the amount of water that the crop can extract from the water each day and is well represented as 10% of the available water in the soil. So if available water content is 20 mm soil water supply will be 2 mm on that day.

Rainfall and irrigation amounts need to be recorded accurately to reliably apply a water balance. The timing of rainfall and irrigation has an important bearing on when irrigation is required next so the exact day of rainfall and irrigation events should be recorded frequently in a diary or spreadsheet. Rainfall varies substantially over short distances so it is best to use records from a rain-gauge that is within a few kilometres of the paddock of interest. Irrigation application rates can often vary substantially from manufacturer specifications and the best way to get certain measurements of the amount of irrigation that is applied in each irrigation event is to put rain-gauges out under irrigators at least once per season to check the application rate is consistent with the irrigation systems settings. There are also a number of inefficiencies associated with irrigation systems and these may need to be accounted for in a water balance. There are commercial services available to assess the application rates and efficiencies of irrigators and provide advice

on possible improvements. In the absence of such an assessment it should be assumed that an irrigator is 80% efficient so the application amount determined from rain-gauges or flow meters should be multiplied by 0.8 for entry into the water balance.

Drainage should be minimal under well managed irrigation because SWC will be maintained below field capacity. However, drainage events still occur sometimes when rainfall events full the soil to above field capacity and when the practicalities of managing an irrigated farm cause deviations from optimal management. While drainage is included in the soil water balance the need to calculate it can be avoided by simply assuming that soil water content can not exceed field capacity. Any water in excess of field capacity will disappear as a residual and this amount can be calculated to represent drainage if a quantification of drainage is of interest.

A water balance must be started from some arbitrary point and for autumn sown crops (where irrigation is usually not needed in the autumn) it is appropriate to assume the SWC will be at field capacity on 1 July and start the water balance from there. For spring and summer sown crops it is necessary to start the water balance on the day of planting. In this case it will be necessary to make an assumption about SWC on the day of planting. If the soil is wet, SWC could be assumed to be at field capacity, if it is moderate assume 80% of field capacity and if it is dry assume 60%.

Applying a soil water balance

An example of a soil water balance is presented in Figure 3. In this example an assumed wheat crop was planted on 1 May. The soil has 0.6 m of upper soil overlying gravels and a root depth of 1.5 m giving an AWC of 120 mm a TP of 60 mm and a refill amount of 50 mm. SWC remains close to field capacity during July and August while PET is low and a number of large rainfall events occur. This begins to drop in September when PET increases and rainfall was low. The SWC reaches the TP for the first time in early October and 50 mm of irrigation is applied. This shows up as 40 mm in the water balance because of the irrigation efficiency of 80% and returns the SWC to 100 mm. A second irrigation is triggered in late October followed soon after by a rainfall event. Because the refill amount allowed some capacity to absorb rainfall in the soil this did not cause any drainage. Irrigations were needed frequently through November as PET is high and there was little rainfall. However, substantial rainfall in December meant irrigation was not needed again until January. This crop was expected to finish grainfill at the end of January and irrigation was withheld in late January aiming to have SWC at trigger point soon after grainfilling finished (when the crop is no longer sensitive to moisture stress)

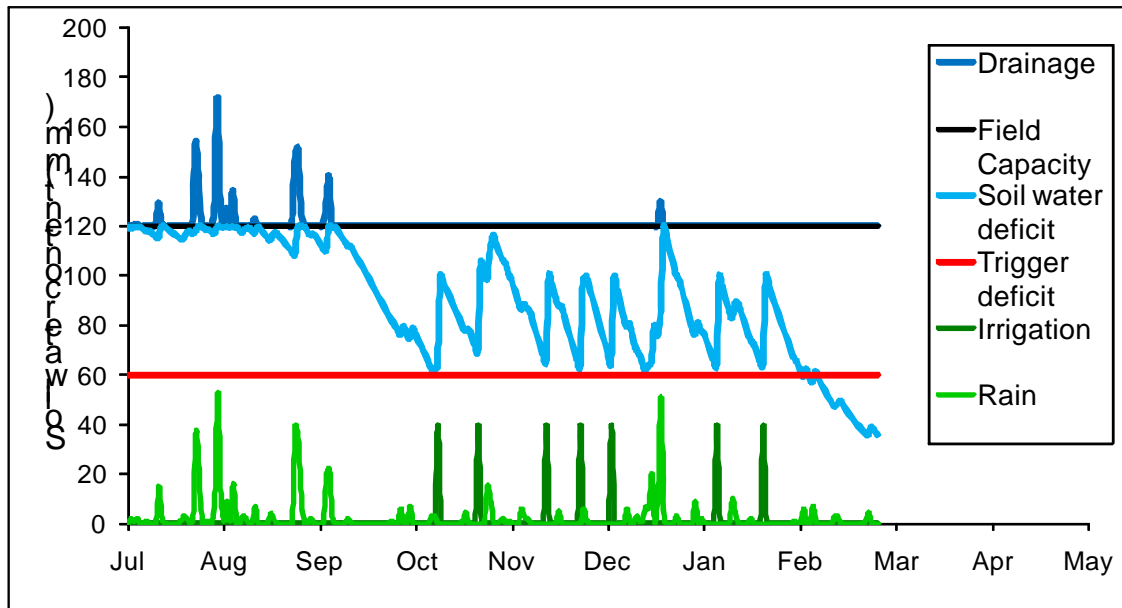


Figure 3: An example of a water balance.

To apply such a water balance throughout the season it is necessary to enter actual PET, rainfall and irrigation information up to the current date to calculate the current SWC. To predict when the next irrigation is needed (when future SWC reaches trigger deficit) it is also necessary to have an estimation of the upcoming weather events. Upcoming PET can be represented by long-term average values for the area and for the purpose of irrigation scheduling it is appropriate to assume upcoming rainfall is zero. If PET substantially differs from long term averages or if rainfall occurs between the current date and the next scheduled irrigation date it may be necessary to update the water balance to determine if irrigation is needed sooner (in hot conditions) or later (if rainfall occurs) than the initial date.

When to stop irrigating

The facts outlined above presume that crops require optimal water supply at all times. Some crops require a period of moisture stress when reduced irrigation should not be applied. To identify when irrigation should be stopped to produce a stress period it is simply a matter of identifying when the period of stress is wanted and use the water balance to work out when irrigation should be stopped to ensure the soil will be below trigger point at that time. The water balance can be used in a similar manner to determine when irrigation should be stopped at the end of the season. Simply estimate when the crop will complete grainfill, identify this point on the water balance and stop applying irrigation so SWC is reaching TP at about this time.

**WHAT WILL IT COST YOU IF IT'S NOT
DESIGNED RIGHT?**

**John Bright
Aqualinc**




AQUALINC
AQUALINC RESEARCH LIMITED

Making Irrigation Pay

What will it cost you if it's not designed right?


John Bright
October 2009



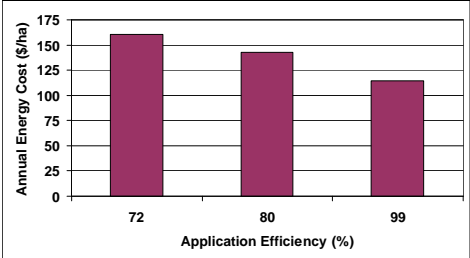
Types of Costs

- Extra energy costs
- Extra labour costs
- Production losses due to:
 - Uneven water application
 - return period too long
 - running out of water

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Increasing Efficiency Reduces Energy Costs



Application Efficiency (%)	Annual Energy Cost (\$/ha)
72	165
80	145
99	125

Based on \$0.25 per mm of water applied

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Uneven watering




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Uneven watering



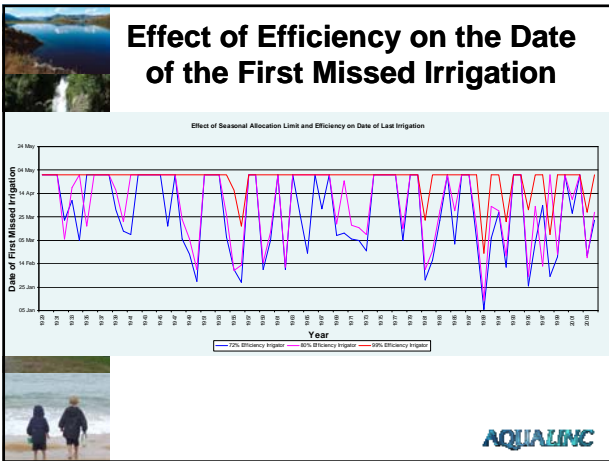
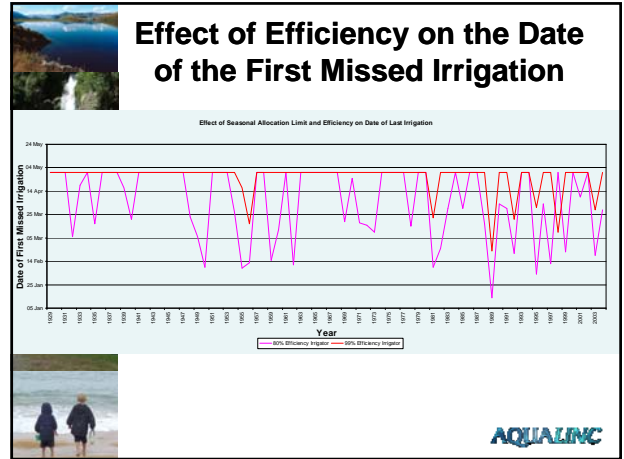
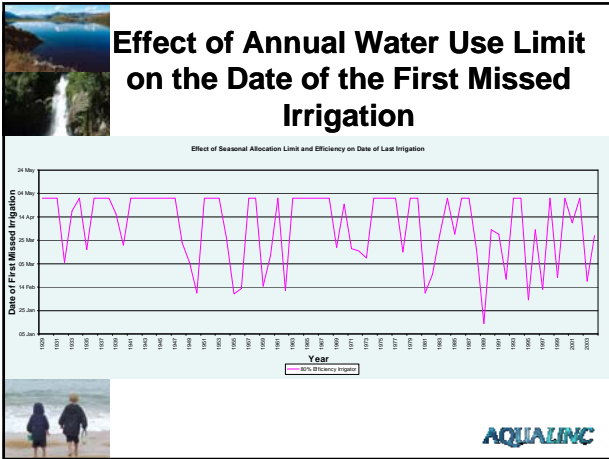
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Annual Irrigation Water Use Limits

- In combination with water meters, provide certainty about how much water has been allocated.
- Encourage efficient irrigation
- Penalise inefficient irrigation

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Key Messages

- With seasonal irrigation water use limits in place, application efficiency affects when your irrigation season stops.
- The difference between a 70% efficient irrigator and one which is 95+% efficient is about a months irrigation.
- How much does a month of soil moisture stress cost you in lost production?

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Key Messages

- Irrigation design determines whether you will be able to irrigate efficiently
- Good irrigation management is required to turn this potential for efficient irrigation into reality
- Together, good design and good management determine how far through the season you will get.

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Thank you

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WHAT SHOULD YOU BE LOOKING OUT FOR?

**Ian McIndoe
Aqualinc**



Making Irrigation Pay

What should you be looking out for

Ian McIndoe
1 October 2009



Taratahi farm plan



Where should the focus be?

Typical water losses expected on typical spray irrigation systems:

- | | |
|---------------------------------|-------|
| • Leaking pipes | <1% |
| • Evaporation | <5% |
| • Blown away by wind | <5% |
| • Watering non-irrigation areas | <2% |
| • Interception | <2% |
| • Surface runoff | <5% |
| • Uneven/excessive application | 5-30% |



Checking for uniformity

- Use standard Warehouse buckets
- 20 buckets are equivalent to 1 square metre
- (1 litre = 1 mm per square metre)
- Put buckets across irrigation run and irrigate
- Measure millilitres of water in buckets
- Take 2% of that value
- Answer = mm depth applied.
- Calculate the average and look at range



Measuring uniformity and depth



Measuring uniformity and depth



Measuring uniformity and depth



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Sprinkler pressure

- Often is the cause of poor uniformity
- Run sprinklers at recommended operating pressure – gauge working?
 - Too low won't get stream breakup
 - Too high will get misting and energy wastage
- Maintain them in good condition

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Operating pressure



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Measuring pressure



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Sprinkler overlap

- Becomes visibly evident in more extreme conditions
- Do whatever it takes to get uniformity as high as practically possible, e.g.
 - Reduce lane spacing if necessary
 - Try not to water in very windy conditions
 - Shift K Lines into the gap every second shift
- Keep the maintenance up.

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Application rate

- The rate at which water is applied to the soil by the irrigator
- One of the biggest causes of low performance – redistribution, ponding and macropore flow
- Two aspects, average and instantaneous rates

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Application rate & ponding



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Application rate & ponding



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Application rate & ponding



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Application rate & ponding



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Application rate

- Best addressed at the design stage
- Usually a trade-off between uniformity and application rate
- Hard to retrofit systems to solve the problem
- Some management techniques to reduce problem – little and often

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Energy use

- Operate pumps as close to their maximum efficiency point as possible (will need design specs to check)
- If a crackling noise is heard in pumps or headworks, cavitation will be occurring – get the system seen to asap.
- Calculate the kWh/m³ and record it
 - Measure units of electricity at meter and volume with flow meter over 1 hour

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Simple checks

- Check you are getting the correct flow – flow meter.
- Check pressure gauges to ensure the system is operating at the correct pressure.
- Measure the application depth and compare it with the design system capacity.
- Check that sprinkler pressures are as even as possible (pitot tube pressure gauge).
- Visually check that there is correct overlap of sprinklers

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Simple checks

- Use catch cans to measure the evenness of watering.
- Measure soil moisture (or dig a hole before and after irrigation) to determine how much water is retained in the soil.
- Check for ponding during irrigation.
- Measure production to ensure you are meeting your production targets.
- Regularly check valve and pump performance

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Summary

- Fix the easy things first
- Know what your system should deliver and how well it is doing it
- Keep an eye on pressures and flows
- Visually check for ponding and runoff
- Be prepared to adjust the system or system operation to improve performance
- Measure production, water use, and soil moisture, (at least)

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Calculate and record indicators, e.g.

$$\text{Application efficiency} = \frac{\text{Water stored in root zone}}{\text{Water supplied to field}}$$

$$\text{Energy efficiency} = \frac{\text{Energy used for irrigation}}{\text{Total annual water use}}$$

$$\text{Labour efficiency} = \frac{\text{Irrigation time}}{\text{Irrigation} + \text{O\&M time}}$$

$$\text{Water use efficiency} = \frac{\text{Annual production}}{\text{Total annual water use}}$$

$$\text{Capital efficiency} = \text{Return on investment}$$

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Thank you

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