



in association with



Irrigation Focus Day Handout

GETTING THE MOST OUT OF WATER

Lunch kindly sponsored by:



The National Bank
of New Zealand

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S I D D C – Partners networking to advance South Island Dairying




Lincoln University
Te Whare Wānanga o Aorangi

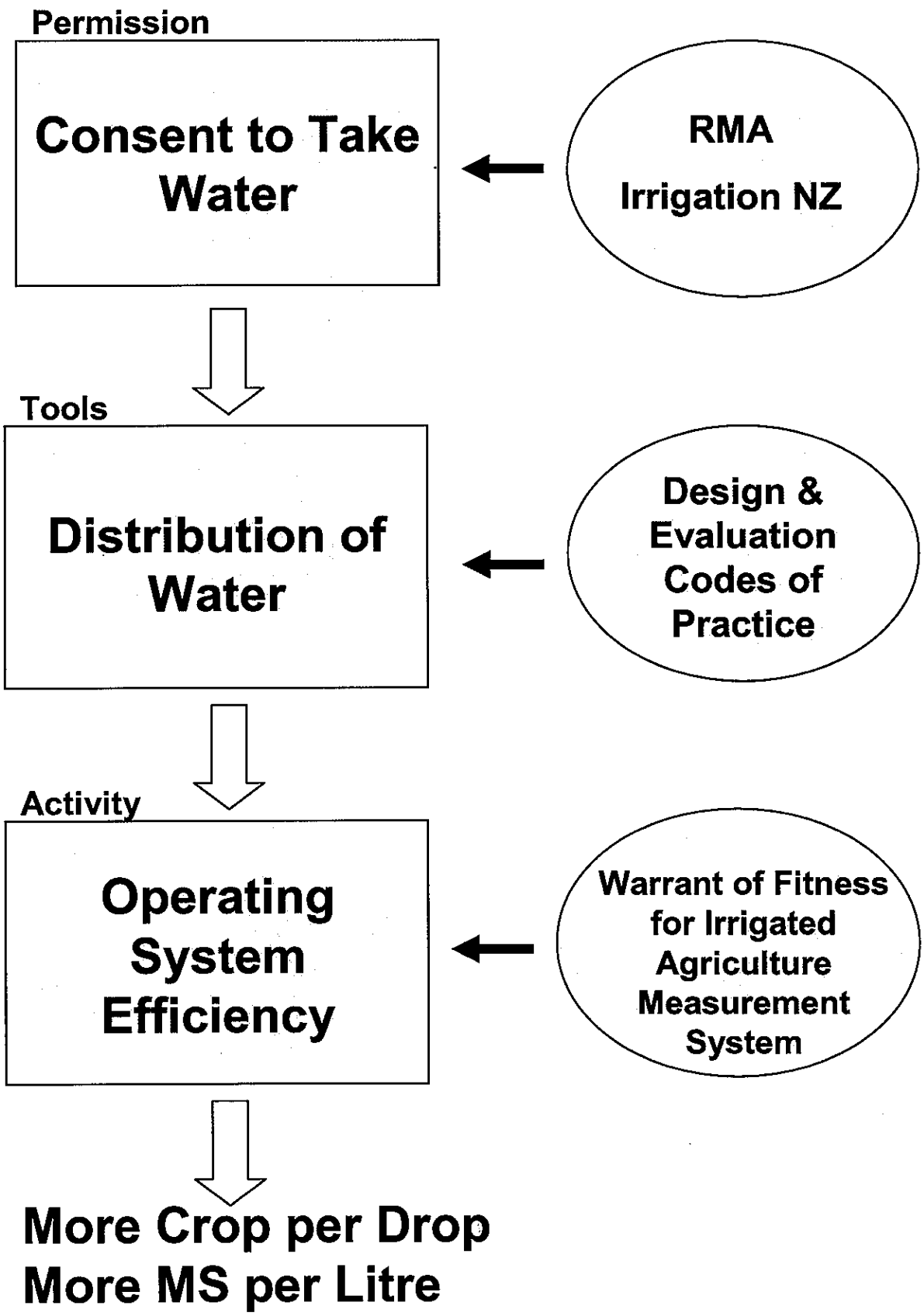


Ravensdown



Programme
GETTING THE MOST OUT OF WATER
Lincoln University Dairy Farm
Thursday 15th March 2007

10.15 am	Register: Tea / Coffee Calf Shed	
	MORNING SESSION	
10.30 am	Welcome, Purpose & Introductions	Richard Christie, SIDDC
10.35 am	Scene Setting	Terry Heiler, Irrigation NZ
10.55 am	What is Irrigation All About - basic principles of irrigation, field capacity, evapotranspiration,	Ian McIndoe, Aqualinc
11.10 am	Lincoln University Dairy Farm - Irrigation & Effluent	Peter Hancox, LUDF and Adrian van Bysterveldt, Dexcel
11.40 am	Presentation 1 - North Pivot Why Evaluate an Irrigation System and its Management - Irrigation Audits - Key actions to improve efficiency	Dan Bloomer, Page Bloomer Associates Tony Daveron, Hydro-Services
12.15 pm	Presentation 2 - Tanker Turnaround Irrigator Design Code of Practice And Warrant of Fitness for Irrigated Agriculture	Ian McIndoe Claire Mulcock, Mulgor Consulting
12.50 pm	Consent to Take Water – now and the future - Impact on LU Dairy Farm - Role of Irrigation NZ	Terry Heiler, Irrigation NZ
1.00 pm	Summing Up – morning session	Graeme Sutton, Irrigation NZ
1.05 pm	Lunch - Calf Shed	 The National Bank of New Zealand
	AFTERNOON SESSION	Chair, Richard Christie
1.45 pm	Installation of Water Meters - what data is required - pitfalls and tips	Kevin McFall, ECAN
2.00 pm	Water In Pasture Out – realising the gains	Dick Martin/Steve Thomas, Crop & Food
2.20 pm	Fertigation - how the system on LUDF works	David Blatchford, Ravensdown, D Cosgrove staff/Peter Hancox
2.35 pm	FINISH	



AQUALINC

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GETTING THE MOST OUT OF WATER

Lincoln University Dairy Farm 15 March 2007

By Ian McIndoe

Basic objective of irrigation

- Primarily risk management.
- Is usually about managing soil moisture at a level to obtain optimum production – pasture yield/quality and milk production.
- Needs good understanding of both the plant/soil/water relationship and the performance and practical limits of the irrigation system.

Different states of soil moisture

- Water holding capacity – the maximum amount of water held in the soil that is available for plant growth.
- Saturation – a soil in a fully wet (drenched) state
- Field capacity (full point) – the soil water content after drainage from an initially saturated soil profile has become negligible.
- Critical deficit – the portion of the maximum available soil water that can be used before growth is detrimentally affected. This changes with crop stage and climate.
- Wilting point – the soil water content at which plants begin to wilt.
- Permanent wilting point – the soil water content when the crop will die.

Aim of managing soil moisture

- Match water applications to pasture needs.
- Keep soil moisture between field capacity and critical deficit, generally.
- If possible, don't refill the profile to field capacity – leave some space for rainfall (as rainfall is the lowest cost water).
- Light soils require more frequent irrigations and soil moisture should be maintained at a higher level in summer to reduce risk.
- Heavy soils require less frequent irrigations and soil moisture can be retained at a lower level to increase application efficiency and use more rainfall.
- Have a good understanding of both the plant/soil/water relationship and the performance and practical limits of the irrigation system.

Good practice

- Know how much, how fast and how uniformly your irrigation system applies water. Have it evaluated.
- Measure water use with a flow meter.
- Measure soil moisture.
- Measure rainfall.
- Use the measurements to make good irrigation decisions.

Irrigation Design Code of Practice Programme

Objective is to implement a programme to improve the efficiency and sustainability of use of water, energy, labour and capital in irrigation systems in NZ.

- **Initiated by irrigation industry**
- **Led by Irrigation New Zealand (INZ)**
- **Wide irrigation industry backing (end users, suppliers, consultants)**
- **Support of regional councils, government agencies**
- **Funded by MAF SFF (Projects 02-051 & 02-079) and the irrigation industry, through INZ**

Key steps of programme:

- **Key performance indicators (KPI's) for irrigation systems – provides means of measuring design performance**
- **Irrigation design code of practice and standards – specifies level of performance and design standards**
- **Irrigation evaluation code of practice – to measure/evaluate design performance**
- **Industry recognised design and evaluation certification programmes – to help performance measures are met**
- **NZQA recognised unit standards – to train irrigation designers and evaluators**

Fundamental concept - efficient irrigation depends on both design and operation of an irrigation system:

- **Design sets the platform for efficient use**
- **If the design & installation is up to standard, the potential for efficient operation exists**
- **If design is not up to standard, it is very difficult or impossible to achieve efficient irrigation**

Main issues revolve around:

- **Uniformity of applications**
- **Application rates**
- **Energy requirements**
- **Maintenance**
- **Scheduling of applications**

Outcomes

- **National adoption by irrigation designers/evaluators**
- **Irrigation courses, unit standards and training in New Zealand**
- **Acceptable irrigation performance level expectations by farmers**
- **Adoption of principles into water allocation and use policy**
- **Recognition by regional councils, with credit given for adoption**

Present situation

- **KPI's – completed**
- **Design code of practice/standards – final version being prepared for release as soon as possible**
- **Designer unit standards – currently being finalised**
- **Designer certification programme – to follow release of code and unit standards**
- **Evaluation programme running and producing results**

Description of Existing Irrigation and Effluent System
on Lincoln University Dairy Farm 2007

Areas

	North	South	East (Support Land)
Centre-pivots	70 ha	57 ha	
Long laterals	11 ha	13 ha	
K-Lines		10 ha	
Southern Cross Gun			18 ha
Total irrigated	81 ha	80 ha	18 ha
Total irrigated area	179 ha		
Total farm area + Runoff	180 ha		
Irrigation system capacity	5.5 mm/day		

Pivots

	North	South
Model	Zimmatic	
Length of basic pivot	402 m	
Length of corner unit	81 m	None
Maximum flow rate	53 l/s (700 gpm)	37 l/s (500 gpm)
Max application rate	39 mm/h	33 mm/h
Sprinklers	Nelson Rotators (pressure regulated)	
Sprinkler operating pressure	14 m (20 psi)	
Pivot pressure	30 m (43 psi)	
Typical rotation time	1-5 days	

Long Laterals

	North	South
Number of sprinklers	21	33
Total flow rates	9 l/s (120 gpm)	14 l/s (185 gpm)
Hectares/sprinkler	0.40 ha/sp	0.39 ha/sp
	On 12 m hose, 8 day round, 0.36 ha with no overlap	
Sprinkler type	Rainbird 30 EM Impact	
Sprinkler pressure	335 kPa (48 psi)	
Sprinkler flow	0.42 l/s (333 gph)	
Connecting hose	40 m	

Wells and Pumps

	North	South
Well diameter	300 mm	300 mm
Well depth	89 m	93 m
Static water level	4 m below ground level	1.5 m below ground level
Well capacity	>100 l/s (1300 gpm)	
Pump model	Pleuger	Ritz
Size	68 kW	100 kW
Supplying	Pivot, stock, dairy	Pivot, orchards, BHU
Starter	Soft start	Variable speed drive

Operation of the Centre Pivots

- South Block Pivot audited on 5 October 2004 (Bloomer and Davoren – supported by MAF Sustainable Farming Fund).
- North Block Pivot audited on 22 January 2006 (Bloomer – supported by Dairy InSight).
- North Block best practiced is compromised by having irrigator speed increased due to effluent spraying requirements.
- The North Block pivot can complete a full rotation in 20.8 hours for 5.5 mm (At 100% of maximum speed).
- The South Block pivot can complete a full rotation in 29.7 hours for 5.5 mm (45% of maximum speed).
- The application rate for the pivots is around 40mm/hr. Soil infiltration rates are 15 mm/hr so there is the risk of minor water ponding.
- Soils on each block are variable making it difficult to optimise for all soils, particularly when practice is frequently to do one rotation per day applying 5.5mm.
- Fertigation on South Block requires targeted applications of urea onto recently grazed areas, and this can necessitate extra pivot.
- South Block pivot has separate control vales for each span, allowing areas to be (manually) shut off if required.
- Telemetry has just been fitted allowing control of both pivots from the dairy shed office. Only manual intervention is required for effluent.
- Wheel track ruts need particular attention on the heavy soils of the South Block, and the 2006 winter/spring has seen more problems arise on the North Block.
- Tyres are currently tractor tyres but thought is being given to phasing these over to turf tyres.

Operation of Other Irrigation Systems

- K-lines are found in Paddock S10. Water for 2 hours, off for 1.5 hours, on 24 hour cycle.
- Laterals are used around the edges of the pivots where the corner unit or spray guns cannot reach.
- K-lines and laterals are shifted by 4WD bike.
- Coverage from K-lines and laterals is suspect, and water efficiency questionable.
- There is a considerable labour component involved with these areas, even though they only make up less than 29% of the irrigated area.

	Area	Time to Shift	Maintenance	Accuracy
K-line	10 ha	20 minutes	1 hour/week	Good
Laterals	24 ha	1 hour 30 minutes	2 hours/week	Variable

Fertigation Unit

- The unit was commissioned by Dan Cosgrove and Ravensdown in 2006.
- Currently it is only supplying the South Block, as it avoids the complication of managing the effluent area on the North Block.
- The unit automatically dissolves urea from the Ravensdown silo to a solution of approximately 14%N.
- This is then pumped to the holding tank at the centre of the South Pivot.
- Applications of 20 kg N/ha are usually targeted, but there is interest in going to lighter rates more frequently.
- Eco-n has been successfully applied through the fertigation unit, but this is usually applied at times when the irrigator would not normally be operating.

Stock Water

The system was specified on 75 litres per day per cow, with up to 12 litres per cow per hour. It is connected with a Dosatron 8000 injector and backflow preventer.

Effluent

Dairy shed effluent is held in sump capable of holding 33,000 litres (including sediment trays). A 11.5 KW electric pump is used. 100 mm PVC pipe transports to the base of North Block centre pivot. Then it travels through 80mm line to spans 5 to 7 where distribution is through pot spray applicators. Control is available to apply in each span and application is done one span at a time.

Based on the ratios of areas covered by pivot spans, our practice is to apply for 7 days in pivot span 5, 10 days in span 6 and 12 days in span 7. The total area of effective coverage is 28 hectares, which is well within Environment Canterbury guidelines for current herd size. However there is a plan to increase this area further, principally due to potassium accumulation in the soil. We are conscious of sustainability and labour requirements in any modification to the system. There is also the intention to increase the size of the sump to provide an additional 33,000 litres storage providing more robust contingency planning.

There are some disadvantages with the effluent attached to the centre pivot. Irrigation sprinklers can be fouled. The water rate on the effluent area is greater, and the irrigation cycle is partly determined by the need to move the irrigator at a speed to suit the effluent.

Projects

We are seeking to better integrate the disjointed components of the LUDF irrigation information and control system, and reduce manual intervention.

1. Provision of data/information to allow the dairy farm to be operated and managed efficiently and effectively.
2. Provision of data/information for compliance purposes.
3. Provision of data/information for scientific and research purposes, and for teaching Soils students.

Management is also interested in the potential to reduce evapotranspiration by lowering average wind speed through the planting of shelter.

Interesting Statistics and Information

Average Annual Rainfall = 666 mm. Average irrigation input applies an additional 450 mm. Average Evapotranspiration for Lincoln is 870 mm/year.

South Block Data:

Year	Rainfall (mm)	Irrigation (mm)	Total (mm)
04/05	625	438	1063
05/06	449	493	942
06/07 to date	706	307	1013

- Across 161 ha milking platform under irrigation, this is 725,000m³ water use annually.
- Peak requirements are 385 m³/ha/week (38.5 mm/week).
- The farm produces around 3.3 million litres of milk per year. So the ratio of irrigation water to milk is 220:1.
- The farm is spending \$54,000 annually on electricity for pumping water.
- The farm spends approximately \$10,000 on repairs and maintenance for irrigation systems.
- The local water resource (Springston Zone) has seasonal fluctuations in groundwater of 2-4 metres and tends to recover during winter recharge. There is no history of long term decline of water levels, or adverse drawdown effects from the confined aquifer at 80 metres depth.

LUDF Water Supply and Monitoring Inventory

Item	Location	Details	Comments
Bores & recorders			
North Block Bore - irrigation	Beside Pumps near dairy shed	Supplies Irrigation – North only. (Stock water for North, South and East block topped up during milking when shed water demand too high)	Main bore at 94m depth
North Block bore datalogger	In pumpshed	Works off automated meter - inline	Cannot easily get data onto LUDF computer. Laterals not separately recorded, but logger can separate which irrigator is being used.
Stock water bore	Next to North Block irrigation bore	Shed water (priority) and stock water for North, South Blocks and main supply source for East block stockwater, plus farm house	Bore to 10 m (approx)
Stockwater bore datalogger	In pumpshed	Automated meter with datalogger	Cannot easily get data onto LUDF computer. Laterals not separately recorded, but logger can separate which irrigator is being used
South & East Block Bore - irrigation	Near JML and enters LUDF at Pdk S3.	Provides water to LU property around Johnstone Memorial Lab. For LUDF it supplies South Pivot, laterals and K-line and East Block irrigation gun.	Only achieved split readings in 2006. Approximately 60% usage to LUDF.
South Block datalogger	At S4	Automated meter. Measures LUDF share from bore and gives quantity to South Pivot and K Line and laterals (collectively)	Cannot easily get data onto LUDF computer.
East Block irrigation metering	On the Southern Cross irrigator	Manual recording	Provides seasonal data
Other recorders			
Dairy shed water use	None		Calculated by subtracting all stock water and house water from stock water bore
Stock water use – North and South Block	Dairy shed (at Dosatron point)	Manual recorder of stock water use	Recorded daily and entered onto spreadsheet on LUDF computer
East Block stock water use – supply line 1	Dairy shed (at Dosatron point)	Manual recorder	Recorded daily and entered onto spreadsheet on LUDF computer
East Block stock water use – supply line 2	Services other JML land as well	Not measured	Minimal use as mainly supplied from main stock water system from North Block
Farm house use	Dairy shed	Manual recorder of house water	
Fertigation use	Dairy shed	Manual recorder of fertigation tank dissolving system	Recorded monthly, and entered onto spreadsheet on LUDF computer
Effluent	Centre of North Pivot	Automated datalogger installed September 2006.	Not recorded at pumping source. Records are daily. Cannot easily get data onto LUDF computer.
Management Information			
Evapotranspiration and rainfall data	Near University campus	Supplied by LU to LUDF	Held in spreadsheet
Rainfall	Fence mounted rain gauge at in tanker turnaround	Collected by LUDF farm manager	Backed up by LU weather station data. Recorded in weekly datasheet.
Aquaflex (3)	Installed in 2002 in S7, S9 and N1.	Some setup and data transfer problems.	Not in use but seeking to re-commission
Neutron Probes	Sites established by Hydro Services in 2006, in S8, N7 and N11.	Weekly visits and reporting during season.	Main form of irrigation decision guidance currently used.

LUDF getting better value for irrigation.

In 2005 the South Block centre pivot at LUDF was audited. Some very minor changes to two sprinklers were required to get the pivot operating with better than a 90% uniformity of application. After this a soil moisture monitoring system was adopted where irrigation decisions were made on a weekly basis neutron probe reading of a variety of sites on LUDF.

Fig 1 shows the results of this approach on pasture yield on the LUDF South Block.

Fig1

LUDF South Block

	04/05 yield	05/06 yield	diff	comment
S1	16.5	18.9	2.4	Re-grassed
S2	20.1	21.0	0.9	
S3	18.4	20	1.6	
S4	22.2	22.2	0	
S5	22.7	20.6	-2.1	Oldest Tabu
S6	17.9	20.2	2.3	
S7	17.6	20.4	2.8	
S8	17.0	21.9	4.9	
S9	17.8	19.3	1.5	
S10	14.3	21.9	7.6	Re-grassed
S11	18.6	18.4	-0.2	drainage

There was an improvement in pasture yield over most of the paddocks on the block that had not been re-grassed. The same amount of fertilizer (and N) was used in the two years and the soil temperature profiles were very similar. We have attributed this improvement to better irrigation decisions. The soils in this area are heavy clays and from the information we have we were over watering in the past.

In 2005 neutron probe reading from two sites on the North Block were also used to monitor soil moisture deficit reading and irrigation scheduling was decided on the basis of this information. The two sites reflected the two major soil types on this block, a light Eyre soil and a Templeton silt loam.

In 2006 an audit was carried out on the North Block Pivot. This found that there was insufficient water pressure for the pivot to deliver the target amount of water or uniformity of water application when the end swing boom was receiving water. This pressure problem was tracked down to an incorrect setting on the pressure gauge at the pump.

Pasture yield records for this block showed the following results (fig 2)

Fig 2.

LUDF North Block

	04/05 yield	05/06 yield	diff
N1	20.3	18.6	-1.7
N2	17.9	18.3	0.4
N3	20.7	19.0	-1.7
N4	17.4	18.7	1.3
N5	23	19.7	-3.3
N6	21.8	18.4	-3.4
N7	18.8	16.3	-2.5
N8	19	20	1.0
N9	22.5	22.8	0.3
N10	21.4	21.0	-0.4
N11	21	22	1.0

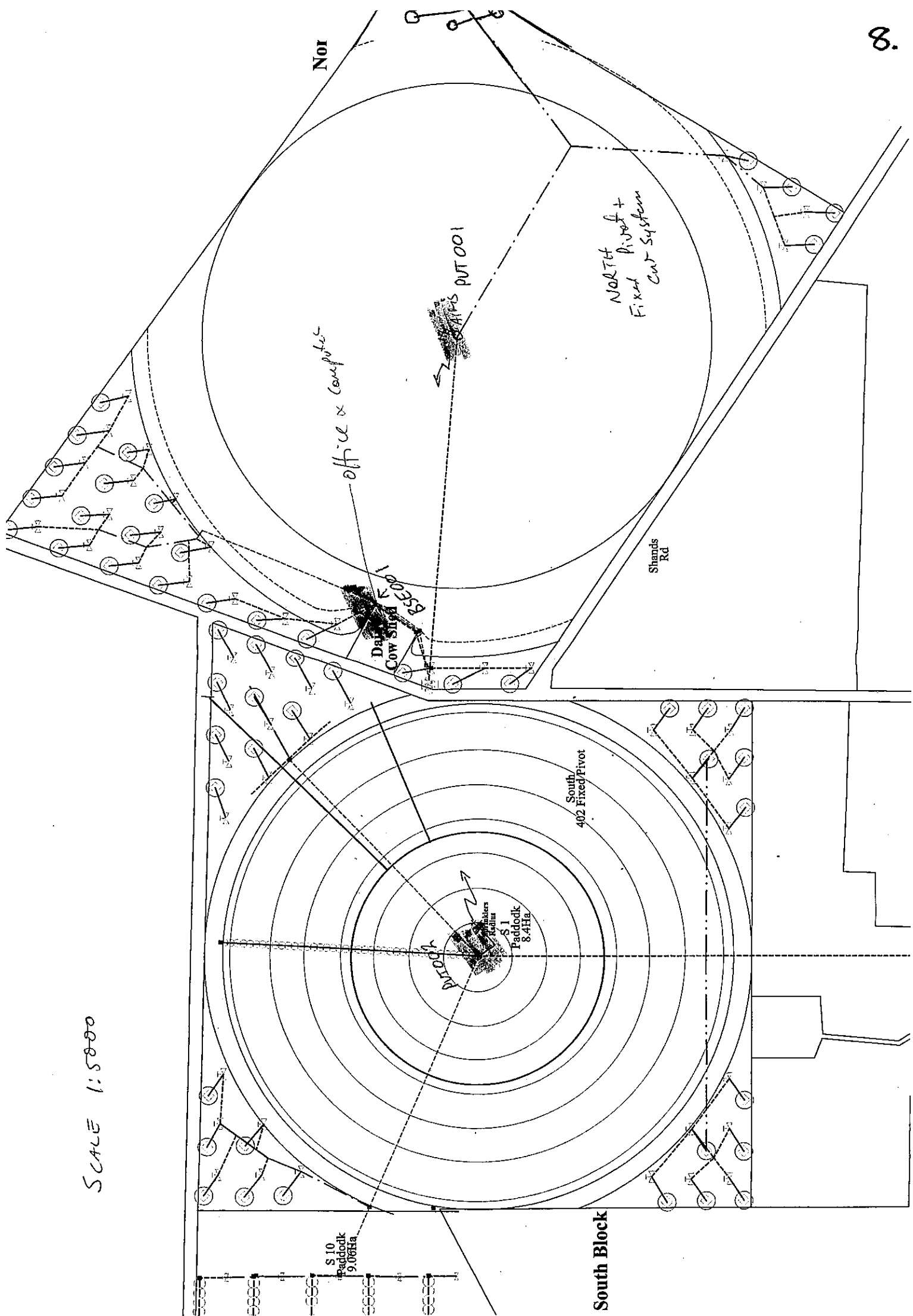
Again fertilizer, N applications were the same in the two years and soil temperature profiles were very similar. Many of the decreases in pasture production across the block look to have been reasonably explained by the pressure problem that the audit found. The extent of the impact on pasture production was a surprise to the management team. Comment had been made during the year that parts of the North Block looked like needing more irrigation that the weekly soil moisture deficit readings were suggesting. A recent review of all aspects of our irrigation management observed that the two Neutron Probe sites on this block were also in the area that received effluent, and so were receiving both irrigation water and effluent water.

We now believe that we have the full explanation of the causes of lower pasture production on many of the paddocks on the North Block. This also explains why those paddocks with the heavier soils were less affected.

- 1) The soil moisture deficit recordings were being taken from an area also receiving effluent water. This area accounts for 29 ha out of the 81 ha of the North Block. As a result the 52ha outside the zone receiving effluent was under-watered.
- 2) The reduced pressure setting at the pump resulted in insufficient water getting to the pivot.

The information required to identify and fix this issue only became apparent as a result of paddock pasture yield information, an audit of the South Pivot and a review of our irrigation management.

SCALE 1:5000



North

NORTH Pivot + Fixed System

Shands Rd

South Fixed/Pivot 402 Fixed/Pivot

S1 Paddock 8.4Ha

S 10 Paddock 9.06Ha

South Block

office & computer

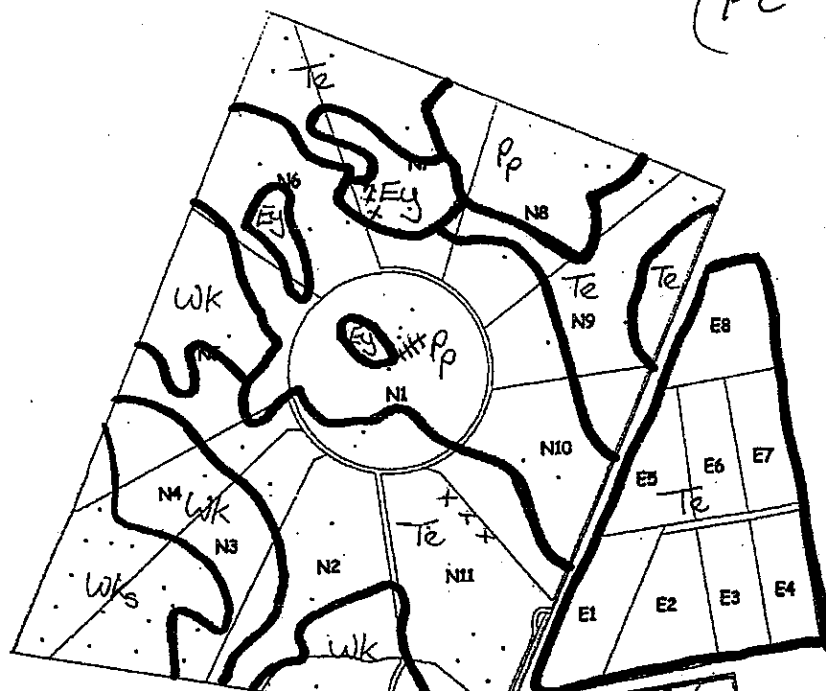
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Data Cow Sheds

**LINCOLN UNIVERSITY DAIRY FARM
PRELIMINARY SOIL MAP**

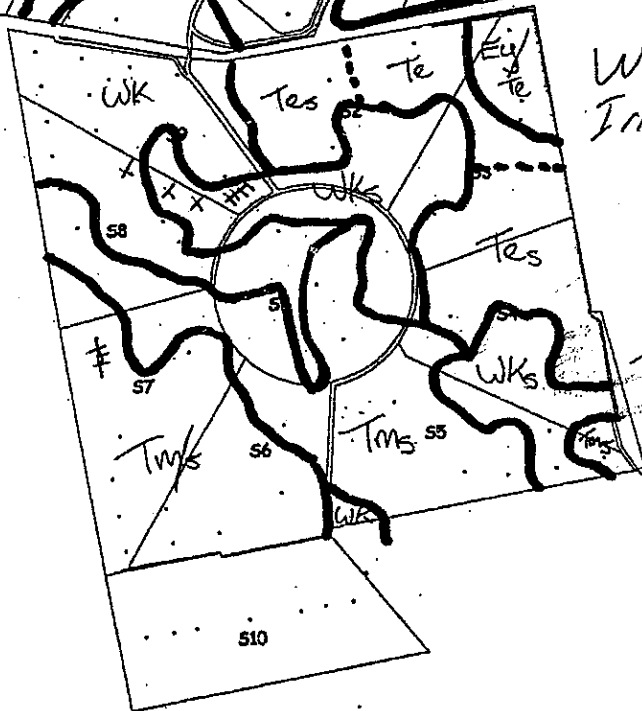
*Pp and Te soils
Irrigate at 27%
(FC = 32%)*

*x-Neutron probes
Aquaflex*

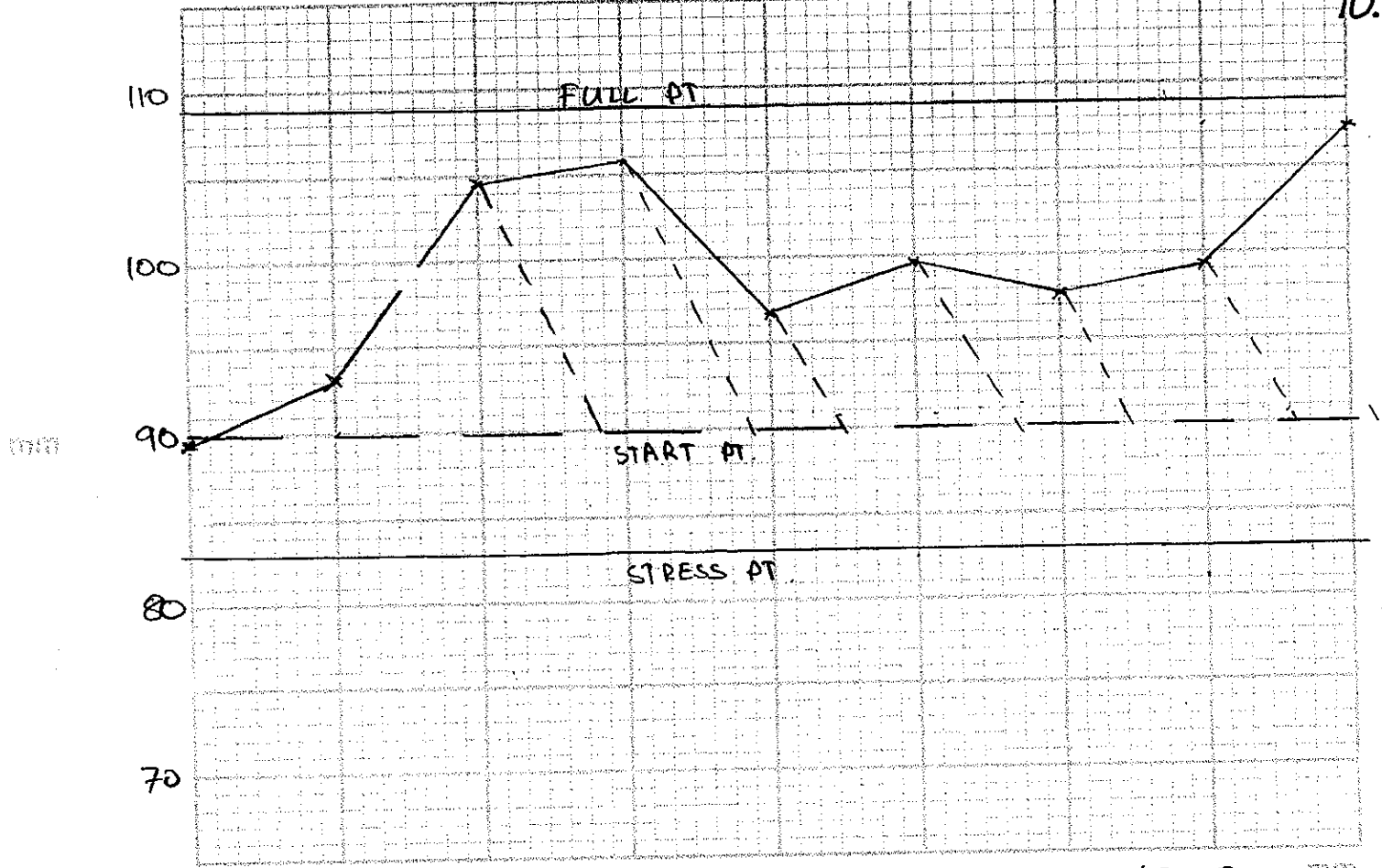


*Wk soils
Irrigate at 30%*

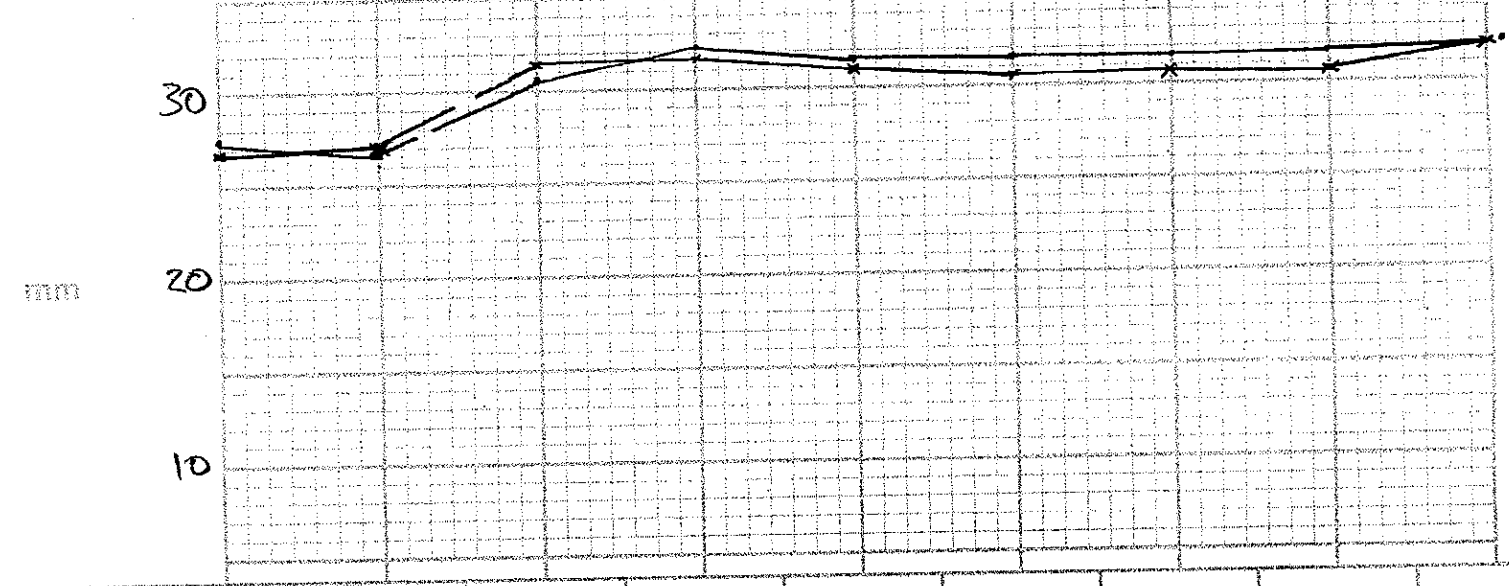
- Ey=Eyre (light, stony soil)
- Pp=Paparua (free draining sandy soil)
- Te=Templeton (same as Pp)
- Wk=Wakanui (heavy soil, slow draining)
- Wks=Wakanui slow (same as Wk)
- Tm=Temuka (very heavy soil, very poor draining)
- Tms=Temuka slow (same as Tm)
- Tes=Templeton slow (sandy soil with slower drainage)



*Tm
Irrigate at 37%*



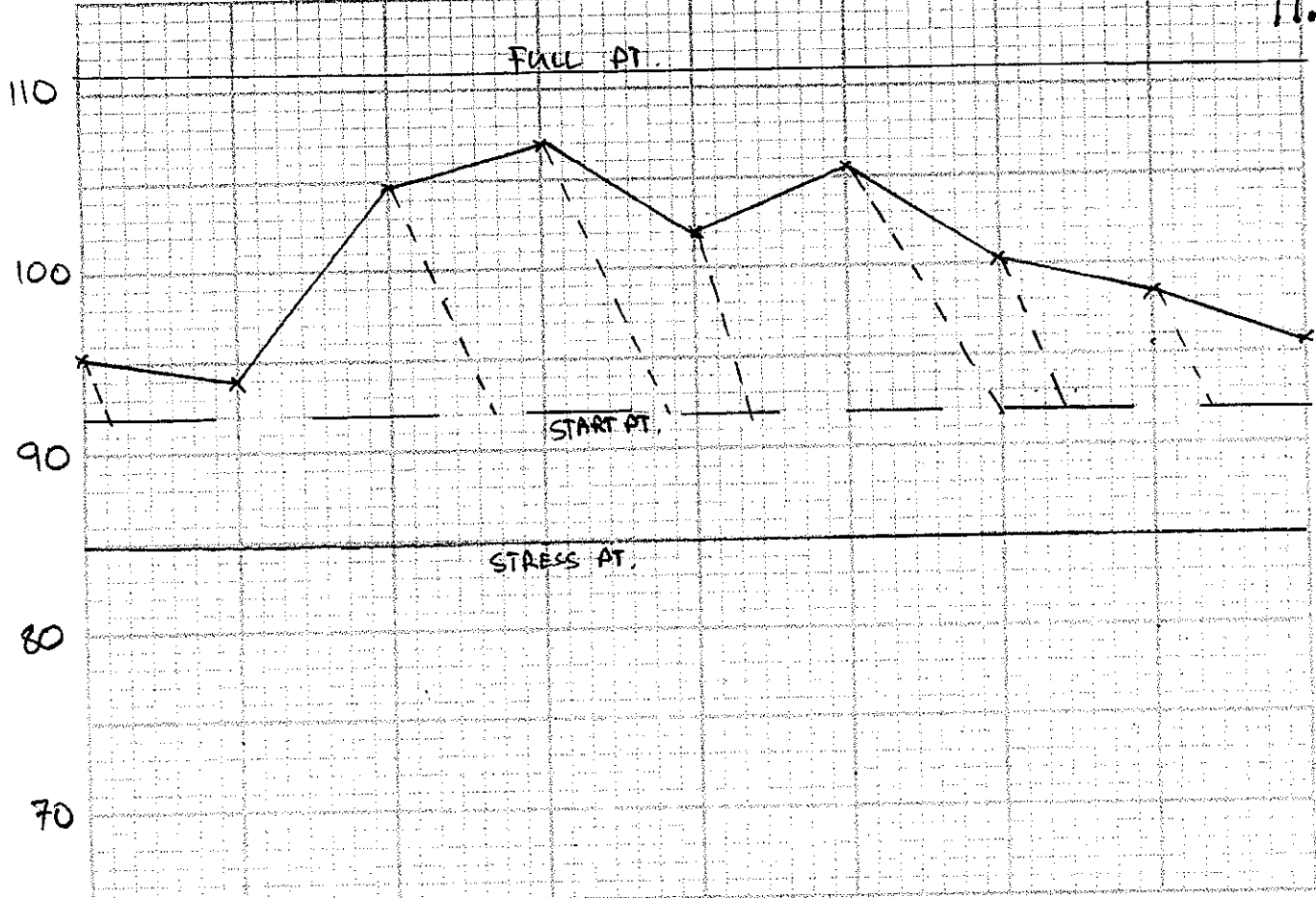
Soil Layers: _____ = 300-400 mm, _____ = 400-500 mm



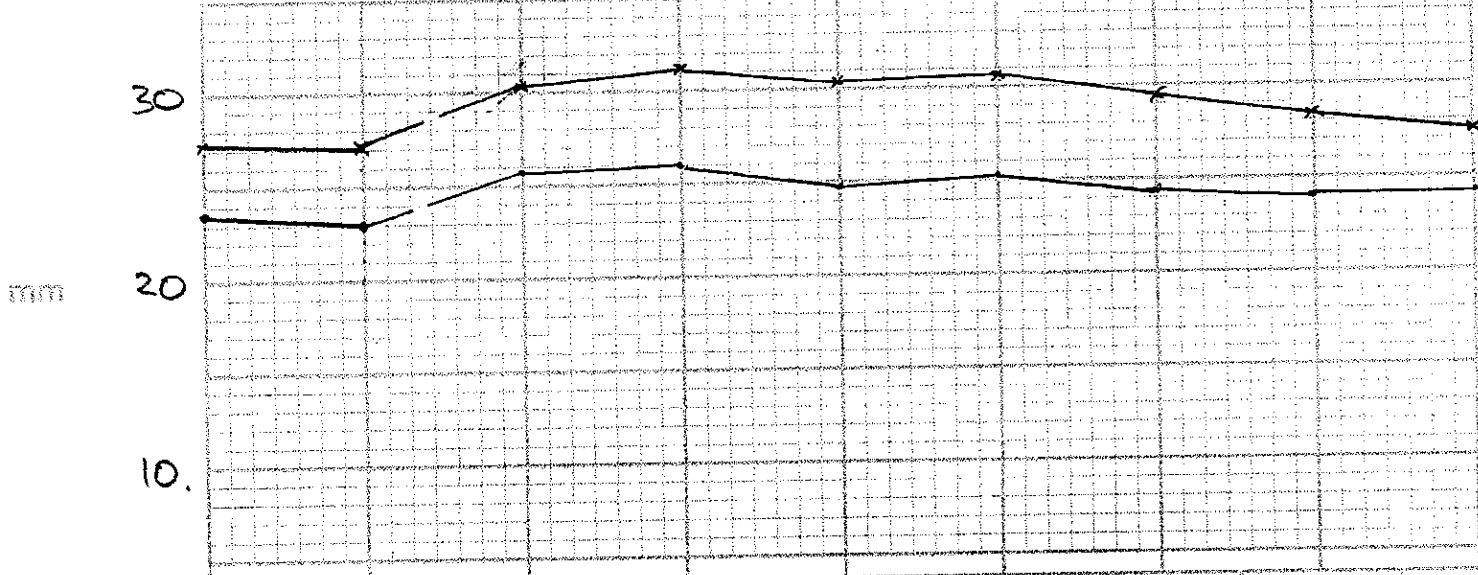
Date	11-12-06	18-12-06	27-12-06	03-01-07	08-01-07	15-01-07	22-01-07	29-01-07	06-02
Rain									
Irrigation		5x6mm							
Water use	3mm/DAY				2mm/DAY	2mm/DAY	2.3mm/DAY	2.2mm/DAY	
Next Irrig.	ASAP		Start in 6 DAYS	START IN 6 DAYS	START IN 3 DAYS	Start in 5 DAYS	Start in 3 DAYS	Start in 4 DAYS	Start: DAYS
Amount	12mm/wk	5x6mm)	5x6mm/	5x6mm/	5x6mm/	5x6mm/	5x6mm/	30mm/wk	30mm
Comment		WEEK.	week	week.	week	week.	week.		

Soil - Wakanui Deep Clay Site/Cron SB + pasture

Critical Root Zone: 0 - 300 mm

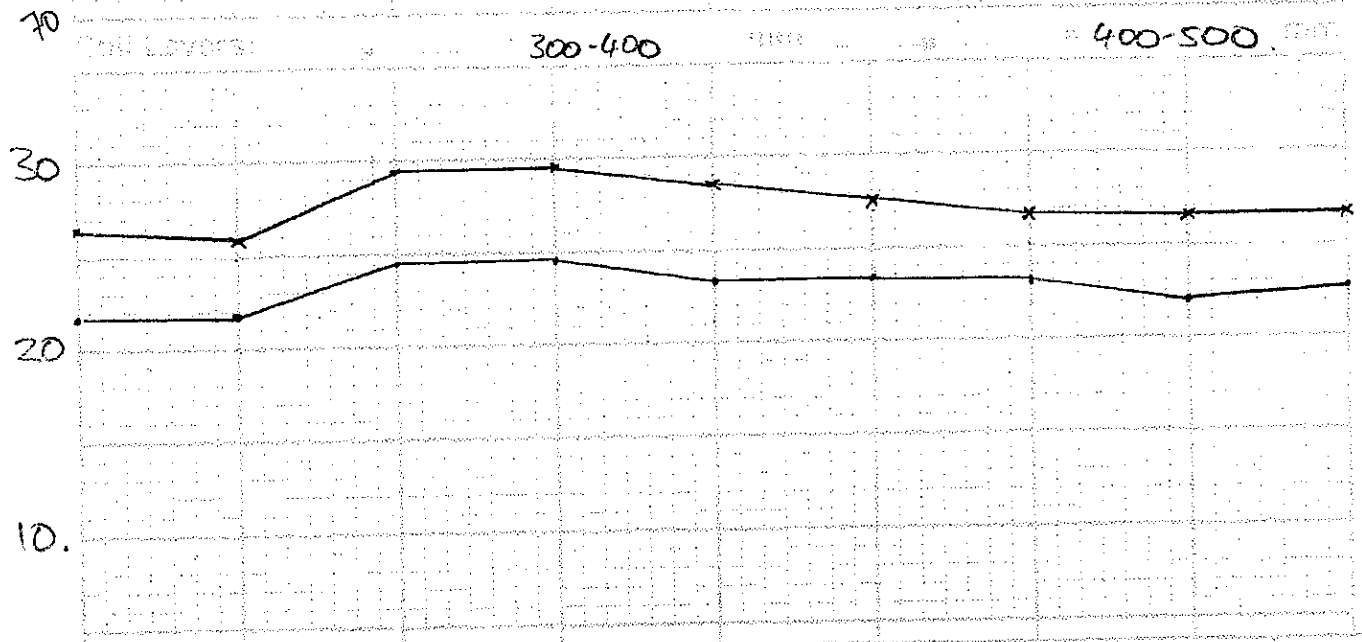
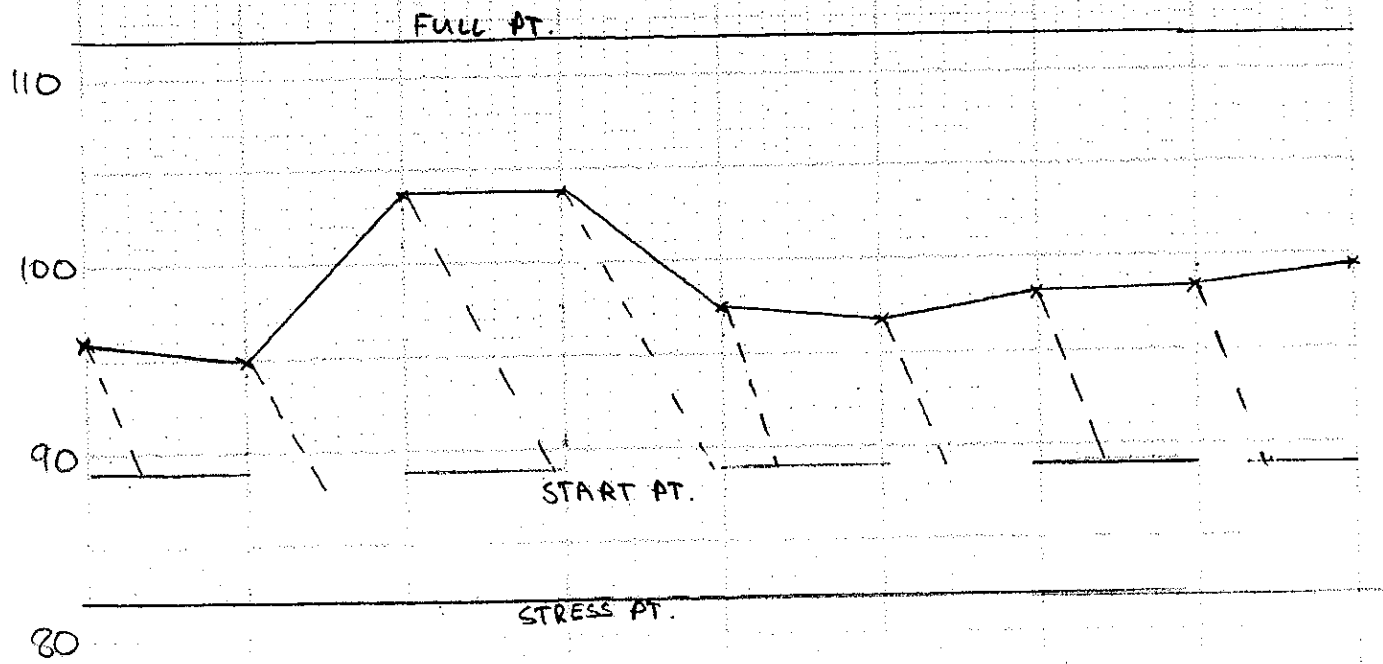


Soil Layers: = 300-400 mm = 400-500 mm



Date	11-12-06	18-12-06	27-12-06	03-01-07	08-01-07	15-01-07	22-01-07	29-01-07	06-02-
Rain		11							
Irrigation		5x6mm							
Water use	3mm/DAY				4.4mm/DAY	2mm/DAY	3mm/DAY	3mm/DAY	3mm/DAY
Next irrig.	Start in 1 DAY		Start in 5 days	START IN 6 DAYS	START IN 2 DAYS	Start in 7 DAYS	Start in 3 DAYS	start in 3 DAYS	1-2 DI
Amount	18mm/wk	5x6mm/ WEEK.	5x6mm/ week.	5x6mm/ week.	5x6mm/ week.	20mm/wk	20mm/wk	20mm/wk	20mm
Comment									

Paddock N7 Pasture Soil Eyre Shallow



Date	11-12-06	18-12-06	27-12-06	03-01-07	08-01-07	15-01-07	22-01-07	29-01-07	06-02
Rain		11.							
Irrigation		4x6mm							
Water use	3mm/day				3.8mm/day	3mm/day	3.02mm/day	3mm/day	3mm/c
Next Irri.	Start in 2 DAYS	SAME AGAIN	START IN 7 DAYS	START IN 7 DAYS	START IN 2 DAYS	Start in 3 DAYS	start in 3 DAYS	Start in 3 DAYS	SAN
Amount	12mm/wk	4x6mm	12mm/wk	26mm/wk	24mm/wk	24mm/week	24mm/wk	24mm/wk	AS L WEL
Comment				= 4x6mm/week.	= 4x6mm/week	= 4x6mm/week.	= 4x6mm/week		

Soil Templeton Deep

01/10/06 1/11 Pasture

DAIRY IRRIGATION UNIFORMITY

Can the system do the job well?
Is management as good as it could be?



PAGEBLOOMER
making useful things happen

Centre pivot assessment

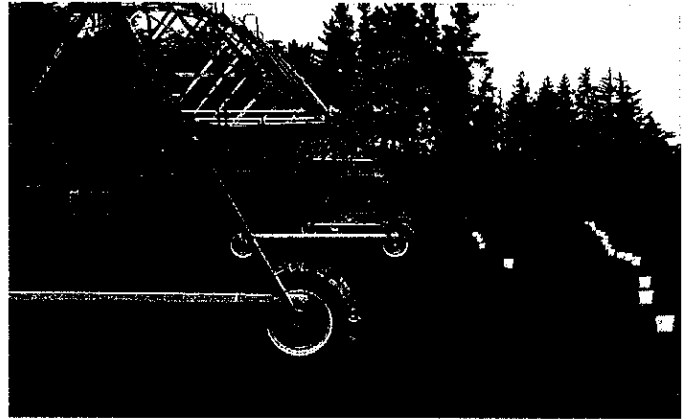
Check pump, inlet and end pressures (before and after regs)

Measure speed at end wheels, visual checks

Catch irrigation in 2 lines of ~40 collectors radiating from centre

Account for outer parts irrigating higher percentage

Determine depth applied, uniformity, application rates



Rotary boom assessment

Determine lane spacing and wetting widths

3 lines of ~30 collectors across path; beginning, middle and end

Account for overlap from adjacent runs

Measure speed at each transect

Determine depth applied, uniformity, application rates



Multiple lateral sprayline assessment

Determine shift spacing and wetting widths

Grid of ~90 collectors between three sprinklers

Account for overlap from adjacent runs

Measure pressures beginning, middle and end

Determine depth applied, uniformity, application rates



Irrigation manager assessment

Get normal practice info – timing and depth applied

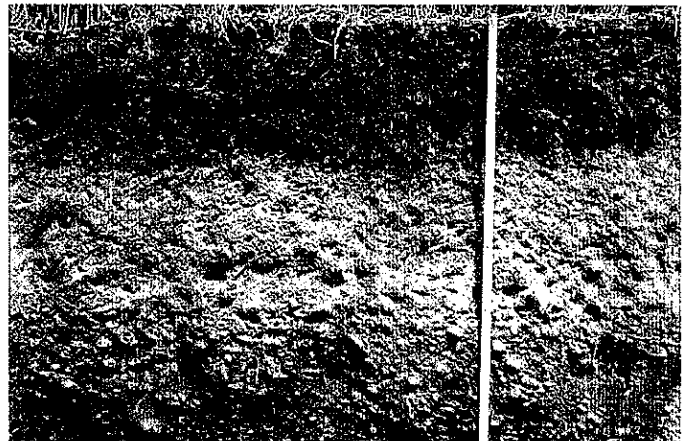
Estimate potential water use

Develop soil moisture budget based on soil type

Assess other practices – maintenance etc

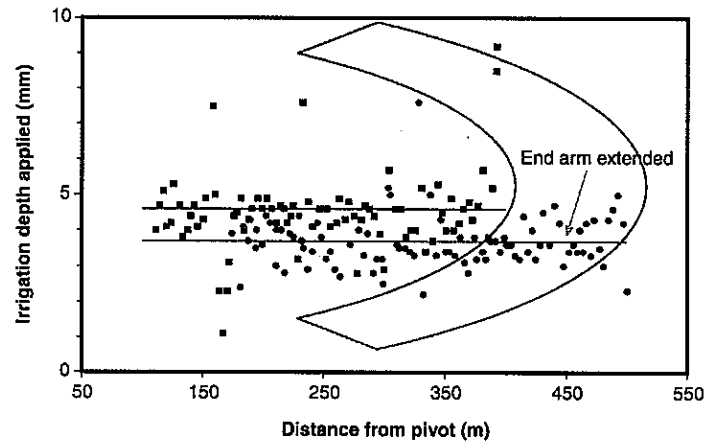
Provide information on ways to improve performance

Grow more grass, use less water/kg, reduce costs



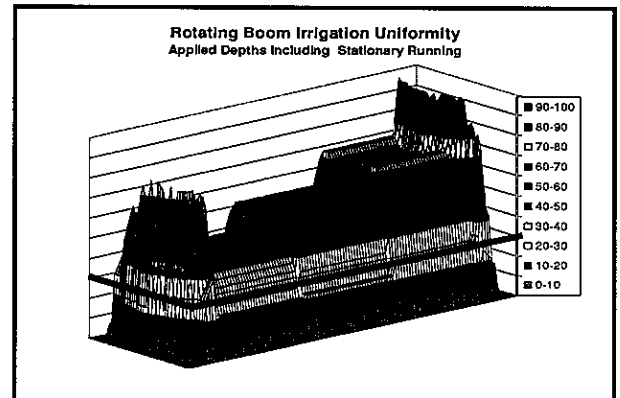
Centre pivot performance

- Performance isn't always what the machine says
- Centre pivot corner arms can affect overall performance
- End arms use far more water per metre of machine length
- Pump capacity must provide flow and pressure to end
- Watch performance at towers if dry wheel packs fitted
- More sprinklers generally means better performance



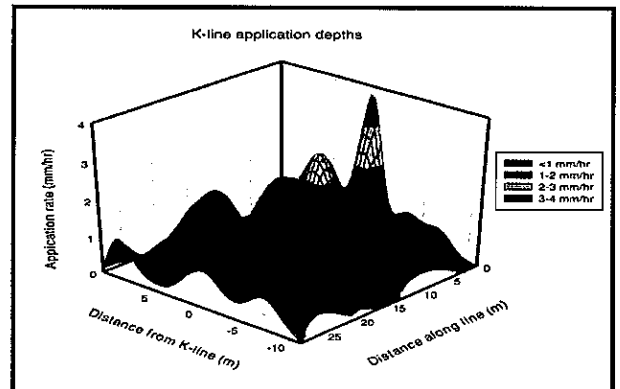
Rotary boom performance

- All travelling irrigators need correct lane spacings
- Wind conditions can have significant effects on performance
- Maintain stable machine speed for the entire run
- Do not leave irrigators running at the ends for long periods
- Over-watering and over-long return intervals are common
- Plan speeds to give required depth, not set run time



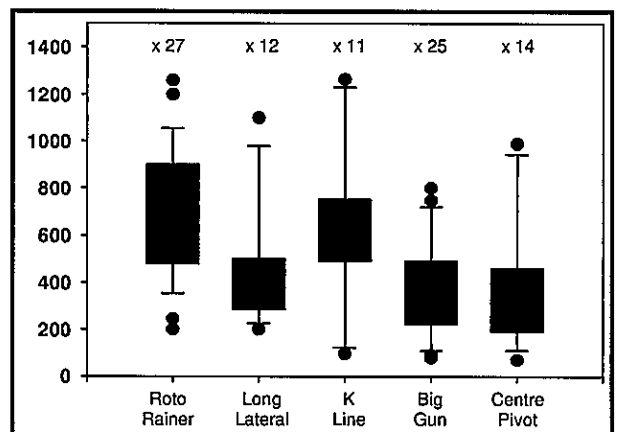
Multiple lateral sprayline performance

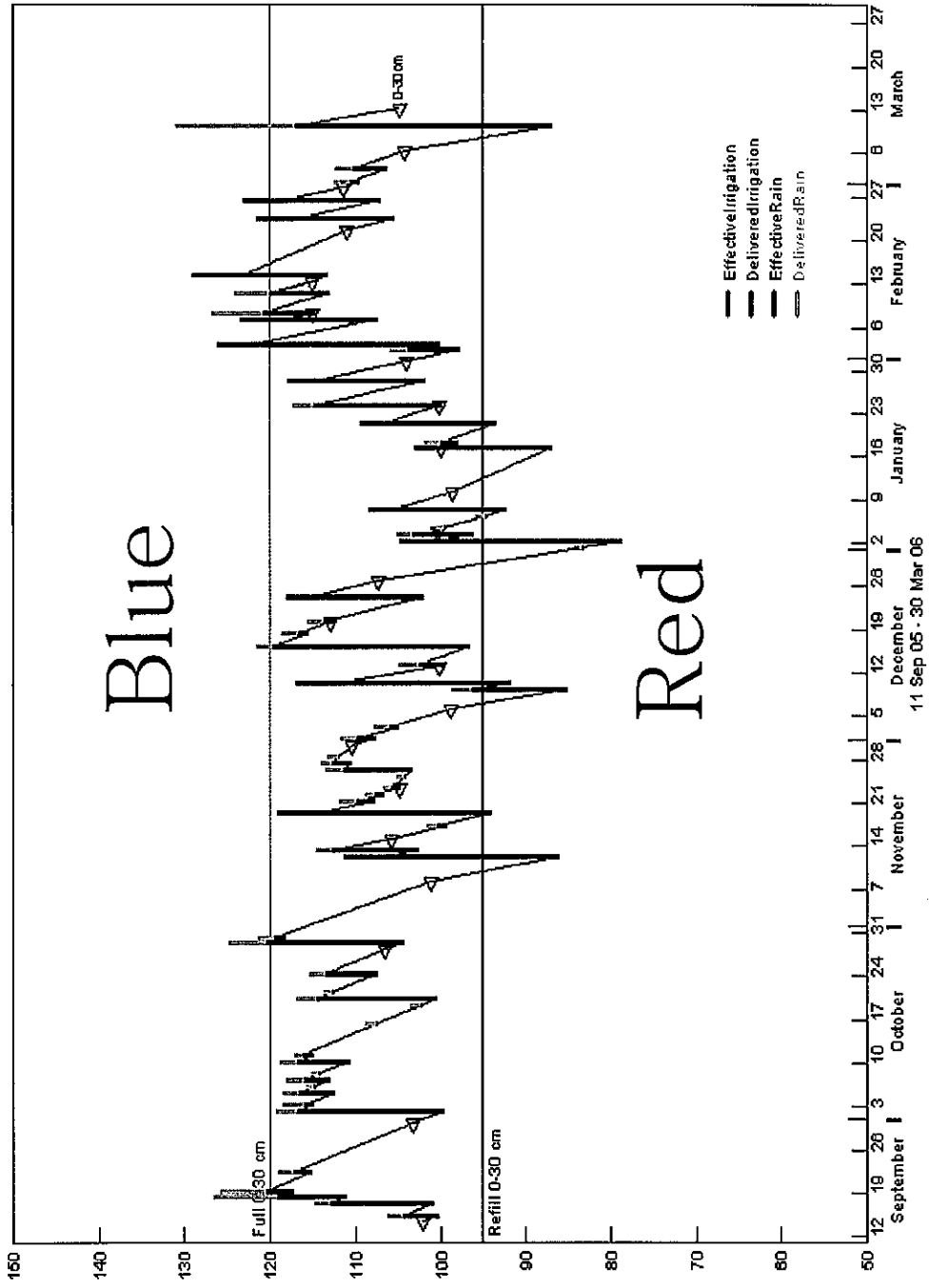
- Field uniformity combines grid pattern & sprinkler flows
- Wind causes considerable variation – not always bad
- Wide variability in applied depths using these systems
- Use best possible sprinklers, ensure pressures are even
- Ensure laterals are positioned in different places each time
- Apply half as much, twice as often – but 2 x labour



Irrigation manager performance

- 450 dairy farms surveyed, 135 responses analysed
- How much irrigation do you apply? How often?
- ⇒ Huge range in water use <math>< 100\text{mm}</math>, >1200mm
- Poor records, limited understanding of scheduling
- Plan irrigation around milking programme?





IRRIGATION MANAGEMENT

- **YOU have control of this**
- **How you manage your system effects**
 - **Grass Production**
 - **Power Bill**
 - **Fertiliser Bill**
 - **Wages Bill**
 - **Resource Consent Compliance**
- **You Need to be in the “white”**
- **If you are in the blue then**
 - **High power bill**
 - **High fertiliser bill**
 - **Breaching your resource consent**
- **If you are in the red then**
 - **Grass production will be down**
 - **Milk production will be down**
- **For good management you need to**
 - **Measure rainfall**
 - **Know your system**
 - **Measure soil moisture**
 - **Match soil moisture deficit with application depth + allowance for system uniformity**

A 'Warrant of Fitness' for Irrigated Agriculture

Claire Mulcock (Mulgor Consulting Ltd)

WHY?

- Want to be able to show that irrigated agriculture can be environmentally sustainable
- Objective is
 - Profitable farmers
 - Sustainable systems
 - Healthy environments

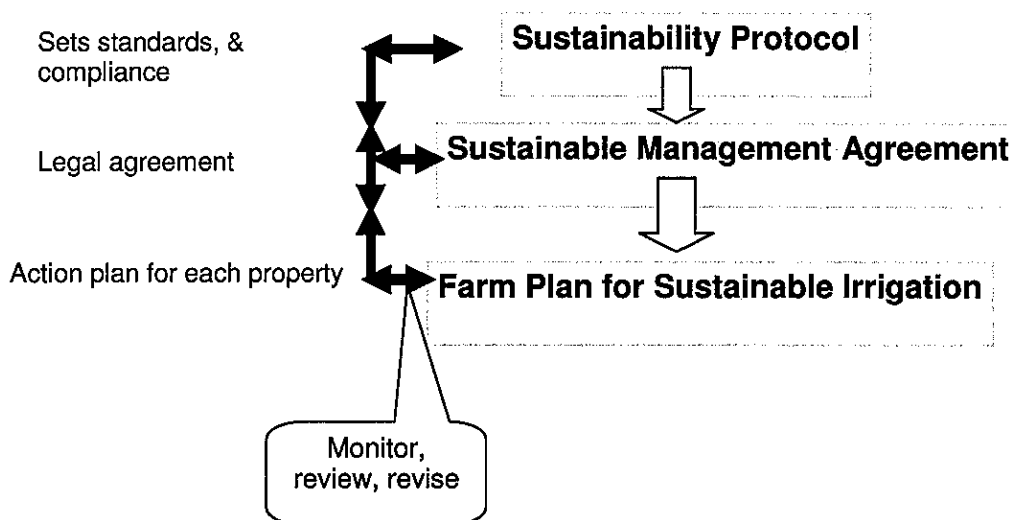
Background

- Farmers and irrigation schemes are under increasing pressure to demonstrate effective environmental management
- Regulators will impose consent conditions, but industry can be pro-active to get practical solutions
- Environmental groups believe that new irrigation means more environmental problems
- New schemes are required to demonstrate how they will manage environmental effects

Why 'WOF'?

- Standards – set to protect water user, wider community & environment
- Responsibilities – to meet standards; be audited
- Leadership – setting standards & compliance procedures

Irrigation Scheme WOF



Irrigation Scheme WOF

Farm Plan for Sustainable Irrigation

- Use existing codes e.g. Fertiliser CoP, Irrigator Design, ECAN stream planting, Spreadmark
- Best practices become normal practices
- Covers matters relevant to irrigation and environmental management
- Doesn't include e.g. animal welfare, business management, rubbish disposal, air pollution, sector specific q.a. (E.g Fonterra "Market focussed" programme)

Farm Plan

- Keep it simple (and short)
 - Don't have (yet) straight forward methods to monitor all troublesome effects at farm level (or in short term) (e.g. N leaching to groundwater)
 - Uses Best Practice approach to minimise environmental risks.
 - Focus on self-management, with an audit process
-
- Builds on the Farm Plans that North Otago Irrigation Co have developed as part of the requirements of their consent conditions

Summary of Key Environmental Concerns re Irrigated Agriculture and Best Management Practices to avoid or mitigate problems

Activity	Key environmental concerns/ Potential impacts	Examples of Best Management Practices
Irrigation management	<p>Wasteful use of water e.g.</p> <ul style="list-style-type: none"> • irrigation during/after rainfall • ponding of irrigation water • inefficient application • drainage to other properties 	<p>Use INZ code of practice for design Use INZ evaluation code Schedule & apply water taking into account: crop type, soil type, rainfall etc</p>
Soil management	<ul style="list-style-type: none"> • Soil compaction / pugging • Soil erosion • Soil health problems • Soil contamination 	<p>Avoid stock pugging – use stand off pads or 'sacrifice' paddock Use shelter planting & reduced tillage to avoid wind erosion Avoid irrigation during or after heavy rainfall to minimise erosion Use only FertMark certified fertilisers to avoid soil contamination</p>
Nutrient management	<ul style="list-style-type: none"> • Fertiliser getting into ground & surface waterways • Runoff and leaching of stock effluent from paddocks into water ways (including through tile drains) 	<p>Follow the NZ code of Practice for Fertiliser Use Use soil test results to plan fertiliser needs Use Nutrient budgeting & nutrient management Manage fertiliser applications e.g. to avoid waterways, timing re crop needs, rainfall etc.</p>
Collected animal effluent management	<p>Contamination of ground & surface water during disposal of collected animal effluent (e.g. dairy shed or piggery waste)</p>	<p>Preparing an effluent disposal plan, including spillage management including nutrients from effluent in nutrient budget and management</p>
Riparian management	<ul style="list-style-type: none"> • Damage to stream banks. • Nutrient and faecal contamination of waterways • Sediment 	<p>Stock management, including fencing to keep stock from waterways Crop management, including buffer zone around waterway. Stream bank planting</p>
Biodiversity & Ecosystem management	<ul style="list-style-type: none"> • Loss of native plants and animals and their habitats; • Loss of ecosystem diversity • Soil health problems 	<p>Protect existing habitats (e.g. wetlands) as an integral part of farm management Plantings (native & exotic) to support ecosystem diversity</p>
Pesticides/Agrichemical management	<p>Contamination of ground or surface water</p>	<p>Follow 'Grow Safe' protocols; ensure all staff are trained Store chemicals safely Apply chemicals to avoid contamination of surface water or into groundwater</p>
Energy management	<p>Wasteful use of energy</p> <ul style="list-style-type: none"> • Electricity • Diesel • Petrol 	<p>Design on-farm infrastructure for energy efficiency (INZ CoP) Driver education and awareness re machinery use Use reduced tillage where appropriate</p>

Irrigation Management

Our objective for best practice irrigation management is to use water efficiently, minimising runoff and drainage.

The problems that we will avoid, remedy or mitigate include:

- Wasteful use of water e.g.
- irrigation during/after rainfall, or when significant rain is forecast
- ponding of irrigation water
- inefficient application
- drainage to other properties

We undertake to comply with NSI Ltd's specific requirements relating to irrigation management which include:

NSI LtdL requirements	Checklist	
	Yes	No
Compliance with Regional Council conditions relating to the supply of water to NSI Ltd (Appendix 1)		
All new on-farm irrigation infrastructure to be designed by an accredited designer (as per INZ CoP) to meet scheme KPIs (Appendix 2)		
Prior to receiving scheme water, existing irrigators to report to NSI Ltd on their performance with respect to irrigation efficiency KPIs (Appendix 3), including timelines for upgrades if required.		

In addition we will implement our own policies and procedures for best practice irrigation including:

To achieve best practice irrigation we will:	Checklist	
	Yes	No
Apply irrigation water at rates equal to or lower than soil moisture holding capacity of the soil ¹ .		
Plan & schedule irrigation so that it is applied according to evapotranspiration, rainfall and soil moisture status ² .		
Match application rate to crop or pasture being grown as far as possible, according to the capability of our system		
Avoid ponding of irrigation water, as far as possible		
Avoid drainage of irrigation water to adjacent properties or to groundwater		

Self Assessment

Does my management achieve the objectives above?

Yes Objectives achieved No Please fill out table below

List actions required	Person responsible	Timeframe for completion	Completion date

Verification

The information provided is verified as correct.

Signature

Date

¹ Need to provide info on how this can be measured/validated
² As above



Challenges

- Simple but effective
- Adaptable, but fair
- Acceptable to regulators
- Demonstrate that irrigators are good environmental managers (not just do it!)
- Want to avoid controls on farm inputs e.g. fertiliser, stock limitations
- Improve urban understanding of irrigated agriculture

Acknowledgements

This project is funded by

- Sustainable Farming Fund
- Central Plains Water Ltd
- The Ritso Society Inc. (www.ritso.org.nz)

INSTALLATION


Installation of your flow meter in accordance with the manufacturer's specifications is necessary for your meter to be as accurate as its claims. Good installations leave sufficient straight length of pipe between gate valves, elbows etc and the flow meter to ensure that there is no turbulence in the water passing through the meter. Turbulence reduces the accuracy of water meters.


GOOD INSTALLATION


Meters installed with sufficient distance between the meter and upstream and downstream sources of turbulence, such as elbows and valves, in accordance with the manufacturer's specifications.



BAD INSTALLATIONS

- 

1. Meter too close to elbow.
- 

2. Meter too close to flange and gate valve, and insufficient straight length of pipe.
- 

3. Meter too close to control valve and gate valve.

ENVIRONMENT CANTERBURY'S FLOWMETER REQUIREMENTS

- Under field conditions the flowmeter must have an accuracy of +/- 5%. In order to achieve this accuracy we recommend that each flowmeter shall be documented with a wet calibration carried out under laboratory conditions demonstrating an accuracy of at least +/- 2%.
- The wet test should be only undertaken in a laboratory that is accredited by IANZ (International Accreditation New Zealand) or one of the organisations recognised by IANZ worldwide through mutual recognition arrangements.
- A detailed plan of the installed meter and distances to any potential turbulence sources (eg elbows, valves etc) shall be submitted to Environment Canterbury within 30 working days of the installation by the person responsible for the installation, or a competent person, to certify that the flowmeter has been installed to the manufacturer's specifications.
- The flowmeter shall be tamper-proof, or where unauthorized interference can occur, it should be easily detectable.
- The flowmeter should be simple to operate and read, and provide flow data as both instantaneous rates and/or totalized volume with provision for remote interrogation and/or transmission of data.

ENVIRONMENT CANTERBURY'S DATA LOGGING REQUIREMENTS

- The datalogger must provide over 12 months worth of data logging at 60-minute intervals.
- The datalogger must be a tamper-proof recording device or be able to record tampering if it should occur.
- Water use information from the datalogger in its raw form (ie a .dat file) must be submitted to ECan at the completion of each irrigation season.
- Alternatively, you can use a telemetered data logger which gives you real time information and saves having to manually download the data yourself.

Information in this pamphlet is based on "Know the Flow - Flow Metering Training Manual" by the Australian National Committee on Irrigation and Drainage 2002.

Flowmeters

Systems and requirements explained

CUSTOMER SERVICES

(03) 353-9007
or 0900 EC INFO
(0800 324 636)

CHRISTCHURCH

58 Kilmore Street
PO Box 345 Christchurch
Phone (03) 353-9007
Fax (03) 365-3194

KAIKOURA

Beach Road
PO Box 59 Kaikoura
Phone (03) 319-5761
Fax (03) 319-5809

TIMARU

75 Church Street
PO Box 559 Timaru
Phone (03) 684-0300
Fax (03) 684-0305



**Environment
Canterbury**
Working for a better future



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Canterbury**
Working for a better future

SELECTING A FLOW METER

There are a number of parameters to consider when deciding on what type of flow meter to choose for a particular job.

WATER SOURCE – This could be a river, surface water, groundwater, open channel or pressurized pipe. Water source will have a bearing on water quality (silt, weed etc), range of flow rates and head.

HEAD – How much head do you have? Do water levels fluctuate during a season? If so by how much? What is the minimum head a meter needs to work? Do you need to minimize head loss?

FLOW RANGE – What is the flow range throughout the year and what are the fluctuations in flow? Most meters have a minimum flow below which they cannot provide an accurate reading. If you choose a large meter, you may lose accuracy at the lower end of the flow range. Meters continually operated in the high flow range wear out and fail much quicker than meters that operate in the middle of their flow range.

ACCESS TO POWER – When selecting meters for remote locations you will need to consider if they can run accurately on solar power, batteries or even need power at all. This also applies to dataloggers.

ACCURACY – If there is a requirement for a data accuracy of 2% then it would not be useful to choose a meter that only reads with accuracy of 5%. A manufacturer's claims for meter accuracy are usually well substantiated by laboratory tests supplemented by standardized field tests. A meter will only be accurate if the metering situation meets all the manufacturer's requirements of flow profile, temperature, humidity, flow range, vibration etc.

RELIABILITY – A meter needs to be reliably accurate so it provides the correct reading time after time.

DATA OUTPUT – What level of data accuracy do you need? What units do you need your data in? Does the data need to

be a measure of instantaneous flow, totalized flow or both? Does the data need smoothing or integration?

TAMPER-PROOF – Meters can be buried and some manufacturers provide special containers for just this purpose. Access to the meter can then become a problem.

LONGEVITY – What is the average operating life before overhaul? This will be dependent on the meter type and the situation the meter is used in.

COST – One of the most crucial parameters is cost. Generally, the more accurate and reliable the meter, the more expensive it is. But, purchase price is not the only cost. Other aspects should be considered such as the cost of installation, maintenance, data collection, calibration and longevity.

MECHANICAL INSERT METER

An impeller is rotated by water passing through the meter, which is translated to a volumetric reading. The mechanism is calibrated by an adjustable device which is pre-set and security sealed. The meters are available in various sizes and have to be full of water during measuring.

Advantages

- Reliable and accurate means of measurement providing the meter is correctly installed.
- Relatively low initial cost.
- In-line maintenance with simple efficient mechanism.
- Headworks replacement readily available.

Disadvantages

- Difficult to detect malfunction or unauthorised interference to meter while operating, if operated without a datalogger.
- Prone to wear in silty water, potentially resulting in loss of accuracy.
- Some head loss characteristics.



SPECIFICATIONS

	ELECTROMAGNETIC FLOWMETER	MECHANICAL INSERT METER (PADDLE OR TURBINE)	ULTRASONIC FLOWMETER
Accuracy (laboratory)	+/- 0.15% - 2%	+/- 2% - 5% of rate	Better than +/- 2%
Reliability and tamperproof protection	Very high	Medium	High
Flow rate indication available	Yes	Yes - with datalogger attached	Yes
Remote reading capability	Yes	Optional	Yes
Average operating life before overhaul (depending on water quality)	20 years	4 years	15 years
Pressure loss (head loss)	Negligible	400mm insertion type meter Negligible (paddle type meter)	Negligible
Resistance to blockage	Very high	Medium	Very high
Resistance to weed	High	Medium	High
Relative installed cost	Medium	Medium	Low
Power required	Yes or solar battery	No	Yes or Solar
Water quality	Can cope with silty water	Prone to wear with continued exposure to silty water	Can cope with silty water

Please note: The above table is a guide only, based on general information and manufacturer's literature where available. Contact the manufacturer for complete details.

ELECTROMAGNETIC METER

An electromagnetic meter consists of a section of pipe with a magnetic field around it and electrodes to detect electrical voltage changes. When a conductive fluid passes through the pipe an electrical voltage is created in the fluid, which is proportional to the fluid velocity. Electrodes in the probe detect the voltages generated by the flowing water. Measurement of the voltage is then converted to velocity from which the flow rate can be derived for a given pipe section. This type of meter is produced in a range of standard sizes and flow capacities.

Advantages

- High degree of accuracy (+/- 0.15% - 2%) and consistent over full flow range.
- Wide flow range and no obstructions to flow.
- Robust with only minimal routine maintenance required.
- No moving parts.

Disadvantages

- Power supply required.
- Electronic components vulnerable to lightning damage.
- Repairs require skilled technician and specialized equipment.



ULTRASONIC METERS

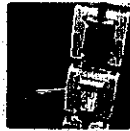
Ultrasonic meters use transducers to measure water velocity in full pipe applications and convert this to a flow rate. Transducers are fixed on the outside of the pipe and a transit time method is used to calculate the velocity of water within the pipe. The transit time method calculates velocity from the differences in time for an impulse to pass between two transducers located on the outside of the pipe.

Advantages

- Robust with minimal routine maintenance required.
- Simple to install and no moving parts.
- Same meter can be used in a wide range of pipe sizes.
- Consistent over full flow range.

Disadvantages

- Repairs require skilled technician and specialized equipment.
- Power supply required.
- Electronic components vulnerable to lightning damage.



Water in pasture out - Realising the Gains.

Steve Thomas and Dick Martin, Crop & Food Research

Introduction

Are you getting the most out of your irrigation?

Can you save on irrigation costs?

How much more can you produce from your irrigation?

What is your potential pasture production under irrigation?

- Measured at 18,000 kg/ha/year
- Uses around 900mm of water (including rainfall)
- Pasture water use efficiency (WUE) of 20 kg DM/mm
- Many farmers not achieving 20 kg/mm of water used
- Optimum irrigation strategies will achieve close to the potential pasture production and potential water use.

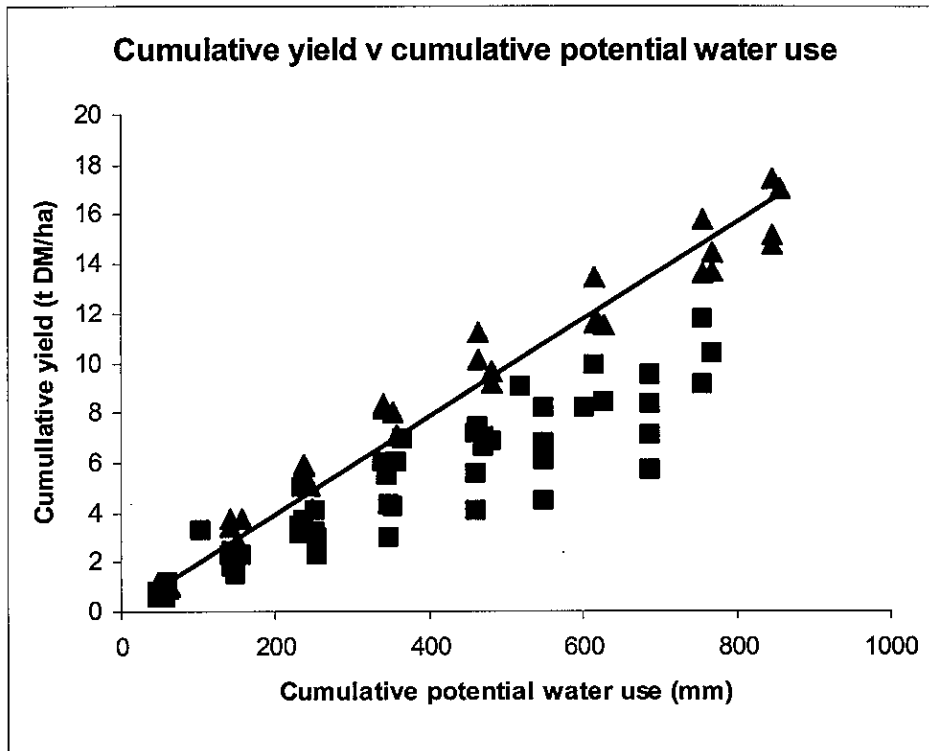


Figure 1. Measured pasture production for a range of irrigated farms plotted against the potential water use for pasture.

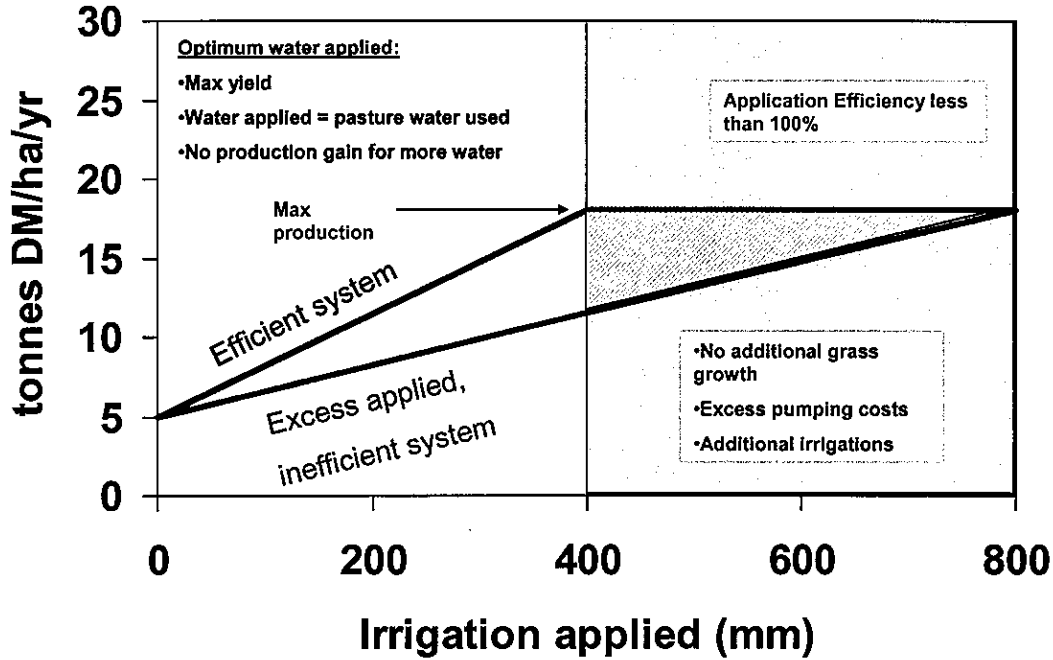
What happens when you are not achieving optimal water use?

- Excess water applied = excess drainage = excess costs
- Lower than potential WUE
- Yields may be lower

Examples:

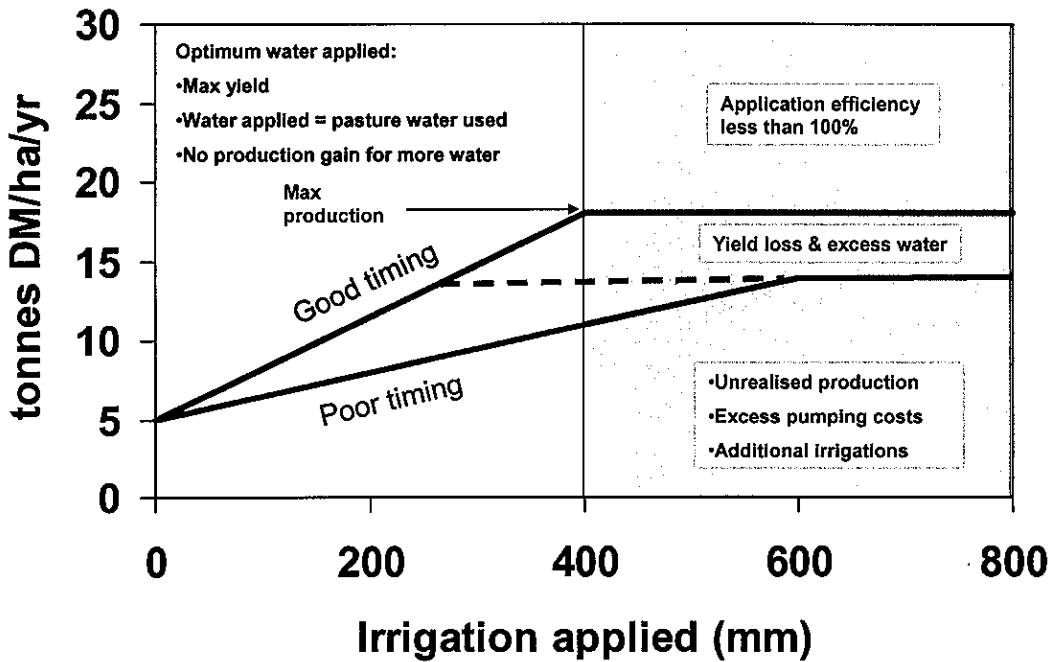
1) Excess application

- May achieve max yield, but uses excess water



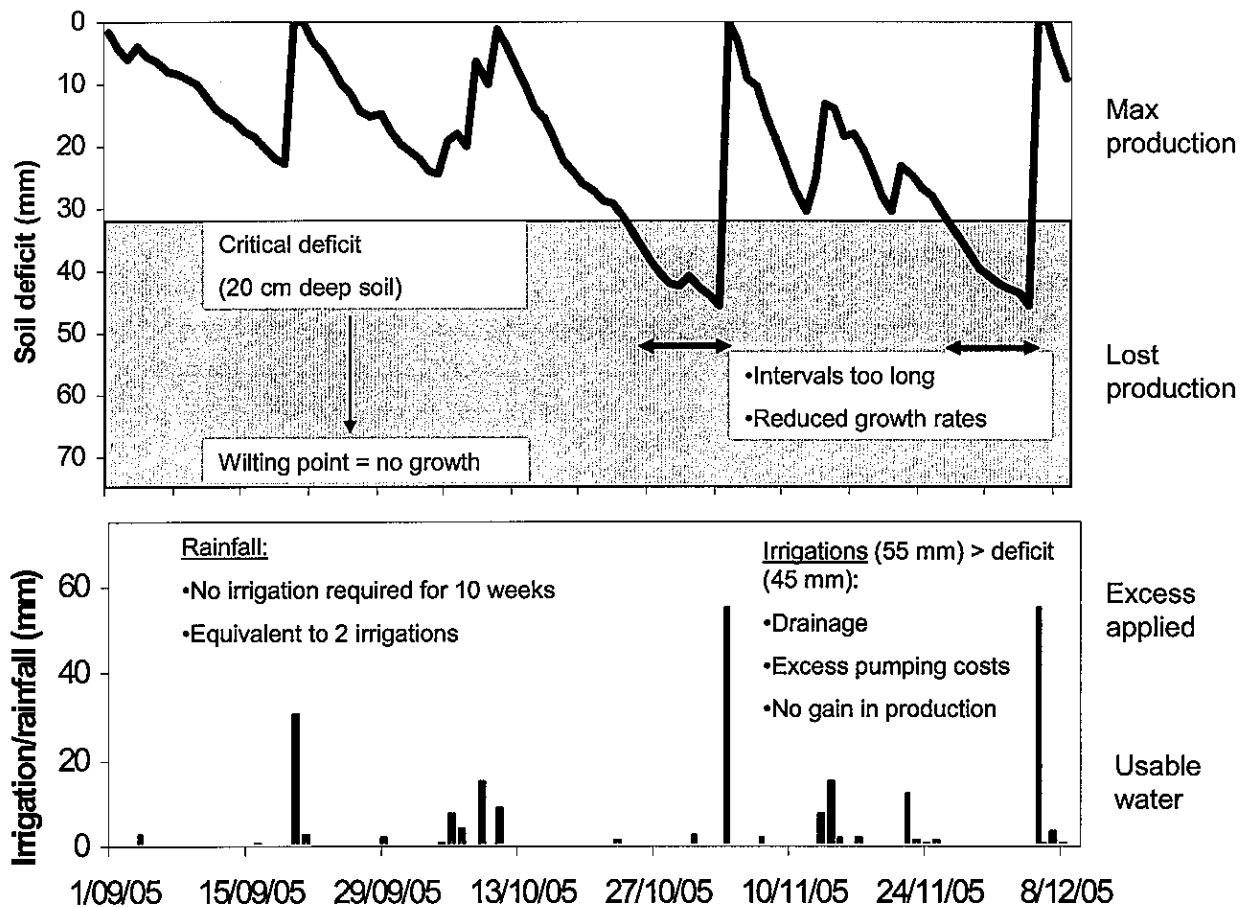
2) Poor scheduling

- Does not achieve max yield and may use excess water



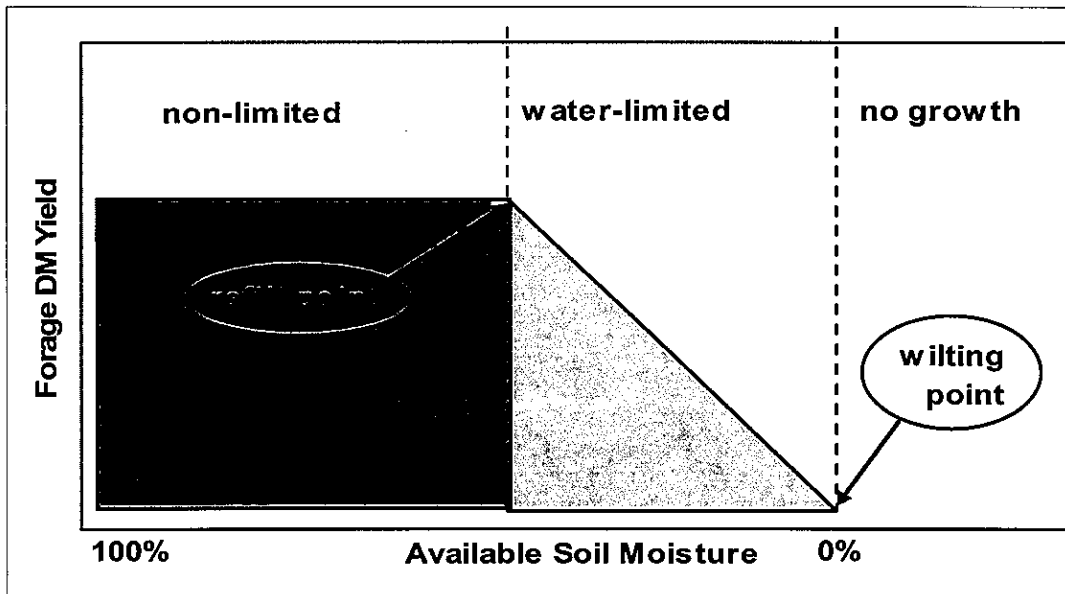
How to achieve optimal water use?

- Schedule irrigation accurately:
 - Know what your trigger point is before you lose yield
 - Know how much your irrigator applies
 - Know when to apply irrigation
 - You can apply too much water! More than the soil can hold.
- Make best use of rainfall. Average rainfall over the season is worth about \$300/ha. Especially important early and late in the season.
- Need a high application distribution uniformity for your system



What is my critical soil water deficit or trigger (or refill) point?

- Yield is depressed below the critical soil water deficit. This yield loss can not be recovered.
- This point can be estimated from the amount of soil water storage which depends primarily on soil depth.



How do you know if you are achieving high water use efficiency?

Need to know:

- How much water you are applying
- How efficiently your system is applying irrigation
- How much pasture you are producing

Irrigation scenarios:

Soil depth – 20 cm (eg shallow Lismore)

Critical soil water deficit = 36 mm

Weather data from September to April 2005-06

Assumes very high application distribution uniformity.

- 1) Optimum irrigation. Variable interval. Fixed application depths (16 mm).
- 2) Optimum irrigation. Variable interval . Larger application depths (30 mm).
- 3) Fixed 14 day rotation. Fixed application depth of 55 mm.
- 4) Irrigations too late. Trigger point (45 mm) is set below the critical deficit (36 mm). Fixed application depth of 55 mm.
- 5) No irrigation

Description	Season DM Production (kg)	MS/ha	Irrigation applied (mm)	Irrigation cost/ha	MS production \$'s	Overall costs - irrigation + lost production
1. Optimum. Low application depth (16mm).	13759	2293	432	\$ 346	\$ 9,631	\$ 346
2. Optimum. Low application depth (30mm).	13759	2293	510	\$ 408	\$ 9,631	\$ 408
3. Fixed 14 day rotation. Fixed application depth.	13295	2216	825	\$ 660	\$ 9,307	\$ 985
4. Late irrigations. Fixed application depth.	11127	1855	330	\$ 264	\$ 7,789	\$ 2,106
5. No irrigation.	4570	762	0	\$ -	\$ 3,199	\$ 6,432

Summary points:

- Flexible systems, able to apply small amounts, can more closely match water supply and demand = less water use.
- Fixed rotation used more water but still may not be able to avoid yield limiting deficits = increase in irrigation costs and yield loss.
- Applying too much water does not recover earlier yield loss.
- Need to know your trigger points to avoid under and over irrigation.
- Poor timing reduces number of irrigations, but greatly reduces yield.
- Poor application uniformity increases costs, reduces production or both.
- Need to know your system application rates and efficiency.

Development of a farm irrigation scheduling tool

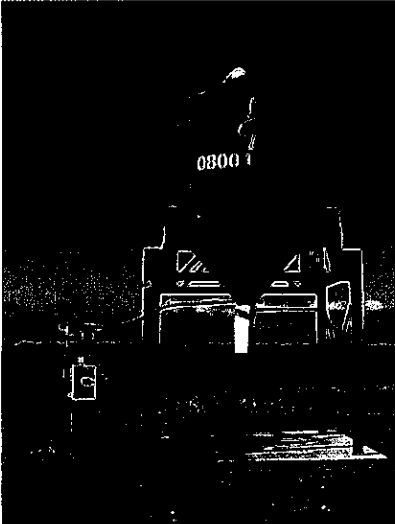
Dairy InSight is funding the development of an irrigation "calculator" to help make on paddock decision for when best to irrigate. The model behind the Calculator was used in the scenario predictions.

Acknowledgement

This work is supported by Dairy InSight and by the Foundation for Research Science and Technology.



Technical Specifications for an Automated “On Farm Urea Mixing and Fertigation System”



There is a tremendous amount of growth in the mechanised irrigation market as farmers try to raise the productivity of their farms, with many farmers installing Pivots and Laterals to irrigate pasture.

Fertigation (the application of nutrients through an irrigation system) or Chemigation (the application of pesticides through an irrigation system) has been around for many years, but its uptake for use on pasture has been slow partly due to the fact the liquid fertilisers/pesticides for use with irrigation systems were expensive.

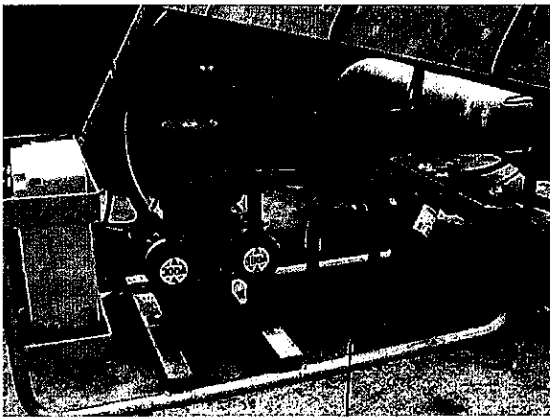
Ravensdown, in collaboration with Dan Cosgrove Ltd, wanted to find a method of applying a solid based fertiliser, by converting it to a liquid able to be used in fertigation. Urea was used for the trial as it is 100% water soluble, and it is used extensively in pasture management.

The solution developed allows the farmer to make a quality liquid Urea solution on farm and apply it as often as required. The system is capable of making up to 1000 litres per hour of 10 - 14 %N solution and apply it at a rate of up to 50 kg N/ha. Higher application rates can be achieved if larger fertigation pumps are installed. This system is therefore capable of supplying enough Nitrogen to cover over 6 Ha per hour at 20 kg N/ha on more than one centre pivot, or 3.5 Ha per hour on one system. Larger mixing and application rates are being considered to suit cropping farmers who wish to apply larger concentrations of Nitrogen in a shorter time frame.

The system Ravensdown and Dan Cosgrove Ltd have developed consists of a Urea Silo, Urea mixing system, and fertigation delivery system.

- The **14 Tonne Urea silo** is leased by the farmer and will be re-supplied via blower truck. The Urea silo will be sighted at a central location and requires good road access. The height of the silo and frame will in most cases mean that the silo must be sighted on the outside of the arc of the centre pivot as the Silo is over 7.0 metres tall when installed. The silo is installed with load cells and is linked to the Urea mixings system control panel.

- Adjacent to the Urea Silo is the **Urea Mixing System. (Pat No. 529386)**. The system is fully automated requiring no intervention from the farmer (other than starting at the beginning of the season and monthly checks). This system will make batches of 1000 litres and will keep the centre fertigation tank(s) full via a centrifugal transfer pump. The Urea mixing system makes batches by feeding in a known weight of Urea (measured using load cells) via a coreless auger into a known volume of water resulting in a 12%N solution. On completion of a batch the process stops until all the liquid urea solution has been discharged via a transfer pump. When the mixing tank is empty the batch process starts again. Strainers in the system prevent un-dissolved urea prills and other insoluble products from blocking the fertigation nozzles. The Mixing system has been developed jointly by Ravensdown and Dan Cosgrove Ltd and has been patented by Dan Cosgrove Ltd.
- A **Transfer pump** pumps the batch of liquid urea through to a central fertigation tank sited at the centre of the centre pivot, or can be designed to supply up to three fertigation systems.
- **The fertigation system** (in most cases) will be sited at the centre of the centre pivot; it consists of a 3000 to 5000-litre liquid storage tank and a variable speed fertigation pump. The

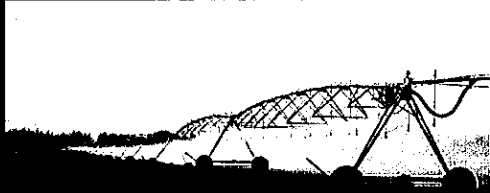


fertigation pump can be adjusted to supply from 0 – 600 litres per hour Urea solution. The fertigation pump is wired into the centre pivot control to allow sector fertigation. Larger application rates can be developed by changing the size of the fertigation pump units.

Any number of nutrients and animal health products can be applied utilising a similar technique as long as the product will dissolve (water soluble) or can be made as a suspension liquid. Care has to be taken if mixing certain products together.

Eco-n has successfully been applied using a fertigation system.

Meters & Water Use Data



Introducing:

Kevin McFall
Senior Environmental Protection Officer
ENVIRONMENT CANTERBURY

Based at the Timaru Office.



Water usage information

- As the demand for Canterbury's water continues to grow, there's an urgent need for robust and reliable water usage information.
- Previously water usage information has been reported or surveyed data and its reliability and accuracy is sometimes questionable.



Water Meters

- The **mechanical meter**,
- the **electromagnetic meter**, and
- the **ultrasonic meter**

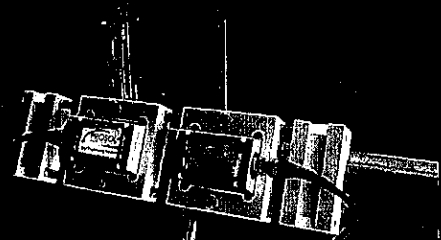
are the three most common types of flowmeters used in Canterbury today.



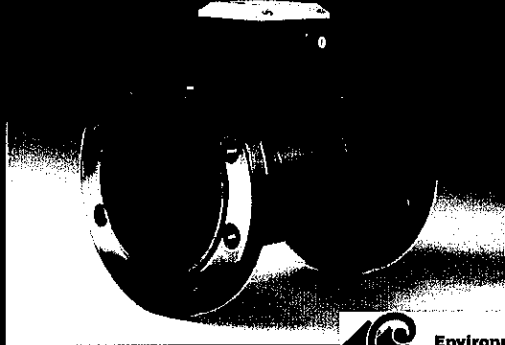
AHS Alpe Mechanical Flowmeter



Ultrasonic Flowmeter



Electromagnetic Flowmeter



Environment Canterbury's Flowmeter Requirements

• Under field conditions the flowmeter must have an accuracy of +/- 5%. In order to achieve this accuracy we recommend that each flowmeter shall be documented with a wet calibration carried out under laboratory conditions demonstrating an accuracy of at least +/- 2%.

• The wet test shall only be undertaken in a laboratory that is accredited by IANZ or one of the organisations recognised by IANZ worldwide through mutual recognition arrangements.



Ecan's Flowmeter Requirements Continue

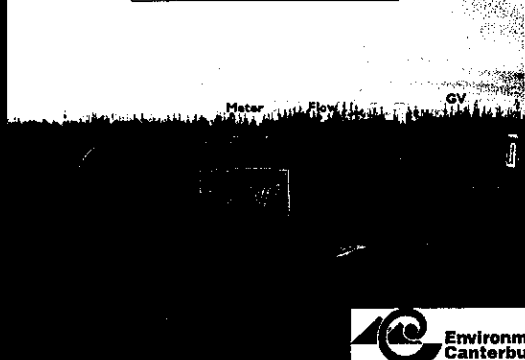
- A detailed plan of the installed meter and distances to any potential turbulence sources (e.g. elbows, valves etc) shall be submitted to Environment Canterbury within 30 working days of the installation by the person responsible for the installation, or a competent person, to certify that the flowmeter has been installed to the manufacturer's specifications.



Good Installation

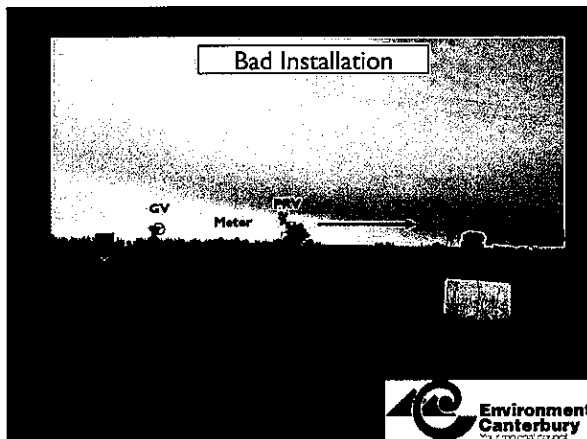


Good Installation



Bad Installation





Ecan's Flowmeter Requirements Continue

- The flowmeter shall be tamper-proof, or where unauthorised interference can occur, it should be easily detectable.
- The flowmeter should be simple to operate and read, and provide flow data as both instantaneous rates and/or totalised volume with provision for remote interrogation and/or transmission of data.

Environment Canterbury
Your resource council

An example of an iRIS 320 datalogger used on Environment Canterbury's 2004/2005 Telemetry Trial

Environment Canterbury
Your resource council

Ecan's Data Logging Requirements

- The datalogger must provide over 12 months worth of data logging at 60-minute intervals.
- The data logger must be tamper-proof recording device or be able to record tampering if it should occur.
- Water usage information from the datalogger in its raw form (i.e a *.dat file) must be submitted to Ecan at the completion of each irrigation season.
- Alternatively, this real time data can be transmitted (telemetered) to a remote station where it is recorded and analysed.

Future Applications

- Access to real time data is as an essential management tool to actively manage and share the allocated rate or volumes during times of restriction with other users.
- This information can also be integrated with other data such as low flow sites, climate stations, soil moisture and temperature data etc.
- Telemetry would allow consent holders and water user groups to actively manage their own resource.

E.g. Queensland's installation requirement

