Irrigation Efficiency

Principles to Practice

Evaluating Your Pressurised Irrigation System

Perth Region NRM

CARING FOR OUR COUNTRY

Version: WA 20 September 2011

These materials are part of the WaterWise on the Farm education program Introduction to Irrigation Management. They were developed by NSW Agriculture staff from the Water Management subprogram with major input from Lindsay Evans.

CONTENTS

AIM

The aim of the workshop is to give you skills and knowledge to assist you improve your water use efficiency and irrigation system management.

The workshop will highlight the importance of efficient irrigation and methods available to manage and/or modify an irrigation system for efficient operation and improved production.

The skills you learn in this workshop will assist you to perform tests on your own system, and identify if changes to equipment, or how you operate it, are required to improve your irrigation efficiency.

INTRODUCTION

The Irrigation Efficiency – Principles to Practice course was developed to improve the water use efficiency of the irrigation industry. Irrigation Australia define water use efficiency (WUE) as:

Water use efficiency	**=**	**Volume (tonnes of kg)**	**÷**	**Unit of water applied**

Water use efficiency is typically described in terms of tonnes per megalitre, or bales of crop per megalitre. It represents a combination of the irrigation system and agronomic efficiencies for a crop.

Managing our water more efficiently (increased WUE) may lead to increased production and greater control over the quality of our produce from a given amount of water.

In order to manage our water more efficiently it is essential that our irrigation systems are efficient and use water wisely. In this workshop we look at two areas of irrigation system efficiency of a pressurised irrigation system:

- Distribution uniformity; and
- Mean Application Rate

'I learnt about measuring soil moisture requirements and the distribution uniformity percentage (DU%) of my system.

'Previously we had irrigated on a gut feeling: now we are a lot more precise, and, from our newly acquired knowledge on pressure requirements and DU%, we have plans to improve our irrigation system.'

The scheduling workshop introduces you to skills in timing your irrigations and how much water is required, however to use scheduling effectively you must know that your application rate is correct and water is distributed evenly.

LEARNING OUTCOMES

When you have completed this workshop you will be able to:

- Identify the importance of irrigation efficiency.
- Measure and record performance characteristics of an irrigation system.
- Discuss how the performance characteristics impact on total water use and crop uniformity.
- Perform calculations in order to evaluate the functioning of an irrigation system.

A well-designed, maintained and operated system uniformly delivers the correct amount of water to the crop, at the correct time, with the minimum of water losses.

Workshop activities

To assist you achieve these learning outcomes there are a number of workshop activities for you to complete. These activities include:

- Discussing irrigation efficiency.
- Using a checklist to evaluate your system's operation.
- Interpreting technical data and making comparisons between emitters {note: emitters are sprinklers, drippers, micro and mini-jets, and so on. We use the term 'sprinkler/emitter' in these notes.}*
- Measuring and Calculating how much water is being applied by the system.
- Measuring and Calculating the uniformity (evenness) of application of an operating irrigation system.
- Measuring pressure and flow at various locations in the system.

Assessment

The course is competency based. By satisfactorily completing Workshop activities during the course, you will demonstrate that you have met the learning outcomes. This method of training and education benefits both you and the trainer as any topics that have not been clearly covered may be quickly reviewed.

These activities are designed to give you experience in measuring and calculating the figures needed to determine your system's mean application rate and distribution uniformity.

Program

This workshop is made up of three Topics:

- Irrigation efficiency
- Irrigation system evaluation
- Specific system evaluation

The topics include workshop activities, notes, worked examples and practical application of material.

HOW EFFICIENT IS YOUR PRESSURISED SYSTEM?

Your irrigation system is one of the most important features of your enterprise. To supply water to your crops in the right amount and at the right time it is vital that your irrigation system is performing efficiently. An irrigation system that is running inefficiently will cost you water!

Activity 1: How efficient is your irrigation system?

Start by taking a few minutes to answer these questions:

Does your irrigation system:	**Yes**	**No**	**Unsure**
Deliver water at a rate that is less than the infiltration rate of the soil?			
Have the capacity to apply enough water to meet crop requirements without waterlogging?			
Run for the right amount of time to deliver the amount of water needed by the crop?			
Apply water evenly to the root zone, and across the paddock?			
Use the emitters (the sprinklers or drippers) that the system design and crop requires?			
Use an efficiently operating pump (one that is operating with correct suction and delivery pressures, no blockages, and at the most efficient point on the pump performance curve)?			
Operate within specific design parameters?			
Operate efficiently within the physical and topographic conditions of the area (for example, rock, slope, trees, power poles, water quality)?			
Match the overall management and labour constraints of the farming enterprise?			

This workshop aims to give you the skills to be able to assess aspects of your system efficiency. With our irrigation systems, we need to look closely at its performance in order to determine whether it is operating correctly and whether that operation actually does what we expect.

IRRIGATION EFFICIENCY

The aim of efficient irrigated agriculture is to get maximum production for the same or less input. For example, growing more or better quality crop with the same or less amount of water.

One measure of efficiency relates product to unit of water applied. For example, tonnes of product per megalitre of water applied. This is called water use efficiency. This measure of efficiency combines system, crop, and agronomic aspects.

Irrigation efficiency is the percentage of water that actually gets into the soil and is used by the crop, compared with the amount supplied to the system.

The amount or volume of water available for irrigation is a major limitation to our ability to water crops and pastures. Over-irrigating or irrigating inefficiently not only wastes water but also money and adversely affects the environment. Consider the cost of unnecessary pumping and or nutrient wastage (particularly with fertigation).

There are many situations in the irrigation system where water may be lost and become unavailable to your crop (figure 1).

Water losses typically occur through:

- Over-watering;
- System leakage;
- Deep drainage; and
- Direct evaporation from foliage and soil.

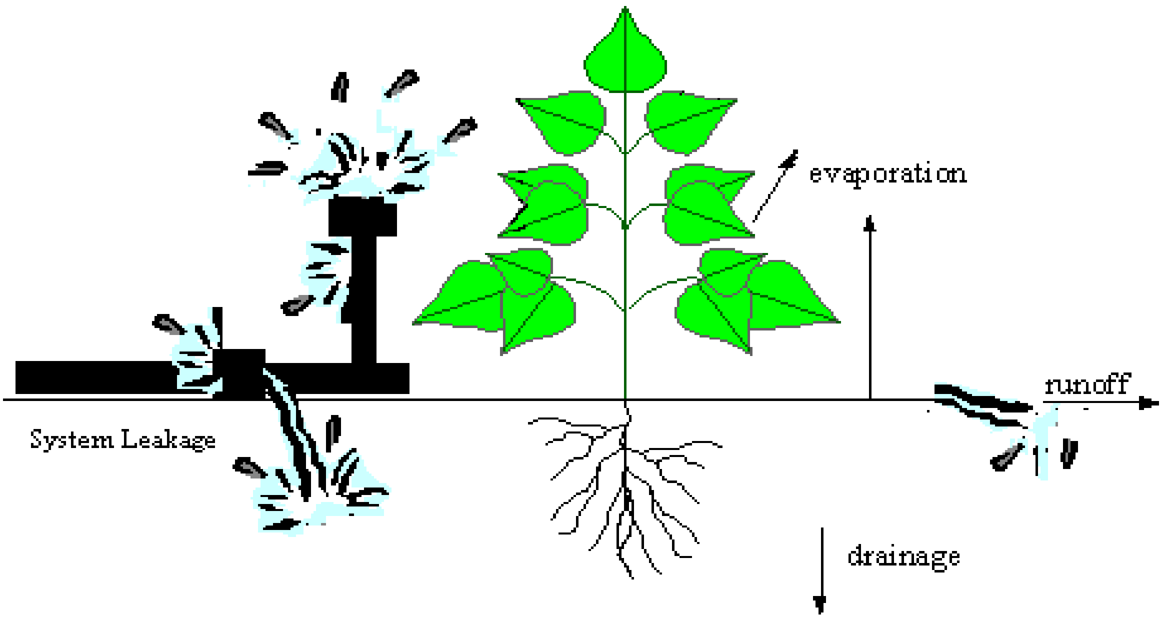


Figure 1: Areas of potential water loss in an irrigation system

In order to meet the crop water requirements an irrigation system should take into account the soil types, topography, and the crop. To avoid excessive water loss the system should also be installed and maintained correctly.

With an efficiently operating, well-designed, and well-managed pressurised sprinkler system, nearly all the water supplied to the crop will be used by the crop.

There are many ways of assessing the efficiency of the components of an irrigation system. In this workshop, we are concerned with measuring the rate and uniformity of water application. To determine the rate and uniformity of water application, we:

- Calculate the mean application rate (MAR).
- Calculate the evenness of application at various points in the system (that is, the distribution uniformity, DU).
- Measure the pressure and flow at various points in the system and compare this to the manufacturer's data.
- Compare this to the soil infiltration rates.

This information will indicate the application efficiency of our irrigation system. That is how well we are applying water to our fields. In order to evaluate the efficiency of our whole irrigation system we will however, need to also investigate the pump, pipelines, valves, supply, drainage, and other associated components of the irrigation system.

Applying water evenly

Avoiding excessive water waste is an important feature of irrigation efficiency. However, even if losses are kept low, the system may still be inefficient if the water is not getting to where it is needed. If the application is not even (or uniform) over our irrigated area then some areas will get over-watered while some will not get enough.

A common tactic to compensate for uneven watering is to apply the water for longer. While this may mean that all areas get sufficient water, there are penalties from over-watering, including:

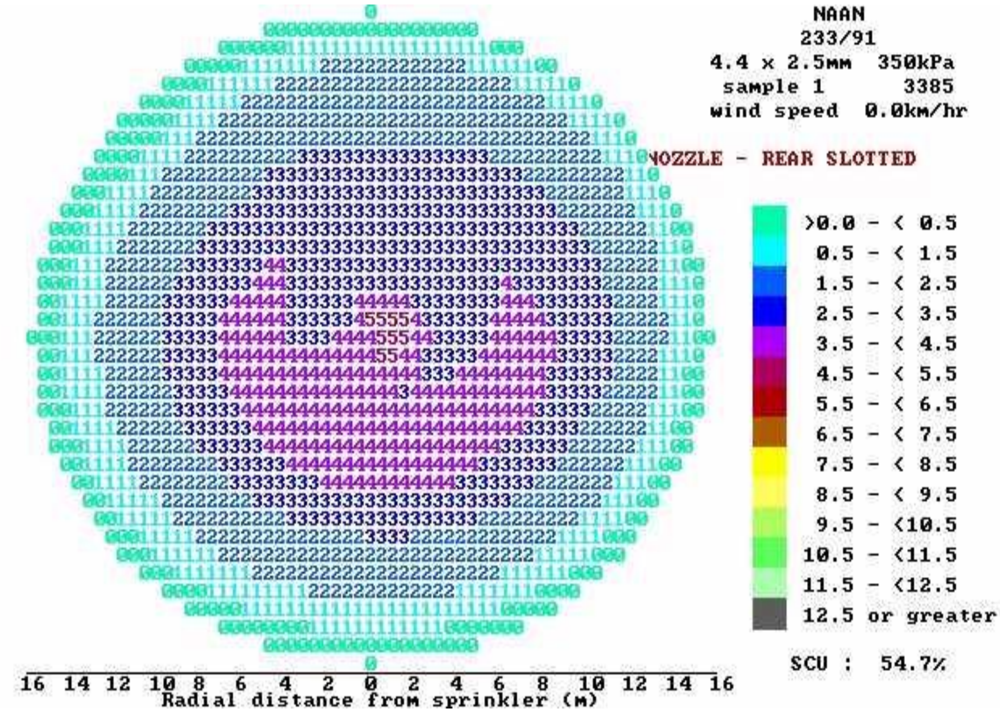
- increased water use;
- increased pumping costs;
- excessive run-off and losses to deep drainage;
- reduction in the area that may be irrigated; and
- decrease in yield due to waterlogging roots in some areas.

The aim of an efficient irrigation system is to evenly apply the correct amount of water to the target area. Therefore, in order to achieve irrigation efficiency we must first investigate the wetting pattern of our sprinklers and the factors that influence this pattern.

Wetting patterns for sprinklers

With the exception of drippers and specialised nursery nozzles, the general wetting pattern of sprinkler/emitter is circular. However, the amount of water over this wetted area will vary greatly. That is not all of the wetted area receives the same amount of water.

In Figure 2, we can see (from a bird's eye view) how the amount of water decreases as we move away from the sprinkler/emitter at the centre of the wetted area.



⊕ Emitter

Figure 2: Wetting pattern of a sprinkler/emitter.

Note: The numbers on these charts represent the amount of water falling at that point in millimetres per hour.

This means that the area covered by the sprinkler/emitter does not receive equal amounts of water. If we took a cross section of our sprinkler distribution, we could see pattern of the nozzle (Figure 3).

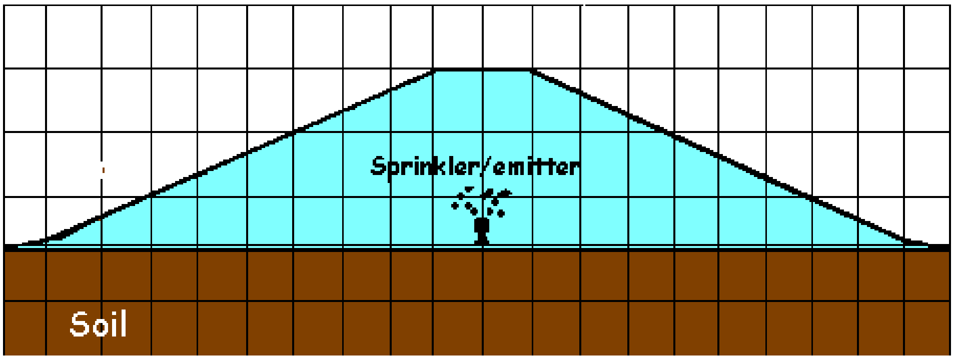


Figure 3: General soil wetting pattern from a sprinkler/emitter

To achieve an even distribution of water many irrigation systems overlap the wetting patterns of the sprinklers (Figure 4). This results in an even amount of water over the irrigated area. That is, the total amount of water received in the overlapping areas (hashed area in Figure 4) is similar to the highest amount received near the sprinkler/emitter.

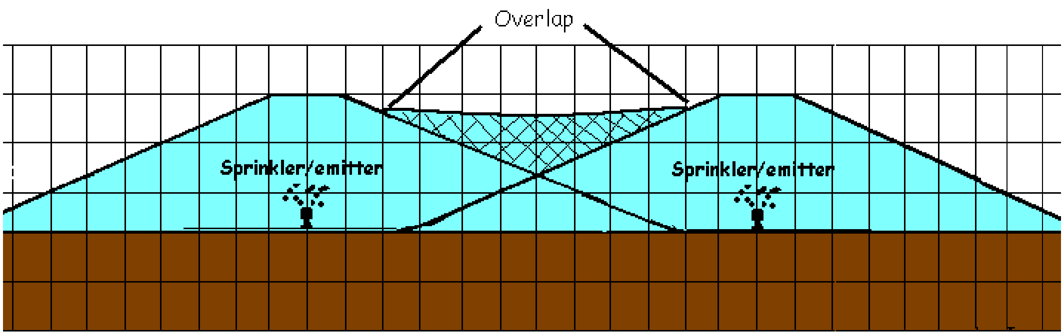


Figure 4: Overlapping wetting patterns of sprinklers to produce a uniform application of water

In order to determine the efficiency of our irrigation system we therefore need to determine how much water is being applied and how well it is being distributed. The two terms we use to describe the application rate and uniformity of an irrigation system are the mean application rate (MAR) and distribution uniformity (DU). When you are able to calculate these for your own system you will be able to evaluate how effectively it is operating.

Mean Application Rate (MAR)

The mean application rate (MAR) is the average rate (in mm/h) that water is applied to the wetted area of the soil. It is very important that the MAR does not exceed the infiltration rate for the soil. Otherwise, run-off will result.

With travelling systems, the situation is different because the machine moves over the field. In this case it is the instantaneous application rate (not the MAR) that must not exceed the long-term infiltration rate of the soil. Increasing travel speed does not reduce the instantaneous application rate. Less water is applied (less RAW is replaced) but you may be just filling the cracks in the soil. This is a common occurrence with travelers.

The mean application rate tells us the average amount of water being applied at any given point in the wetted area each hour. However as we discovered earlier, the wetting pattern of a sprinkler/emitter will vary. In order to determine how evenly our system is distributing this water we will need to estimate the Distribution Uniformity (DU%).

Distribution uniformity (DU)

The DU, often expressed as a percentage, gives an indication of how evenly your sprinklers/emitters are operating or overlapping.

The higher the DU, the more evenly your water is being distributed. A DU greater than 75% is acceptable for most sprinkler systems. New drip systems should have a DU of 95%, while in older drip systems a DU of 85% is acceptable.

The MAR and DU will indicate how well your system supplying water to the crop. If you discover that you system is performing poorly then the next step is to discover the possible sources for this poor performance.

MAR and DU may be effected by sprinkler/emitter wear and, with overlapping systems, the sprinkler/emitter position. Incorrect spacing of sprinklers in both fixed and travelling systems will result in a low DU. It is therefore very important to have the system correctly designed and installed.

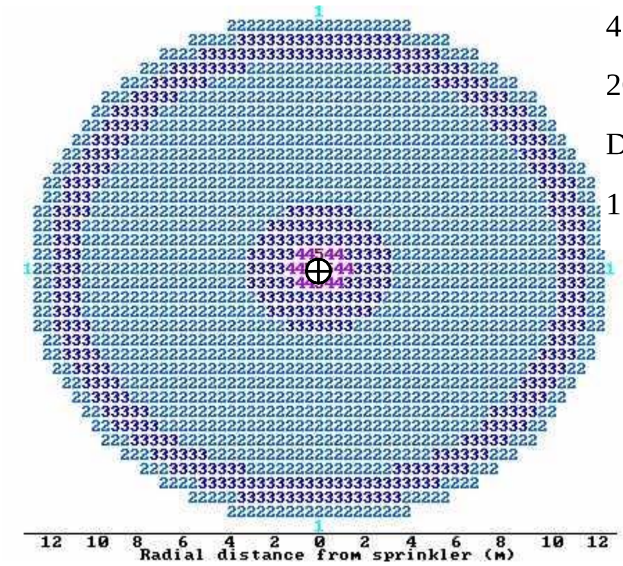
However, if the irrigation system is correctly designed and still performing poorly we may need to investigate the Operating Pressure and Flow Rate. After the design of your irrigation system, the most important aspects to consider are the manufacture specifications of **Operating Pressure** and **Flow Rate**.

Pressures and flows

Incorrect pressures and flow rates are common causes of system inefficiency. It is important to run your system at the designed pressure. Operating pressure can dramatically affect the sprinkler/emitter pattern and output, and therefore the efficiency of an irrigation system.

This is because the sprinkler/emitter is manufactured to create specific sized droplets and wetting pattern at the designated pressure.

For example if a sprinkler/emitter is operated below its correct pressure, large droplets are formed and tend to be thrown further than small droplets. This results in a 'doughnut ring' shaped output (Figure 5).



4.4 x 2.5 mm

200 kPa

Discharge

1312 l/H

4.4 x 2.5 mm
200 kPa
Discharge
1312 1/H

⊕ Emitter

Figure 5: Operating pressure too low.

Note that the correct operating pressure for this nozzle (Figure 2) is 350 kPa.

The cross section of our sprinkler pattern outlines the unequal distribution of water from the sprinkler run below pressure (Figure 6). This means that some areas of your irrigated crop would not receive the correct amount of water.

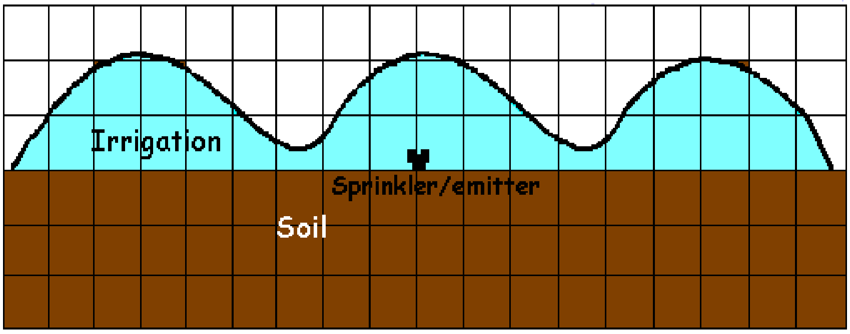


Figure 6: Pressure to too low.

The uneven application is magnified when the sprinklers are overlapped (Figure 7).

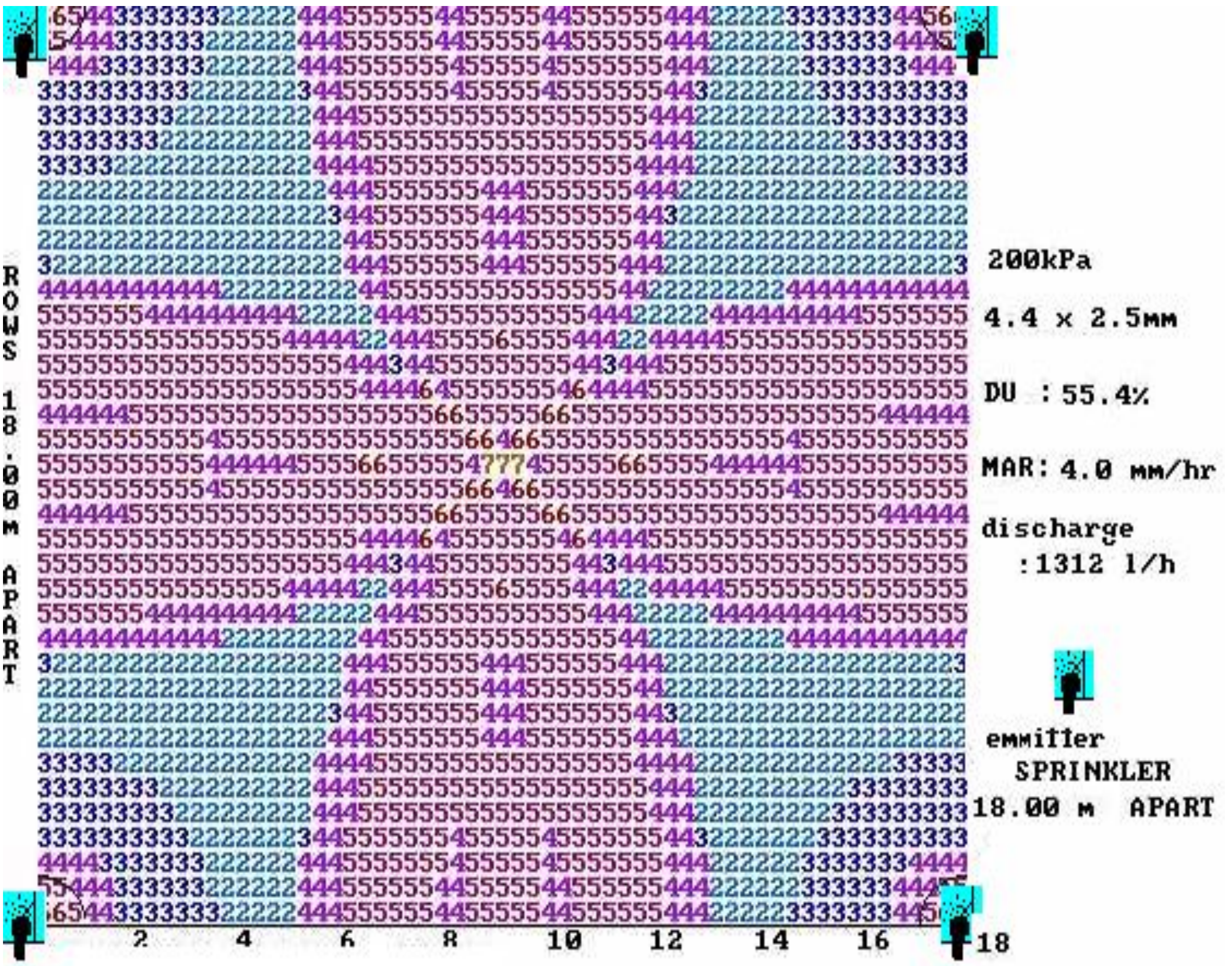


Figure 7: Overlapping sprinkler patterns.

Note: There is a sprinkler/emitter at each corner.

Operating below the specified pressure will therefore result in areas receiving too much water while other areas receive too little (Figure 7). This has the potential to reduce crop production while at the same time wasting valuable water.

Operating your system at pressures above the manufacturers level will also cause an irregular wetting pattern. If the pressure is too high, the sprinkler/emitter will produce fine droplets. This will cause the water to fall close to the sprinkler/emitter (Figure 8), or create a fine mist that will drift with wind and be prone to evaporation.

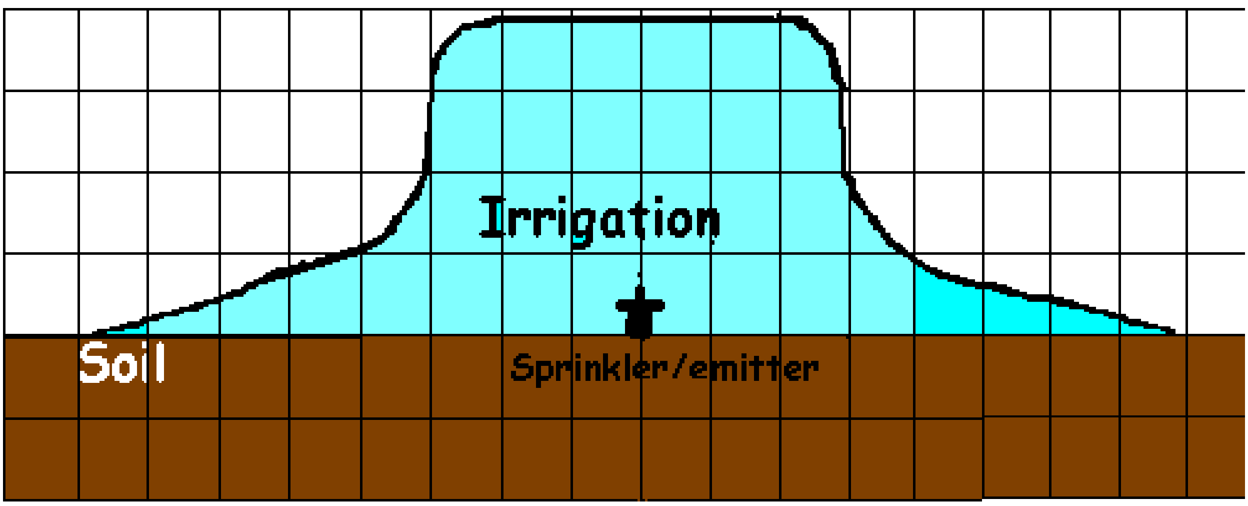


Figure 8: Pressure too high.

Operating at pressures above the recommended may leave areas under-watered while other areas receive more than is necessary.

A variation in pressure between sprinklers/emitters of more than +/- 10% is an indication that the system is not operating efficiently. If pressure is restricted then the flow will be reduced. Similarly, a flow variation of greater than ± 5% is unacceptable.

Reasons for pressure and flow variations include:

- wear and blockages in sprinklers/emitters;
- system not designed correctly;
- system not being used as designed;
- system leakages; and
- pump not performing (the pump may be worn or not being operated at best efficiency).

Pressure compensating sprinklers/emitters are used in many systems to maintain the flow rate and pattern across a wide range of pressures that may occur along a sprayline or due to differing positions in the paddock of travelling systems.

When evaluating your system you must measure pressures and flows and compare these to the pump and sprinkler/emitter specifications. In Table 2, you can compare some typical sprinkler/emitter pressures and flows.

Table 2. Common operating pressures and flows of various irrigation systems

Sprinkler/emitter type	Pressure range (kPa)	Flow rate range (L/h)
Dripper	100-300	1.2–8
Micro-jet	100–150	25–200
Mini-sprinkler	100–300	35–350
Low-throw impact sprinkler	180–300	300–1200
Overhead impact sprinkler	240–400	700–3000
Centre pivot	100–400	100 000–200 000

SYSTEM EVALUATION

By evaluating the delivery of water by your irrigation system, you can tell whether it is causing or contributing to any of the problems mentioned earlier. Depending on your exact system and layout, the evaluation procedure will vary. The worksheets cover evaluation methods for specific systems in more detail, however there are four general steps.

Step 1: Check components

Before you take any measurements, you should conduct a general physical check of all components and make sure the system is operating as correctly as possible. This means checking that there are no leaks or suction problems, and that the number of outlets operating, their size and their pressure match the system design.

Step 2: Measure pressure and flow

If possible, you should have the original design figures for the system available. As a minimum, you should have the pressure and flow charts for the sprinklers/emitters.

Check pressures and flows at various points within each block and across the whole system. After taking the readings, make any adjustments needed before continuing.

You may find the output and distribution of a system is correct at one point, and not at another. This could be because:

- a different supply main or hydrant is being used (end or high point versus start and low point);
- a hydrant is not set correctly (these can be adjusted to adjust pressure), or
- other sections are being irrigated.

Make sure all testing is done with the system operating in its normal configuration.

Measuring across a whole shift and within a block

One way to check pressures and flow for any system, including drip, is to measure at the ‘near’, ‘far’, ‘high’ and ‘low’ points of the complete system. After that, each individual block or section should be tested.

With travelling systems, it is important to check the pressure when the traveller is at high and low points.

Step 3: Measuring mean application rate (MAR)

To measure MAR, catch cans are placed in the irrigated test area and the amount of water (mL) collected is measured, converted to a depth in mm, and then divided by the number of cans to give a MAR in mm/h.

MAR	=	**Total depth (mm) collected in catch cans per hour**	÷	**Number of catch cans**

For drip systems, the procedure varies slightly. The output from a dripper is collected over a measured time, and the amount collected divided by the wetted area.

Dripper MAR	=	**Volume collected from the dripper**	÷	**Average wetted area**

The result then needs to be converted to an hourly basis. That is, the mm applied is divided by the number of minutes the test. Then this answer is multiplied by 60 to get the "per hour" rate

Note: We multiply by 60 because there are 60 minutes in one hour.

If the MAR exceeds the infiltration rate of the soil (or half the infiltration rate, with some overlapping sprayline systems), you should make adjustments to reduce the MAR. This is further explained in the worksheets.

Note: With traveling irrigators it is the instantaneous application rate (rather than the MAR) that must not be exceeded.

Step 4: Measuring distribution uniformity (DU)

Distribution uniformity (DU) was defined earlier. When all the volumes have been converted to depths, the lowest 25% are selected. The average of the lowest 25% is divided by the MAR to give the DU figure.

DU	=	**Average depth of lowest 25% of cans**	÷	**MAR**

(For drippers, use the volumes of the lowest 25% of the drippers being checked.)

Non overlapping systems by their nature do not require a distribution uniformity. However, we still need to estimate where the water is being delivered so we calculate a distribution coefficient.

Comparing systems by MAR and DU

To see how distribution uniformity affects water usage, we will compare the effect of a particular irrigation system operating at two different pressures: 200 kPa, and 350 kPa. The example system is a bike-shift system operating on 33 hectares of perennial ryegrass and clover pasture.

System details

Sprinklers – Naan 233/91 – 4.4 mm x 2.5 mm jets, spacing 18 m x 18 m with each of 126 sprinklers having 9 shift positions.

This system requires each sprinkler to be moved twice per day for an irrigation interval of 4.5 days in times of peak demand.

		System 1	System 2
Operating pressure	A	200 kPa	350 kPa
Irrigation deficit	B	20 mm	20 mm
Mean application rate	MAR	4 mm/h	5.2 mm/h
Distribution uniformity	DU	55.4% (0.554)	76.6% (0.766)
Number of shift positions	C	9	9
Number of sprinklers	D	126	126
Flow rate	E	1312 L/h	1670 L/h
Irrigation time	**=**	**Irrigation deficit ÷ MAR ÷ DU**	
	F	B ÷ MAR ÷ DU 20 ÷ 4 ÷ 0.554 = 9 hours	B ÷ MAR ÷ DU 20 ÷ 5.2 ÷ 0.766 = 5 hours
Pump flow required:		**Number of sprinklers x flow rate**	
	G	D x E 126 x 1312 = 165,312 L/h	D x E 126 x 1670 = 210,420 L/h (Note the higher flow rate required.)
Total volume per application = Pump flow x Irrigation Time x Number of shifts positions			
		G x F x C 165,312 x 9 x 9 = 13,390,272 L = 13.39 ML	G x F x C 210,420 x 5 x 9 = 9,468,900 L = 9.47 ML
If there are 18 irrigations over the 33 hectares per season, then the total water use is			
Total volume required		= 13.39 ML x 18 = 241 ML or 7.3 ML/ha	= 9.47 ML x 18 = 170 ML or 5.2 ML/ha

You can see that the system operating at the higher pressure and flow is applying 71 ML less every year. The higher water use of System 1 is the result of its poor (low) distribution uniformity. System 1 uses a lower pressure and flow rate, but takes almost double the time to achieve an irrigation of 20 mm over the area.

Having a higher DU results in savings of water and time. Pumping costs are also reduced - however, higher pressures may not always be the solution. An alternative sprinkler may provide the best option.

Always make sure that the MAR does not exceed the infiltration rate of the soil.

SPECIFIC SYSTEM EVALUATION

Due to the range of pressure systems in use throughout the irrigation industry, specific technical reference material for the different systems has been developed. Select the group that best describes your irrigation system from those listed below. This will contain the appropriate reference material/worksheets for your particular irrigation system evaluation.

Reference material and worksheets	System #
Travelling irrigator and rotating boom	1
Non overlapping lateral boom and linear move	2
Centre pivot	3
Spraylines, (side rolls, end tow, hand shift)	4
Fixed overlap under canopy micro	5
Fixed overhead, solid set, bike shift	6
Non overlapping under canopy spray	7
Drip	8

Refer to specific system evaluation notes for methods and calculations.

CONCLUSION

When you have completed the evaluation exercises, you will know how to measure the pressures and flows within a system and determine the mean application rate and distribution uniformity of a pressurised irrigation system.

You should now work through an evaluation of a system as outlined in the worksheets.

APPENDICES

Mini/micro sprinkler performance chart

Sprinkler colour	Nozzle size (mm)	Pressure (kPa)	Diameter (m)	Flow rate (L/hr)
Black	1.0	100	5.4	29
		150	6.3	35
White	1.3	100	6.0	46
		150	7.2	56
Green	1.6	100	7.1	72
		150	8.3	87
Blue	2.0	100	7.4	104
		150	8.6	126
		200	9.1	147
Yellow	2.4	100	8.2	140
		150	9.6	183
		200	10.3	211
Red	2.8	100	8.3	192
		150	9.8	240
		200	10.5	276

Medium pressure rotating sprinkler performance

Colour	Grey		Green		Orange		Yellow		Blue		Red		Maroon	
Size (mm)	4.4		4.9		5.4		6.1		6.6		7.1		7.6	
Kpa	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m
200	26.0	17.9	26.3	20.9	25.8	24.2	27.7	30.2	29.2	35.1	28.0	37.8	30.0	43.0
250	26.6	20.1	26.4	23.4	28.2	27.3	28.1	33.9	30.8	39.0	32.0	42.9	31.5	48.1
300	27.1	22.0	29.3	25.8	30.0	30.0	30.0	36.9	32.0	42.5	32.0	47.0	32.4	52.5
350	27.6	23.8	30.0	27.8	30.0	32.4	30.6	39.9	33.7	46.0	33.9	50.8	34.6	56.7
400	28.5	25.4	30.0	29.9	30.3	34.5	30.7	42.6	34.4	49.0	34.1	54.3	35.9	60.7

Jet	4.4 x 3		5.4 x 3		4.9 x 5		6.1 x 3		7.1 x 3		6.6 x 5		7.1 x 5		7.6 x 5	
kPa	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m	Dia. (m)	L/m
200	25.1	24.8	27.6	30.9	24.4	32.1	26.1	36.5	26.7	43.8	26.1	43.9	25.8	46.9	26.2	50.2
250	26.4	28.1	28.2	34.9	27.0	36.0	27.7	40.7	29.4	48.9	28.1	48.9	28.6	52.6	28.8	56.2
300	27.4	30.8	29.3	38.3	27.6	39.7	28.8	44.8	30.6	53.7	29.7	53.2	30.6	57.7	30.5	61.4
350	28.3	33.2	30.3	41.4	28.7	42.8	29.6	48.1	31.7	58.4	30.6	57.8	30.7	62.5	31.8	66.5
400	28.2	35.4	30.5	44.1	29.0	45.4	30.2	51.8	33.3	62.3	31.7	61.5	31.7	66.7	33.5	73.4

Sprayline discharge and application rates

Spacing	Min. dia. of coverage	Application rate (mm/hour)			
		7 mm	8 mm	9 mm	10 mm
metres	**metres**	**Sprinkler output (L/min)**			
14.6 x 7.3	22.7 m	12.5	14.3	16.1	17.8
14.6 x 9.1	22.7 m	15.6	17.8	20.1	22.3
14.6 x 14.6	26.9 m	25.0	28.5	33.2	35.7
18.2 x 9.1	28.3 m	19.5	22.3	25.1	27.9
18.2 x 12.2	26.8 m	26.0	29.7	33.4	37.2
18.2 x 14.6	30.4 m	31.2	35.7	40.1	44.6
21.9 x 14.6	34.3 m	37.5	42.8	48.2	53.5
27.3 x 18.2	42.9 m	58.5	66.9	75.3	83.6

Performance data for travelling irrigators

Sprinkler	Nozzle size	Sprinkle pressure	Output rate	Wetted width	Approx. lane spacing	Average preciptation rate (full circle)	Approx. area per run	400 metre run			
								Gross application			
								7.5 hour run	11 hour run	22 hour run	44 hour run
	mm	kPa	L/sec	m	m	mm/hr	ha	mm	mm	mm	mm
NELSON	32.0	482	18.65	104	62	7.9	2.5	20.3	29.8	59.6	119.1
		551	19.86	106	64	8.1	2.6	21.0	30.7	61.4	122.9
P150R	34.0	482	22.44	108	65	8.8	2.6	23.7	34.2	68.4	136.7
		551	24.03	112	67	8.8	2.7	24.2	35.5	71.0	142.0
21o	35.8	482	26.23	112	67	9.6	2.7	26.4	38.8	77.5	155.0
		551	28.13	117	70	9.4	2.8	27.1	39.8	79.6	159.1
	32.8	551	18.35	107	64	7.3	2.6	19.4	28.4	56.8	113.5
		620	19.56	110	66	7.4	2.6	20.0	29.3	58.7	117.4
NELSON	37.1	551	24.03	116	70	8.2	2.8	23.2	34.0	68.0	135.9
		620	25.55	120	72	8.1	2.9	24.0	35.1	70.3	140.5
P200R	39.6	551	28.13	122	73	8.7	2.9	26.0	38.1	76.3	152.6
		620	30.03	126	76	8.7	3.0	26.7	39.1	78.2	156.5
21o	42.2	551	32.53	127	76	9.2	3.0	28.9	42.4	84.7	169.5
		620	34.42	132	79	9.0	3.2	29.4	43.1	86.3	172.5