DIY Irrigation Evaluation

Farmer workbook for checking the performance of spray irrigation systems

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Contents

Why irrigation evaluations are important

Carrying out an irrigation 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, leading to better efficiency, more production and more profit.

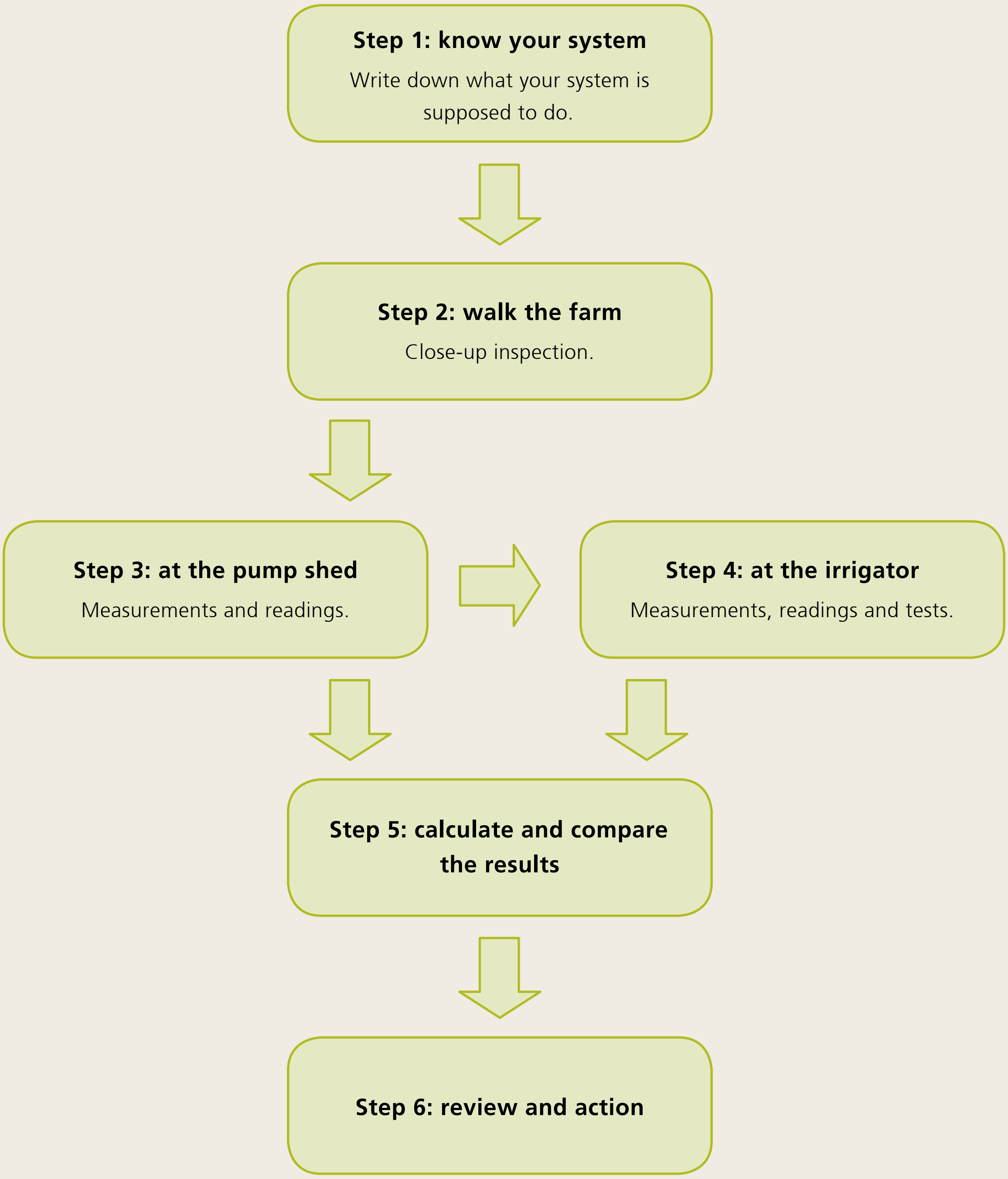
This guide will help record performance values for your system, taking you through the measurements and calculations. These can be compared with the system's design specifications to see if it is performing as it should. The six-step process uses the same principles that irrigation evaluation professionals use.

It should be done at least once each year to ensure that the system is in top shape.

DIY irrigation evaluation process

Steps 1 to 6 will guide you through the evaluation process of observation, data collection, calculation and results review.

Steps 3 to 6 can be completed using this paper version of the evaluation or the web-based calculator at **www.myirrigation.info**



How long will it take?

From start to finish, the evaluation will take up to three hours, depending on how many pumps and irrigators you have. To save time, read the entire evaluation guide prior to starting, so you can plan to conduct certain tests concurrently.

At the pump shed

Allow up to 60 minutes, depending on the type of readouts on your meters and gauges.

At the irrigator

The most time-consuming part is waiting for the irrigator to pass over the buckets, so it is usually best to set these out first. Choose a day that's not too windy. For k-line, the buckets need to be out for at least six hours.

What equipment will I need?

- A set of 10-20 buckets. Ordinary plastic household buckets or ice cream containers are fine
- Measuring jug or cylinder (a kitchen measuring jug is fine)
- This booklet, which has instructions and a recording sheet (perhaps use a clipboard too)
- A couple of pens/pencils
- Calculator (if you want to do calculations as you go)
- Computer and internet access, if you want the web-based calculator at **www.myirrigation.info**
- Tape measure to measure diameter of your buckets
- For conversion factors between different units see page 36.

DIY irrigation performance evaluation

Step 1: know your system

In evaluating your irrigation system, it is important to know what it is supposed to be doing. Fill in the white boxes on the DairyNZ DIY irrigation performance evaluation – results page with what the system provider said it could do. Most of these things should be listed in the information from the system's supplier. If not, contact the supplier to get it.

Also find out:

- how much water your soil can hold. A value for profile available water (PAW) should be available from a soils map, the local council or a consultant. A good resource is S-map online **smap.landcareresearch.co.nz**
- the 'meter factor' of the power meter in the pump shed (if using step 3b, option 2 on page 11 'using the power/electricity meter' to work out the power use). If this is not written on the power meter, contact your electricity supplier (you will need to quote the ICP number on the meter).

Step 2: walk the farm

A close-up inspection should be a regular part of operating any irrigation system. Take time to walk around the irrigation areas and check for obvious problems that may need fixing, before spending time on the details in steps 3-5.

	Record the results of your farm walk here:	OK	Needs repair
2a	Look for leaks at the pump, in pipelines, irrigator hoses and at the irrigator(s)		
2b	Listen for loud noises at the pump, particularly whining or crackling noises		
2c	Check to see if all screens and filters are clean		
2d	Check to see if pressure gauges are installed and working properly at:		
	- the pump inlet		
	- the pump outlet		
	- the irrigator		
2e	Walk out to all irrigators and inspect the spray pattern of each sprinkler		
2f	Check a few sprinklers for any signs of blockage or build-up		
2g	Look for off-target irrigation		
2h	Look for ponding and/or runoff under the irrigator		
2i	Look for visibly stressed plants (e.g. brown grass)		

Notes

For more trouble-shooting information on common irrigation problems, likely causes and how to deal with issues found on the farm walk, see page 34.

Tip: If any problems are identified during the farm walk, try and fix them before moving on to step 3. An irrigation expert may be required to fix some problems, such as noisy pumps or leaky irrigator spans. If you don't fix these problems first, your results will be less useful.

Step 3: measurements at the pump shed

The pump's role is to supply the irrigator with the correct volume of water at the right pressure level and flow rate, using as little energy as possible. It should run smoothly and perform efficiently.

Always start at the pump shed, because it is the start of the water flow into the system. There is no point making changes at the irrigator, if the pump is not supplying the right pressure or flow rate.

Operate your system as usual and work through step 3 to record flow rate (flow meter), total flow (flow meter), pump pressures and pump energy use.

If possible, fix any problems at the pump shed before moving on to step 4.

How to read a flow meter

There are two kinds of readings a flow meter can give:

- total volume (m^3 / litres / gals) – total amount of water that has passed through the pipe since it was set up
- flow rate (l/s) – speed at which water is moving through the pipe.

Digital meters

Digital meters give an instant readout (total volume of 52,052 m^3 and flow rate of 61 l/s as shown in the photo, right).

Analog meters

Analog meters give an instant readout, but may need to be adjusted by a meter factor (x10 in the photo, right). Not all meters have a meter factor.

An example of how to calculate total flow for the analog meter (right) is:

Multiply the readout (total volume) by the meter factor:

87,577 m^3 x 10 = 875,770 m^3

Step 3a

Step 3a: record pump flow rate

Option 1 – read flow rate

If your meter shows flow rate, then just write it down in the box below. Most digital meters will show both total volume and flow rate.

	Pump 1	Pump 2	Pump 3	Units (circle one)
Read flow rate				l/s m³/hr gpm

Enter this answer in **3a** on results page

Option 2 – calculate flow rate

Most older meters will not show flow rate and you will need to calculate it.

Read total volume twice and write down the number of minutes between readings. Wait 20 to 60 minutes for the best results.

Flow rate	Value	Pump 1	Pump 2	Pump 3	Units (circle one)
Reading 1	**A**				litres m^3 gal
Time 1 (time of reading 1)	**B**				min
Reading 2	**C**				litres m^3 gal
Time 2 (time of reading 2 – wait about 60 minutes after reading 1)	**D**				min

Either complete the calculation below or enter the readings into the web calculator:

Convert volumes in litres or gallons to m^3 (see page 36 for 'flow volume' conversion factors).

	Value	Pump 1	Pump 2	Pump 3	Units
Volume used E = C – A	**E**				m^3
Time elapsed F = D – B	**F**				min
Flow rate G = E ÷ F	**G**				m^3/min

Flow rate H = G x 16.7	**H**				l/s

If there is no flow meter, it is possible to get a one-off flow rate using a portable meter. Many irrigation companies or consultants can do this for you.

Enter this answer in **3a** on results page

Step 3b: measure pump power rating/use

Pump power is measured in kilowatts (kW). A higher value of kW means the pump uses energy faster and results in more total kWh being used. kWh is a running total of how much power you've used and is what the power company charges for.

There are three main ways to measure pump power use at the pump shed: electronic display, power-meter and ammeter.

Option 1 – direct read out

Some pumps have a kW display in the pump shed.
Read operating kW directly from here.

	Pump 1	Pump 2	Pump 3	Units
Read kW				kW

Enter this answer in **3b** on results page

Option 2 – using the power/ electricity meter

kW can be calculated from the power company's meter (see option 1). To do this, you need to contact your electricity supplier to get the 'meter factor'. You'll need to quote the 'ICP' number written on the meter.

	Pump 1	Pump 2	Pump 3
ICP no.			

Collect two readings of kWh from the power meter and write down the number of minutes between readings. Wait about 60 minutes for the best results.

	Value	Pump 1	Pump 2	Pump 3	Units
Reading 1 (from power meter)	**A**				kWh
Time 1 (time of reading 1)	**B**				min
Reading 2 (from power meter)	**C**				kWh
Time 2 (time of reading 2 – wait about 60 minutes after reading 1)	**D**				min
Meter factor (get this from the power company)	**E**				e.g. 40X

	Value	Pump 1	Pump 2	Pump 3	Units
Power used F = C – A	**F**				kWh
Time G = D – B	**G**				min

kW H = E x F x 60 ÷ G	**H**				kW

Enter this answer in **3b** on results page

Option 3: using the ammeter

(this is less accurate than option 1 or 2)

kW can be estimated from motor current (amps), which is read from an ammeter. Most systems have an ammeter. Some systems include the amp reading on an electronic display.

	Value	Pump 1	Pump 2	Pump 3	Units
Current (read from ammeter)	**A**				amps
Voltage (most irrigation pumps are 400 V)	**B**				V
Power factor ("cos φ"is sometimes listed on the pump motor plate or control box – a value of 0.85 is common)	**C**				

For a <u>3-phase</u> power supply:

	Value	Pump 1	Pump 2	Pump 3	Units
kW D = A x B x C ÷ 578	**D**				kW

Enter this answer in **3b** on results page

For a <u>single-phase</u> power supply:

	Value	Pump 1	Pump 2	Pump 3	Units
kW E = A x B x C ÷ 1000	**E**				kW

Enter this answer in **3b** on results page

Step 3c: record the pump delivery pressure

Read the pressure gauge on the outlet side of the pump. Be sure to record the correct units.

How to read the pressure gauge

Read the number that the needle points to, but be aware of which units are being used!

For surface pumps, read both the inlet and outlet pressure. If the inlet is flooded, there may be a positive pressure in the inlet pipe. If the inlet is not flooded, there will be a negative pressure in the inlet pipe.

Multiply the reading by the value in the table, to change units:

Gauge unit \ Desired 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

For example, if the pressure on your gauge says 65 psi (as in the photo above) and you want to convert that into kPa, then multiply 65 by 6.9:

65 psi x 6.9 = 449 kPa

	Pump 1	Pump 2	Pump 3	Units (circle one)
Pressure reading				m kPa bar psi

Enter this answer in **3c** on results page

Tip: Pressure gauges are easily damaged and wear out over time. If a gauge doesn't look right (e.g. it has a bent needle or doesn't read zero when the system is off), it probably needs replacing. Isolating taps can help prevent this. You may also want to have one reliable gauge that can be carried around to check the other gauges.

Step 3d: record surface pump suction or depth to water

Record the pump inlet pressure:

- for groundwater systems, this will be the depth to water in the well, measured while the pump is operating
- for surface water systems, this can be read off a gauge or estimated by measuring the surface water level relative to the pump inlet.

Groundwater:

For groundwater pumps, read the outlet pressure and depth to water in the well, which should be measured while the pump is running. This tells you how far the pump lifts the water before it enters the mainline. Wait at least 20 minutes after turning the pump on or off for the water level in the well to equalise, before you take a well depth reading.

Choose from one of the following four options.

Option 1 – water level meter

If you have a water level meter, drop the end down the well until it indicates you've hit water. Read the measuring tape where it comes out of the well casing.

Many irrigation companies or consultants can do this for you, if you do not have a water level meter.

	Pump 1	Pump 2	Pump 3	Units
Depth to water				m

Enter this answer in **3d** on results page

Option 2 – permanent transducer

Some newer installations have a permanent electronic measuring device down the well. The water level can be read from a display in the pump shed or downloaded from a data logger. Be sure to find out if it shows the depth down to the water or the depth of water above the pump (they are not the same!).

	Pump 1	Pump 2	Pump 3	Units
Depth to water				m

Enter this answer in **3d** on results page

Option 3 – air pressure

Pump up the pressure in the hose until the gauge reading stops rising:

	Value	Pump 1	Pump 2	Pump 3	Units
Pressure (see table in Step 3c page 13 to convert units)	**A**				m
Depth down to pump (get this from pump installer)	**B**				m
Air pressure tube distance above the pump (get this from pump installer)	**C**				m
Depth of tube in the well D = B – C	**D**				m
Depth to water E = D – A	**E**				m

Enter this answer in **3d** on results page

Option 4 – surface water take: depth to water/pump suction

In case of surface water take, measure or estimate the depth of water over the intake pipe.

	Pump 1	Pump 2	Pump 3	Units
Depth to intake				m

Enter this answer in **3d** on results page

Tip: If the water level is above the pump (i.e. flooded suction) enter a negative value.

Step 4: measurements at the irrigator(s)

After checking that the pump runs well, check the irrigator(s). Operate your system as usual and follow step 4.

Step 4a: pressure to run the irrigator

Most irrigators have a pressure gauge at the inlet to the machine. Record this pressure in the box below.

See step 3c page 13 for help with reading this gauge.

	Pump 1	Pump 2	Pump 3	Units (circle one)
Pressure at the irrigator				m kPa bar psi

Enter this answer in **4a** on results page

Some irrigators do not have a pressure gauge (e.g. most K-Line). In this instance, you can: skip this reading; attach a portable gauge to the sprinkler; or call an irrigation expert for help.

Step 4b

Step 4b: measure application depth and distribution uniformity

The 'bucket test'

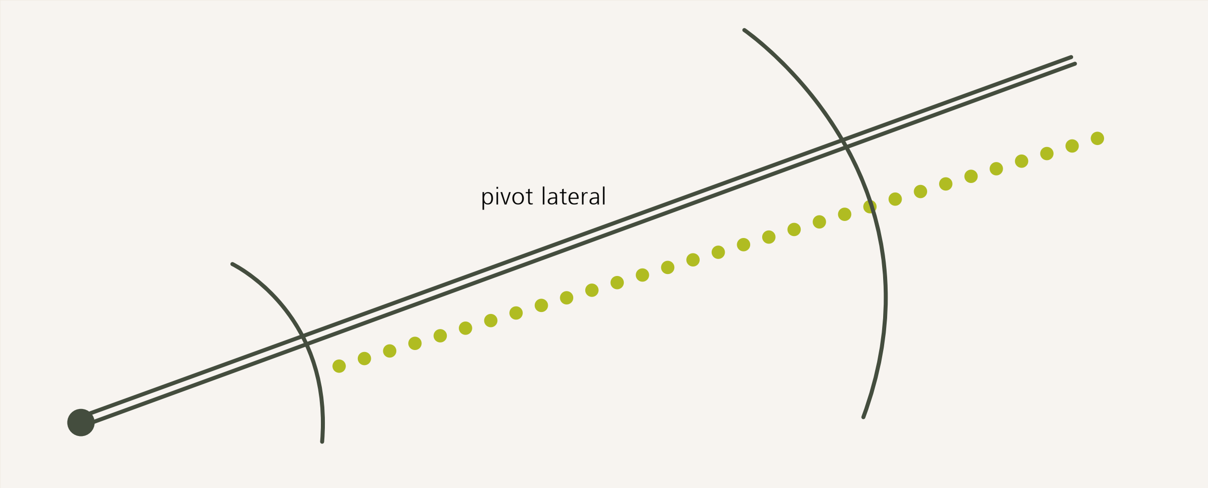
Use a set of buckets to measure how much water is being applied by the irrigator and how uniformly. Carry out these measurements at least once, even if there is a digital readout on the machine, as sometimes they can be wrong.

1. Spread 12 to 48 (a multiple of 4) buckets evenly across the irrigated area putting a stone or weight in each bucket for stability. See the bucket layout suggestions
2. Operate the irrigation on that area as per normal procedure
3. Measure and record how much water is in each bucket using the tables below
4. Calculate the application depth and application uniformity using the steps on the following pages.

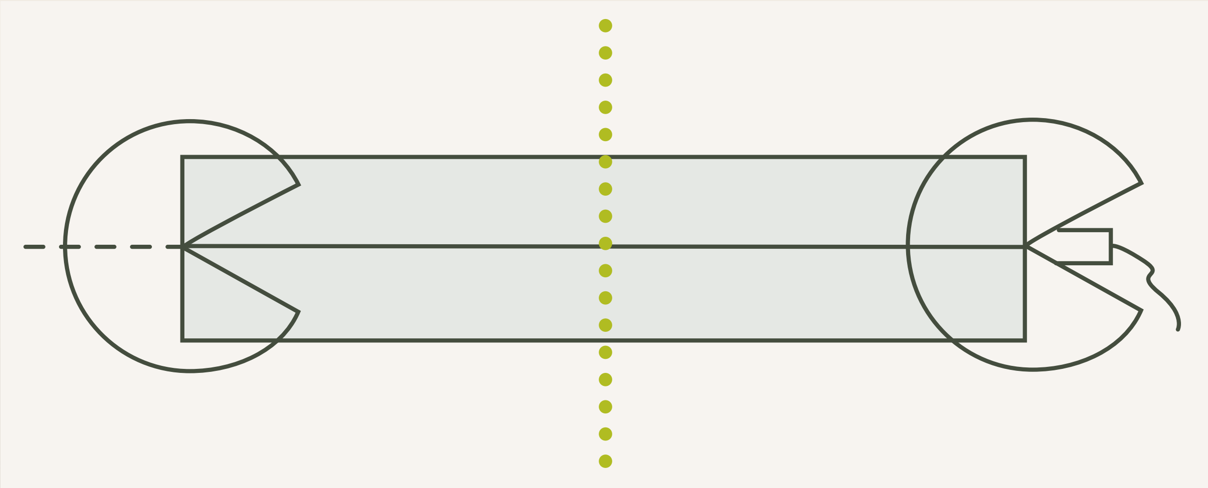
Bucket number	Irrigator 1	Irrigator 2	Irrigator 3
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Total volume	ml	ml	ml

Bucket number	Irrigator 1	Irrigator 2	Irrigator 3
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
Total volume	ml	ml	ml

Bucket test layout: centre-pivot



Bucket test layout: travelling irrigator



Centre pivot and travelling irrigators

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Number of buckets	**A**				
Total volume of all buckets	**B**				ml
Average volume C = B ÷ A	**C**				ml
Total number of buckets ÷ 4 D = A ÷ 4	**D**				
Total volume of water from the lowest 25% of buckets (refer to page 18)	**E**				ml
Average volume of water from the lowest 25% of buckets (refer to page 18) F = E ÷ D	**F**				ml

Width across the bucket (inside top diameter)	**G**				mm
Bucket radius H = G ÷ 2	**H**				mm
Bucket area (ϖr^2): I = 3.14 x H x H	**I**				mm^2

Average application depth J = 1000 x C ÷ I	**J**				mm

Enter this answer in **4b** on results page

Average distribution uniformity (DU) K = F ÷ C	**K**				%

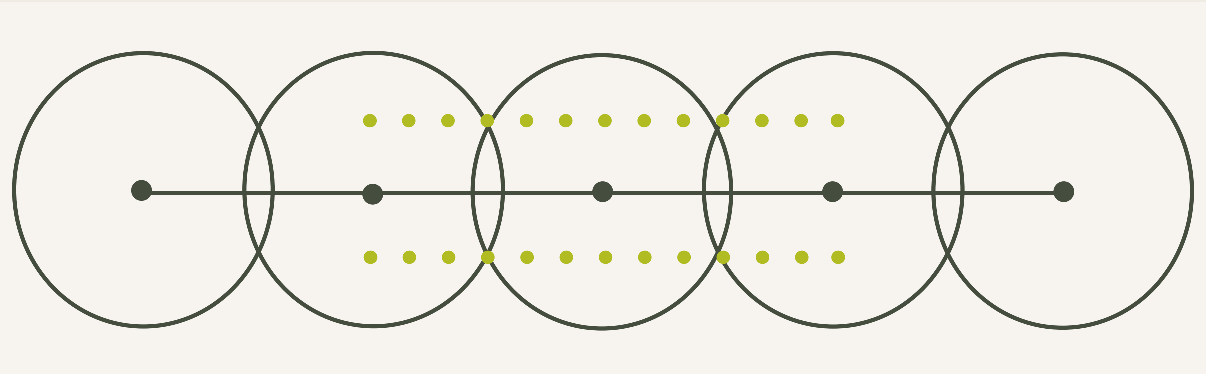
Enter this answer in **4bb** on results page

K-line irrigator

1. Spread 12 to 20 (a multiple of 4) buckets evenly, every 2-3 metres under the K-line, as shown in the diagram, putting a stone or weight in each bucket for stability
2. Operate the irrigation on that area as per normal procedure (allow at least 6 hours to collect enough water to measure)
3. Measure how much water is in the buckets after a known amount of time, and calculate the average application depth and distribution uniformity.

Bucket layout: k-line

The unique watering pattern and low application rate of k-line irrigators require a different bucket test design and slightly different calculations to determine application depth.



To do this:

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Number of buckets	A				
Total volume of all buckets	B				ml
Average volume C = B ÷ A	C				ml
Total number of buckets ÷ 4	D				
Total volume of water from the lowest 25% of buckets (refer to page 18)	E				ml
Average volume of water from the lowest 25% of buckets (refer to page 18) F = D ÷ E	F				ml

Width across the bucket (inside top diameter)	**G**				mm
Bucket radius H = G ÷ 2	**H**				mm
Bucket area (ϖr^2): I = 3.14 x H x H	**I**				mm^2

Time that buckets were under k-lines	**J**				hours

Average application depth (1 hr) K = 1000 x C ÷ I ÷ J	**K**				mm

Or

Enter this answer in **4b** on results page

Average application depth (12 hr) L = K x 12	**L**				mm

Or

Enter this answer in **4b** on results page

Average application depth (24 hr) M = K x 24	**M**				mm

Enter this answer in **4b** on results page

Average distribution uniformity (DU) N = F ÷ C	**N**				%

Refer to Irrig8Quick: **pagebloomer.co.nz** for more detail on application uniformity (e.g. DU or CU).

Enter this answer in **4bb** on results page

Step 4c: measure flow rate at the irrigator

If possible, measure or estimate the flow rate to the individual irrigator.

There are three ways to do this:

Option 1

1. If there's only one irrigator, just use the flow rate at the pump.

	Irrigator 1	Irrigator 2	Irrigator 3	Units
Flow rate (this is the result from **3a** see results page)				l/s

Enter this answer in **4c** on results page

Option 2

2. Flow rate can usually be measured using a portable 'strap-on' flow meter. Many irrigation companies or consultants can do this for you.

	Irrigator 1	Irrigator 2	Irrigator 3	Units
Flow rate at irrigator				l/s

Enter this answer in **4c** on results page

Option 3

3. You can get a rough idea of flow rate from application depth (this will only be an estimate).

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Average application depth (this is the result from step **4b**, see results page)	**A**				mm
Area covered by one run B = length (m) x width (m) ÷ 10,000	**B**				ha
Time taken to complete run*	**C**				hours

*e.g. record 12 hours for a K-Line that gets shifted twice per day. Keep in mind that a travelling irrigator that gets shifted once per day may finish in less than 24 hours.

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Volume of water used D = 10 x A x B	**D**				m^3
Flow rate to the irrigator E = D ÷ C	**E**				m^3/hr

Flow rate to the irrigator F = E ÷ 3.6	**F**				l/s

Enter this answer in **4c** on results page

Step 4d: irrigated area

	Irrigator 1	Irrigator 2	Irrigator 3	Units
Irrigated area (for each irrigator) Total area actually watered by irrigator – from farm map				ha

Enter this answer in **4d** on results page

Step 4e: return interval

	Irrigator 1	Irrigator 2	Irrigator 3	Units
Return interval Number of days it takes your irrigator to return back to the same point on the farm				days

Enter this answer in **4e** on results page

Step 5: calculate the results

To calculate the results:

1. Enter the numbers from your measurements into the web calculator at **www.myirrigation.info**

OR

2. Manually complete the calculations for steps 3, 4 and 5 and enter these results into the green boxes on the results page.

Compare these to the design values. If the two sets of numbers are very different, you may have a problem. See Section 6 (page 33) for guidance about what to do with the results.

Step 5a: calculate system capacity

System capacity will identify if your system can apply enough water to keep up with evapotranspiration (ET).

Typical system capacities range from about 4 to 5 mm/day in Canterbury. Talk to an irrigation expert if you are unsure what your system capacity should be.

System capacity is commonly calculated two different ways:

Option 1

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Total flow rate (this is the value in **3a**, see results page)	**A**				l/s
Total irrigated area (this is the value in **4d**, see results page)	**B**				ha
System capacity C = A ÷ B	**C**				l/s/ha

Enter this answer in **5a** on results page

Option 2

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Application depth (this is the value in **4b**, see results page)	**A**				mm
Time to complete one run*	**B**				hours
Return interval (this is the value in **4e**, see results page)	**C**				days
System capacity D = A ÷ B ÷ C x 24	**D**				mm/day

***** *For travelling irrigators, use actual irrigating time e.g. 22 hours. For centre pivots use 24 hours.*

Enter this answer in **5a** on results page

Tip: Conversion – to get mm/day multiply l/s/ha x 8.64. To get l/s/ha multiply mm/day x 0.116

Step 5b: check the return interval against the soil type

Return interval is the time it takes to complete one full round of irrigation.

For example:

- a centre pivot that takes 3 days to complete one full circle, has a return interval of 3 days
- a travelling gun that irrigates 10 runs, and is shifted once per day, will have a return interval of 10 days
- a K-Line that operates on 16 runs, and is shifted twice per day, will have a return interval of 8 days.

Does the return interval match the soil?

The return interval should be short enough that the soil does not dry out too much before the irrigator can make a full round.

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Application depth (this is the value in **4b** see results page)	A				mm/pass
Soil profile available water (PAW) (get this from regional council or irrigation/soils consultant)	B				mm
'Readily available' soil capacity C = B ÷ 2	C				mm
The smaller of A or C	D				mm
Normal vapo-transpiration (summer ET is assumed to be 5 mm/day in Canterbury)	E				mm/day
Time for soil to dry* F = D ÷ E	F				days

***** *The return interval should be less than this, otherwise the soil will dry out too much between irrigation events.*

Enter this answer in **5b** on results page

Check application depth against soil type

You should ensure the soil is able to hold all the water being applied.

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Application depth (this is the value in **4b**, see results page)	**A**				mm/pass
Soil profile available water (PAW)	**B**				mm
'Readily available' soil capacity C = B ÷ 2	**C**				mm

Application depth **(A)** should be less than readily available soil capacity **(C)**. Otherwise, you're putting on more water than the soil can hold.

Step 5c: calculate pump efficiency

Overall pumping efficiency identifies how good your pump and motor are at converting electricity into pressure and flow. Efficiencies can typically range from 0.3 (30%) in small pumping systems up to 0.8 (80%) for highly efficient systems.

Pump pressure (B) is the TOTAL pressure = inlet (pump depth) + outlet pressure. This is the sum of 3c and 3d page 12-13. Make sure that both results are in m (convert if necessary – see step 3c page 13).

	Value	Irrigator 1	Irrigator 2	Irrigator 3	Units
Pump flow rate (this is the value in **3a** see results page)	**A**				l/s
Pump pressure (this is **3c + 3d** on results page, make sure units are in m)	**B**				m
Power use (this is **3b** see results page)	**C**				kW

Pumping efficiency (i.e. 0.65) D = 0.0098 x A x B ÷ C	**D**				

Enter this answer in **5c** on results page

Tip: Most irrigation pumps operate between about 0.6 and 0.7 (60-70%).

Step 6: reviewing the results

The most common signs of poor performance are:

- pump is operating under-pressure or under-flow
- irrigator is operating under-pressure or under-flow
- incorrect depth applied
- off-target irrigation
- ponding or runoff
- brown grass or dry ground.

The most common reasons for under-performance are:

- incorrect sprinkler nozzle selection
- maintenance has fallen behind. For example, broken sprinklers, blocked screens or worn pumps
- pushing the system too hard. For example, adding new sprinklers without upgrading mainline or pumps
- long return interval. Irrigators that take too long to come back around, resulting in stressed plants
- poor sprinkler spacing. Too little overlap between sprinklers leaves dry areas in between
- application depth is too high and some of the applied water is lost to drainage
- wear and tear due to normal system operation. Equipment just wears out over time, especially pumps
- the system simply isn't designed to do what it needs to do (or what it was designed to do).

What can I do about it?

Firstly, it is important to:

- keep up-to-speed with system maintenance
- check the system regularly
- keep records so you can compare new readings to past readings
- consult your system supplier before making any changes to the system.

If simple problems are encountered, you can fix them yourself. However, the system supplier should be the usual first port of call for anything more complex.

Call the irrigation system supplier when:

- the design information has not been supplied (step 1)
- instructions for operating or maintaining the system have not been provided
- the performance you measure does not match what the supplier said the system would do
- specific components are not working or are worn out.

Sometimes you may need to call in a third-party irrigation expert.

Ask for outside advice when:

- the cause of a problem cannot be found using the basic steps in this guide or by the system supplier
- you and the system supplier cannot agree on who is responsible for a problem with the system
- the system is very complex or has multiple suppliers
- the basic checks show good performance, but you want more detailed checks to maximise efficiency.

Trouble-shooting

Problems with irrigation can range from minor issues which take time to fix, through to major problems which cost time, money and loss of pasture production. It is important any problem is fixed quickly and the cause identified to stop it happening again.

Below is a summary of common irrigation problems, likely causes and possible options to deal with the problems.

1. **Leaks**
   - Any leaks, even minor ones, should be fixed. Leaks mean wasted water, lost pressure and extra pumping. This costs more money and can limit production.
   - Many leaks occur underground. Wet ground or green patches in otherwise dry areas are signs of underground pipe leaks.

2. **Loud noises**
   - Listen for loud noises in any part of the system, such as cracking or high-pitched whining. Cracking is a symptom of cavitation, which can cause damage to pipes, pumps and other fittings.
   - Whining noises or vibration of pumps or pipes can also be a sign of poor performance. Call your pump supplier to inspect if any of these symptoms arise.

3. **Screens and filters**
   - Check all screens and filters to make sure that the flow of water is not restricted.

4. **Gauges**

- Pressure gauges are a quick and easy way to check performance. If pressure gauges aren't installed on the system, get them installed. If pressure gauges are broken, replace them.
- Working pressure gauges should be installed on all pump delivery pipes, inlet pipes and irrigator inlets.

5. **Spray pattern**

- Inspect the spray pattern of each irrigator, as each sprinkler should have an even spray.
- Poorly performing sprinklers will often emit a single jet of water, or a fine mist that blows away in a slight wind.
- Broken sprinklers should be replaced immediately to restore the design spray pattern.

6. **Sprinklers**

- Take the time to stop and check individual sprinklers, even if the spray pattern looks good.
- Remove several sprinklers to see if there is any build-up inside the sprinkler or pressure regulator. Silt, algae or other blockage in one sprinkler probably means they all need cleaning.

7. **Off-target**

- Off-target irrigation is water that is sprayed where it should not be. Some common examples of off-target irrigation are:
  - spraying over fence lines (onto neighbour's property)
  - spraying onto roads or lanes
  - double-watering where lane spacing is incorrect.
- Off-target irrigation can be a big waste of water, a waste of electricity and can mean less production. Make any changes you can to reduce off-target irrigation.

8. **Ponding**

- Some ponding is likely under any type of irrigation. Minor ponding is acceptable, but too much will cause problems. The more ponding and runoff that occurs, the less evenly watered the plant roots will be.
- Ponding becomes a problem when it is very deep (more than a few millimetres), it runs downhill or it collects in the same spots after every application.
- Ponding and runoff may be caused by applying too much water (total depth – mm) per pass, applying water too quickly (rate – mm/hr) for the soil or damaged soil (i.e. pugged or compacted soil) which doesn't let water in as quickly.
- If ponding or runoff are problems, work will need to be done to figure out ways to fix it. Continue with the rest of the evaluation and come back to this later.

Common unit conversions

Flow rate

		Desired unit			
		m^3/hr	m^3/min	gpm	l/s
Starting unit	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

Pump power

1 hp = 0.735 kW

Pressure

		Desired unit			
		psi	kPa	bar	m
Starting unit	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
mm applied (irrigation or rainfall) → m^3	mm x 10 x ha = m^3

Water depths and volumes

		Desired unit
		m^3
Starting unit	litres	0.001
	gallons	0.0045

Other tools

Soil moisture monitoring

There are many methods available to show how irrigation is affecting the plant root zone.
myirrigation.co.nz > Click on 'free guides'

Irrig8Quick

For measuring performance parameters in more detail. Includes application uniformity (e.g. CU or DU).
pagebloomer.co.nz > Click on 'resources'

DairyNZ Guide to Good Irrigation – parts one and two

dairynz.co.nz/irrigation

References

INZ, Irrigation Code of Practice and Irrigation Design Standard

INZ, Irrigation Evaluation Code of Practice **irrigationnz.co.nz**

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DairyNZ DIY irrigation performance evaluation – results page

	Info from supplier			Units (circle one)	Results of evaluation			
	Pump 1	**Pump 2**	**Pump 3**		**Pump 1**	**Pump 2**	**Pump 3**	
Pump flow rate				l/s m³/hr gpm				**3a**
Pump power rating/use				kW hp				**3b**
Pump delivery pressure				m kPa bar psi				**3c**
Surface pump suction, or depth to water				m				**3d**
	Irrig. 1	**Irrig. 2**	**Irrig. 3**		**Irrig. 1**	**Irrig. 2**	**Irrig. 3**	
Pressure to run the irrigator				m kPa bar psi				**4a**
Application depth				mm/pass				**4b**
Distribution uniformity (DU)				%				**4bb**
Irrigator flow rate				l/s m³/hr				**4c**
Irrigated area				ha				**4d**
Return interval				days				**4e**
System capacity				mm/day l/s/ha				**5a**

Soil profile available water (PAW)* (used in step 5b)				mm	* PAW is available from your regional council or irrigation/soils consultant
Multiplier or meter factor ** (used in step 3b option 2)				(e.g. 40x)	**Multiplier is available from your power company, quote your ICP number

Number of days for soil to dry out (the return interval, 4e, should be less than this)				**5b**
Pumping efficiency Most irrigation pumps operate between about 0.6-0.7 (60-70%)				**5c**

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