Guide to Good Irrigation

Part 2: good irrigation practices for farm owners and managers

dairynz.co.nz
0800 4 DairyNZ (0800 4 324 7969)

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For more information visit

dairynz.co.nz

DairyNZ
Corner Ruakura and Morrinsville Roads
Private Bag 3221
Hamilton 3240

Phone 0800 4 DairyNZ (0800 4 324 7969)

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Part 2: good irrigation practices for farm owners and managers

About this booklet

The DairyNZ *Guide to Good Irrigation – Parts 1 and 2* were developed to help dairy farmers fine-tune their farm's irrigation and help with daily operation.

Part 1 is for farm staff and managers operating irrigation systems on a daily basis. It deals with how soil and plant types, climate, various system capabilities, timing and volume of water application influence the farm's irrigation needs.

Part 2 is about making irrigation managers aware of their responsibilities as irrigators, including conditions of water supply, protecting water quality, efficient water use, teaching staff good irrigation practices and improving the system's performance. It also covers soil moisture monitoring, upgrading an old system and considerations when designing and installing a new system.

Contents

Irrigation management

Successful irrigation management is about optimising the returns from water applied, as well as fulfilling responsibilities to the wider community.

There are four components to good irrigation management:

DESIGN

Good systems are designed to apply the right amount of water for the particular farm, as evenly as possible and at the right time.

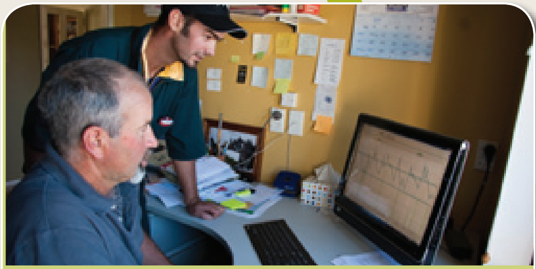
INSTALLATION

New systems and upgrades are checked using the Code of Practice for Irrigation Evaluation to ensure they work as designed.

OPERATION & MAINTENANCE

Managers demonstrate and train staff how to operate and maintain irrigation systems.

MANAGEMENT



Making the best use of water, energy, labour and capital.

I manage the overall irrigation system. What are my responsibilities?

- To understand and work within the conditions or rules that are set by the irrigation scheme or regional council, and govern the supply of water for irrigation
- To protect water quality
- To demonstrate and explain good irrigation practices to staff
- To be as efficient as possible with water and energy use, while maintaining or improving production
- To ensure any new irrigation is designed for efficient use of water, energy, labour and capital.

Understanding the conditions of your water supply

A resource consent or scheme supply will limit the amount and timing of water available. These are likely to include:

- A limit on the **flow** (rate of take) such as litres/second, cubic metres/day or week
- A limit on the total **volume** that can be taken in a month, a season or a year.

There are likely to be penalties for taking more than the set entitlement.

As a manager, it is your responsibility to have strategies in place to manage the farm when water restrictions occur. Both schemes and individual consents will often have particular limits for stream flows or ground water levels, which will result in water takes being reduced or cut-off.

Other consent conditions may include defining the area that can be irrigated and the land uses, plus requirements not to water roads, tracks or other non-productive areas.

Know when your resource consent expires and apply for a replacement consent in plenty of time. If the application is submitted at least six months before the existing consent expires, you can continue using the consent until the new application is finalised.

Measuring and reporting annual water use

In 2010, the Resource Management (Measurement and Reporting of Water Takes) Regulations were introduced, requiring all irrigated farms to measure and record how much water is used.

Those with consents granted since November 10, 2010, must start using a water meter and record water use straight away. All other consent holders have between two and six years to comply, depending on the size of their take. Many dairy farms will have takes of ≥ 20 l/s, so will need water metering installed by November 10, 2012.

The regional council can advise when a meter is required and can direct you to useful guidance material, including information on selecting a water meter and the contact details of qualified installers and verifiers.

It is important that owners and managers of irrigated farms establish what their compliance obligations are for water metering and consider what practical steps need to be taken. Options include installing a new water measuring system or upgrading existing equipment, if necessary.

Make sure any necessary changes are made well in advance of the final date for compliance.

Managing water supply restrictions

When river levels are low during the irrigation season, many surface water supplies are either restricted or shut-off completely. Although such water restrictions are generally beyond the control of those on farms, long and short-term planning to deal with water restrictions can limit production losses.

Short-term measures:

- If you consistently have restrictions, consider planting crops in spring when the risk of irrigation restriction is low, enabling good establishment and providing feed in the dry (turnips and kale)
- Use a longer grazing rotation earlier (as for summer dry farms)
- Water the better performing areas of your farm properly and cease irrigation on the poorer parts
- Store water in soils but allow room for rain, so the soil can absorb it all and not waste any rain through the soil or by run-off (use soil moisture monitoring)
- Reduce stocking rate in line with the decrease in kgDM grown
- Use supplements.

Long-term measures:

- Make better use of water by evaluating your irrigation system to ensure that application uniformity is high and application depth is appropriate
- Explore options to improve system capacity (on-farm storage, change irrigation type or design)
- Form a water user group with others using the same water source. The regional council may give you greater control to manage the available water supply.

Protecting water quality

Protect water quality by being smart about how water is used, minimising drainage through the soil profile and run-off into waterways. Water quality issues on dairy farms are commonly associated with intensive stocking and poor management of fertiliser and effluent. Poor irrigation practices can make these problems worse.

Best practices to avoid water quality issues with irrigation

Fertiliser use

- Use nutrient budgeting and planning
- Apply fertiliser to match soil temperature and plant growth. Avoid application when the soil is saturated, so nutrients don't run-off into surface water or leach into the groundwater.

Effluent management

- Use only the designated effluent discharge area
- Retain effluent in storage if soils are too wet to hold any more water, without draining away.

Waterway health

- Manage irrigators and maintain riparian margins so irrigation run-off does not get into streams and wetlands, taking contaminants from stock, effluent irrigation and fertiliser
- Keep cattle out of waterways, drains and irrigation races.

Teaching good irrigation practices to farm staff

All staff need to understand what good irrigation means, know their responsibilities and be trained in all aspects of operation and maintenance.

Do your staff know the answers to these questions?

- What is the application depth of the irrigators?
- What should I do if the irrigator or pump breaks down?
- What do I do if a leak is spotted or a sprinkler is not working?
- How do I know the pump or irrigator is operating correctly?
- What are the five most important maintenance jobs on the irrigator?
- When is soil moisture at a level to begin irrigating?
- What determines when we do and don't irrigate?

If any gaps in knowledge have been identified from these questions, make sure staff are fully trained in that subject. For technical information utilise the *Guide to Good Irrigation - Part 1: good irrigation practices on-farm*. For ways to communicate and train staff refer to the DairyNZ *HR Toolkit* (**dairynz.co.nz/hrtoolkit**). If you are new to the farm it may be useful to contact the previous farm manager for information specific to the farm.

More efficient water use on-farm

Water use efficiency is the productive return per unit of water applied. In a dairy farm system this is kgDM per millimetre of water applied.

Measuring and monitoring water use helps identify areas in the design or management of irrigation systems that need to change to improve on-farm productivity, such as using less power, growing more grass or less time spent irrigating.

To be able to measure water use efficiency, records need to be kept for:

- Annual volume of water used
- Imported supplements fed (to calculate pasture eaten) and pasture grown.

Entering this data into the industry benchmarking tool, DairyBase, is ideal to measure your farm's water use efficiency and get a comparison against other irrigated dairy farms **(dairybase.co.nz)**.

Why improve on-farm water use efficiency?

Water resources are increasingly under pressure, with demands for increased irrigation takes.

But irrigation and other uses that take water need to be balanced with maintaining river flows and groundwater levels for environmental and aesthetic reasons.

When new or replacement consents are issued to schemes or individuals, the amounts of water requested will need to be carefully justified. Limits on the volume of water taken in a season are increasingly common.

Politically, farmers (particularly dairy farmers), are under pressure to not only be more efficient with water use, **but to have measurements that show it.**

Real data is also needed so the dairy industry can build trust with the wider community by demonstrating positive change to ensure that:

- Seasonal allocation limits are set at a level that will not unnecessarily limit on-farm productivity
- Regional councils delegate responsibilities for water management to the user.

How do I improve efficiency?

Key methods to better irrigation efficiency are soil moisture and temperature monitoring (to identify when to irrigate, especially in spring and autumn), improving the performance of the irrigation system and better matching irrigation system capability to soil type and plant demand.

Soil moisture monitoring

The biggest opportunity to improve how efficiently water is used is by irrigation scheduling (making informed decisions about when to stop and start irrigating), especially during the shoulders of the season, spring and autumn.

Soil moisture monitoring is key to providing the necessary information.

To answer 'do I need to irrigate today?' a good irrigation manager should know:

- How much water is in the soil
- How much water is being extracted by the plant
- How much water the irrigation system can apply
- What rainfall is expected
- Soil temperature.

Providing staff with ongoing access to this information will enable them to make better decisions about when to irrigate.

Farm example

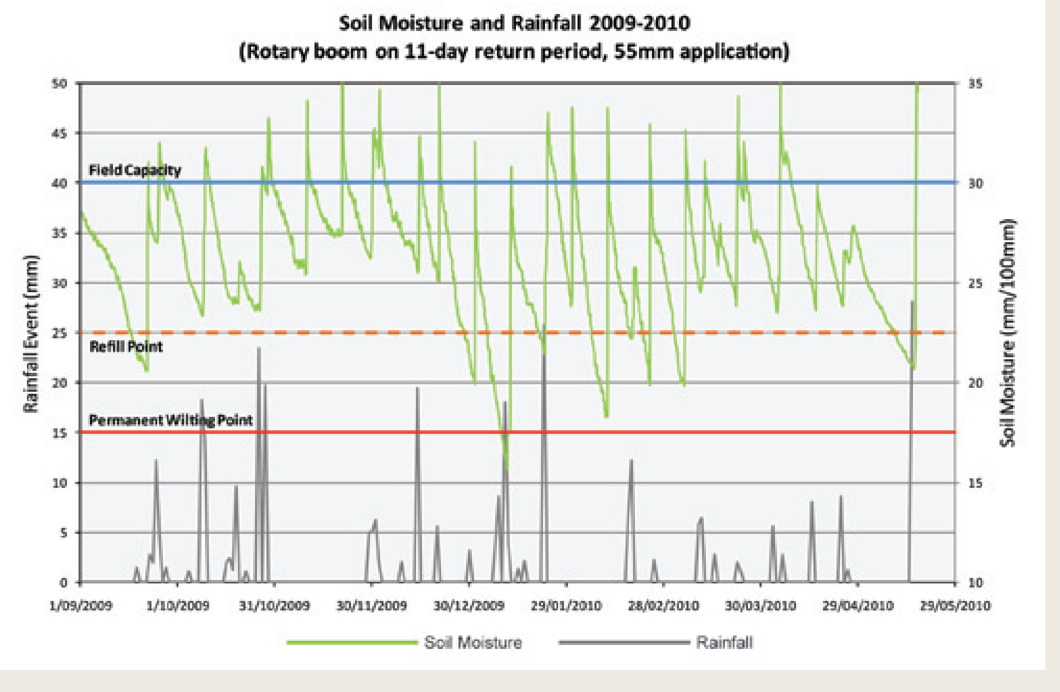
The charts following are real examples of a full season's soil moisture and rainfall monitoring on two farms with different irrigation systems. Both charts provide timely information on the amount of water in the soil, the amount of rainfall and the affect irrigation and rainfall events have on the soil moisture.

Irrigation decisions made aim to keep the soil moisture levels below field capacity (top line) to avoid water and nutrients draining through the soil, and stay above refill point (dash line), preventing plant stress so plant growth is not reduced.

Farm one:

The irrigation system on farm one is rotary booms with an 11-day return period applying 55 mm per application. The return period of 11 days and the soil type of the farm means that when plant demand for water is greatest and ET rates are high (as seen over December, January and February in this chart) this farm cannot always keep the soil moisture levels above refill point until the irrigator returns 11 days later.

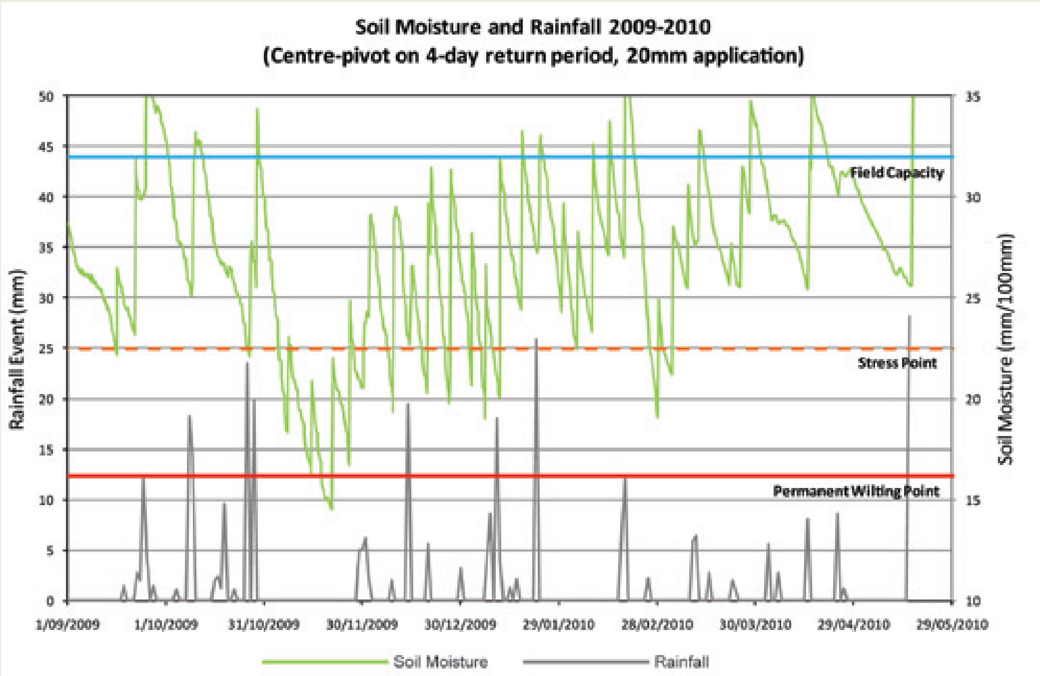
The depths of water applied per application with this irrigation type also make it difficult to avoid exceeding field capacity following rain events. A change to centre pivot or adding another rotary boom to have a reduced application and shorter return period, to better match plant demand and soil type, would likely use less water and grow more grass.



Farm two:

The irrigation system on farm two is a centre pivot with a four day return period applying 20 mm per application. This means the farm is able to apply less water more often. The farm has more flexibility to maintain soil moisture levels above refill point because the irrigator can return to a paddock and apply water sooner.

This chart also illustrates the negative impact that equipment breakdowns or loss of water can have on soil moisture levels. In early November this farm had a major breakdown stopping irrigation, resulting in soil moisture dropping below refill point right down to permanent wilting point causing plant stress and reduced plant growth.



Improving the performance of an irrigation system

Carrying out an evaluation is a good way to know how well a system is performing and where the opportunities are to improve.

An evaluation requires knowing what the system is specified or designed to do and checking it is performing to that level. It is about understanding the limiting factors of the system and taking action to fix it.

The table on pg 11 identifies areas where water losses occur in an irrigation system, and typical amounts. The best ways to improve water use efficiency are to improve how evenly the water is applied, and to optimise the application rate and depth for your system.

Expected water losses on spray irrigation systems

Where water loss occurs	Range	Typical
Uneven application (non-uniform distribution)	5-30%	15%
Excessive application depth	0-50%	10%
Losses from open races	0-30%	10%
Blown away by wind	0-20%	<5%
Surface run-off	0-10%	<5%
Leaking pipes	0-10%	<1%
Evaporation in the air	0-10%	<3%
Watering non-target areas	0-5%	<2%
Interception by plants	0-3%	<2%

(Reference: McIndoe, I. Irrigation Efficiency Gaps – Review & Stocktake)

A detailed system evaluation can be completed by an irrigation consultant or a farmer can carry out their own, using instructions and guidelines developed for farmers.

Two such resources for spray systems are *'IRRIG8Quick'* (Page Bloomer and Associates) and *'DIY Spray Irrigation Performance Evaluation'* (Aqualinc Research Ltd). See the references section for details on obtaining these guides.

How an evaluation can reduce water use and save costs

For example – in 2009, an irrigation system evaluation was carried out for a Dunsandel dairy farm which operates three rotary booms. The evaluation resulted in cut off switches being installed on all three rotary booms at a total cost of $9000 to reduce run-end times, water and energy use.

Mainline pressure was also found to be unnecessarily high and was cut back from 575 to 550 kPa (25 kPa). The overall result was energy savings of $19,000 in one season, due to reduced pumping and less water use, with no reduction in pasture production.

As this farm has a seasonal allocation limit on the total volume of water available, when the cut off switches reduced water use on each run, it provided opportunities for the saved water to be available later in the season. For more detail go to: **maf.govt.nz** (click on *environment & natural resources* > *climate change* > *resources & tools* > *by sector* > *dairy*)

Matching system capability to soil type and plant demand

An irrigation system which provides an appropriate application depth, application rate and return period to match the soil characteristics, plant demands and climate needs will be more able to keep soil moisture levels between field capacity and refill point.

Options for making improvements range from adding to the existing system (e.g. including another rotary boom) in order to reduce the return period and/or the application depth per run, through to a total change in irrigation type e.g. border dyke to spray irrigation.

It is important to remember that changing or improving irrigation system capability should not be done in isolation, but incorporated with soil moisture monitoring and continual performance evaluation to achieve maximum improvements in irrigation efficiency.

New system design and installation

If you are putting in a new irrigation system, it is important to make sure the design suits your land and business.

No amount of good management can resolve problems caused by poor design or incorrect installation. A well-designed system means efficient use of water, energy, labour and capital. There is plenty of useful independent reference material available for farmers.

A new system is a major investment and should be thoroughly researched. Get independent advice and a review of design proposals. Key points to cover when designing a new system:

Checklist for designing and installing a new irrigation system

Consider	Why	Information sources
Water needs	Calculate how much, how often and over what area.	*The Irrigation Guide* *NZ Irrigation Manual* Local irrigation consultants.
Water availability	Where is the water coming from? What rate and volume can be obtained?	Talk to your local irrigation scheme or regional council for access to bore or surface water. If a resource consent is needed, then professional advice may be required.
Irrigation methods	Choose a system that suits your needs.	*The Irrigation Guide* *NZ Irrigation Manual* DairyNZ Farmfact 8-4 – Irrigation: Types and methods Local irrigation consultants and suppliers.
Good design	Gives the ability to provide the right depth of water in the right place at the right time. Follows the Code of Practice for Irrigation Evaluation.	Irrigation suppliers and consultants (Irrigation NZ accredited) Irrigation Decision Support Package Code of Practice for Irrigation Evaluation.
Independent review	Checks that the design follows the Code of Practice for Irrigation Design and is appropriate for the location and farm business.	Irrigation consultants.
Evaluation	Independent check of system operation.	Irrigation consultants Code of Practice for Irrigation Evaluation.
Capital and operating costs	Upfront cost is not the only consideration.	Irrigation Decision Support Package Irrigation consultants Other farmers.
Contracting for construction	Ensure you retain final payment until evaluation is completed and the system operates as designed.	Irrigation Decision Support Package.
Commissioning and completion	For future monitoring and maintenance, obtain specifications for all equipment such as pump performance and sprinkler nozzle replacement.	Irrigation Decision Support Package Code of Practice for Irrigation Evaluation.
Audited self management	Measuring and monitoring water use helps identify and improve areas of design and management as well as demonstrating to the wider community that water users are taking responsibility for water management on their farms.	Water management consultant Irrigation NZ Regional council.

References

The Irrigation Guide (Farmer Irrigation Management Group, South Canterbury)	A must-read for farmers thinking about irrigation development. Will guide farmers through the decision-making process.	Download from: **irrigationefficiency.co.nz** Irrigation NZ Ph: 03 341 2225
Irrigation Decision Support Package (Irrigation NZ)	Framework developed to assist farmers with the design and cost of a new irrigation system, or upgrading old systems.	Download from: **irrigationnz.co.nz** Irrigation NZ Ph: 03 341 2225
The New Zealand Irrigation Manual (Malvern Landcare Group, Central Canterbury)	A practical guide to irrigation. Covers management and maintenance as well as design, installation and regulations.	Download from **irrigationnz.co.nz** Irrigation NZ Ph: 03 341 2225
A financial decision making framework for irrigation conversion (The Agribusiness Group)	Financial decision-making framework and information needs and sources for farmers to do their own calculations.	Download from: **ritso.org.nz** The Ritso Society Inc.
Irrigation Water Calculator (Aqualinc Research Ltd)	Use this to determine the volume of irrigation water required for a specific land use.	Download from: **ritso.org.nz** The Ritso Society Inc.
Irrigation NZ Knowledge Centre	An evolving web-based information resource for all things irrigation in New Zealand. It contains fact sheets, articles, presentations, reports, current research projects, practical irrigation tools, links to other websites, field days and workshops.	Download from: **irrigationefficiency.co.nz** Irrigation NZ Ph: 03 341 2225
DIY: Spray Irrigation Performance Evaluation	Find out how well your system is performing by completing your own system evaluation.	Download from: **myirrigation.info** Aqualinc Research Ltd Ph: 03 964 6521
Irrigation calibrations & efficiency tests	Guidelines and worksheets (IRRIG8Quick) for a series of do-it-yourself, in-field irrigation system calibrations e.g. 'the bucket test'.	Download from: **pagebloomer.co.nz** Page Bloomer Associates Ltd Ph: 06 876 6630
Efficient irrigation	DairyNZ Farmfact 8-5 – Efficient irrigation.	Download from: **dairynz.co.nz/farmfacts** (water)
Irrigation - types and methods	DairyNZ Farmfact 8-4 – Irrigation – types and methods.	Download from: **dairynz.co.nz/farmfacts** (water)

Useful irrigation information

Average available water holding capacity of soils (of various textural classes)

Textural Class	Available water holding capacity (mm per metre depth)	
	Down to 0.3m depth	Below 0.3m depth
Sand	150	50
Loamy sand	180	110
Sandy loam	230	150
Fine sandy loam	220	150
Silt loam	220	150
Clay loam	180	110
Clay	175	110
Peat	200-250	at least 200-250

(Source: NZS 5103 : 1973) / pg G38 Lincoln Technical Manual

Ranges of effective crop root depth under irrigation, with unimpeded growth

Pasture & fodder crop	Root depth (m)	Field crop	Root depth (m)
Pasture (annual & perennial)	0.3-0.8	Barley	0.9-1.1
Rape	0.5-0.6	Wheat	0.8-1.1
Kale	0.5-0.6	Maize	0.6-0.9
Fodder beet	0.5-0.6	Oats	0.6-0.8
Lucerne	1.2-1.8		

(Source: NZS 5103 :1973) / pg G39 Lincoln Technical Manual

Estimated maximum water application rates in mm per hour

	Slopes		
Soil group based on texture & profile	0-8° Level - undulating	9°-12.5° Undulating - low hills	Over 12.5° Low - steep hills
Sands & light sandy loams uniform in texture	31.8	25.4	20.3
Sandy loams overlaying a heavier subsoil	20.3	16.5	12.7
Medium loams to sandy clays over a heavier subsoil	16.5	12.7	10.2
Clay loams over a clay subsoil	12.7	10.2	7.6
Silt loams and silt clays	10.2	7.6	5.1
Clays	6.4	5.1	3.8
Peat	16.5	-	-

(Source: NZS 5103 : 1973) Lincoln Technical Manual

Evapotranspiration (Penman) – daily average for Canterbury districts

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Hanmer	4.1	3.5	2.4	1.3	0.6	0.3	0.3	0.8	1.7	2.6	3.5	4.0
Christchurch	4.8	4.0	2.7	1.5	0.8	0.4	0.5	1.0	1.9	3.0	4.2	4.7
Lincoln	4.7	4.0	2.7	1.4	0.7	0.4	0.5	0.9	1.8	2.9	4.0	4.5
Highbank	4.6	4.0	2.8	1.9	1.0	0.7	0.8	1.4	2.3	3.3	4.2	4.5
Ashburton	4.3	3.6	2.4	1.3	0.7	0.5	0.6	1.0	1.8	2.7	3.9	4.2
Timaru	4.0	3.4	2.3	1.3	0.7	0.4	0.5	0.9	1.6	2.7	3.6	3.9
Waimate	3.6	3.1	2.1	1.2	0.6	0.3	0.3	0.8	1.5	2.5	3.2	3.5

Common unit conversions

Flow rate

Desired unit

Starting unit	m^3/hr	m^3/min	gpm	l/s
m^3/hr	1	0.017	3.7	0.28
m^3/min	60	1	220	17
gpm	0.27	0.0045	1	0.076
l/s	3.6	0.060	13.2	1

Pressure

Desired unit

Starting unit	psi	kPa	bar	m
psi	1	6.9	0.069	0.70
kPa	0.145	1	0.01	0.10
bar	14.5	100	1	10
m	1.4	9.8	0.098	1

System capacity

l/s/ha x 8.64 = mm/day

mm/day x 0.116 = l/s/ha

Water depths and volumes

1 mm applied to 1 m^2 = 1 litre

1 mm applied to 1 ha = 10 m^3

Seasonal volume

m^3 → mm applied

m^3 ÷ ha ÷ 10 = mm total depth

mm applied (irrigation or rainfall) → m^3

mm (depth) x 10 x ha = m^3