

How to evaluate the performance of CP&LM systems

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There has been much pressure on managers of surface irrigation systems to improve their performance. Many have done so by changing management practices and system configuration and design. Quite a few others have opted to change to centre pivot or lateral move systems on the basis that they are more efficient. But this is not necessarily true, even for newly installed systems.

From several simple field tests and a few calculations, you can check the uniformity, application depth, system capacity, speed and emitter performance of your overhead system.

Testing uniformity

For machines using sprinklers, the basic test is a catch can test. By laying out a row or two of containers and measuring the amount of water applied in each individual container, a lot of useful information can be determined. The process is not difficult and no special equipment is needed.

For machines using LEPA socks or bubblers, the same calculations can be performed by substituting the discharge at each outlet for the catch can data.

When using catch cans:

- Use relatively small containers, preferably all the same size and shape to make calculations easier. Plastic food containers with diameter 110–115 mm, as used by takeaway Chinese food restaurants, are cheap and handy. Irrigation Australia sells calibrated catch cans complete with peg and holder. Rain gauges are okay if you can afford to buy enough of them.
- Choose a suitable location for the test so that catch cans are able to be placed across the pathway of the linear move



Checking emitter flow rates.

- or centre pivot. Often the first span or two of a centre pivot (no more than 20 per cent of the machine length) are ignored.
- Lay the cans out in a row, spaced no more than five metres apart. For sprinklers with a smaller throw radius (such as static plate sprinklers) cans should be no more than three metres apart. Avoid placing them where they will be damaged (such as, in wheel tracks), will receive excessive water (directly under tower components) or be knocked over. If they're not pegged, it pays to put a small weight such as a stone in each one.
- Add at least two extra containers on each end to allow for changes in wind speed or direction.

- If rain is likely, place another can away from the boom, to record rain during the test. Any rain must be deducted from the amount caught in each catch can. When the machine has completely passed over all of the catch cans, measure and record the volumes in each container. Each volume must be written in the space on the field record sheet that corresponds with its position. If there is no catch can or no reading at a position, leave it blank.

Testing pressure

- Obtain suitable tees and fittings to be installed above the pressure regulators or emitters sufficient for several emitters, and a suitable pressure gauge.
- Attach fittings, etc. above the pressure

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<14...EVALUATING CP&LM SYSTEMS

regulator and emitter at a number of locations. Select several emitters, at least one on the first span, one on the last span and one in between.

- Record the make, model and nozzle size or colour of the emitters, and the outlet position number from the centre.
- When the system is operating, record the pressure of the selected emitters using the pressure gauge. If possible, take a reading at the centre or cart too.

Checking emitter flow rate

- When the system is operating, measure the flow rate by holding a fairly large container of known volume (such as a 10 litre bucket) under one emitter and timing how long it takes to fill (don't forget your raincoat!). Record measurements from at least one emitter per span and note the span and outlet position numbers.
- Measure the wetted diameter of these emitters. For a centre pivot, avoid the inner spans. Placing pegs or markers at the limits of throw in front and behind the boom, then measuring the distance between them after the machine has passed is the simplest way.
- If a flow meter is fitted, take a reading of the flow delivered to the entire machine.

Measure the speed

- The irrigator must be moving (at its normal speed) throughout the test.
- Record the control panel settings/readings for speed and application depth.
- Mark a point on the ground when you first arrive that is level with a specific point on the machine and record the time. For a centre pivot, it must be a point on the outer tower. When you have finished taking other measurements, mark where that point on the machine has now travelled to and record the time again.
- Measure the distance between your two marks (this distance should be at least 10 metres, otherwise come back and mark the second point later).

Other information

- Measure and record the tyre sizes and pressures – should be around 100 kPa (15 psi).
- Record wind speed and direction.

CALCULATIONS

From the catch can data, the Average Application per Pass and the Distribution Uniformity or Coefficient of Uniformity

can be calculated. Spreadsheet calculators to reduce the time and complexity may be available from your irrigation advisor or agency.

- Convert the volume measurement (ml) of each catch can into a depth measurement (mm).

$$\text{Depth} = \text{Volume} \div (3.14 \times \text{radius}^2)$$

For catch cans of 110 to 115 mm diameter, simply dividing by 10 will be accurate enough.

Average application depth

- *Average Application Depth (AAD) = Total depths of all cans ÷ Number of cans*

Compare this to the application depth specified on the control panel or operating schedule for that speed.

Distribution uniformity

- *Distribution Uniformity (DU) = Average depth of lowest quarter cans ÷ AAD*

For centre pivots, DU must be calculated by weighting each catch can result relative to its position. This is because each can represents a larger area as you move out from the centre, and the output should also increase as you move out from the centre. Calculations of the lowest quarter average depth are complex and spreadsheets are available to do them.

Christiansen's Coefficient of Uniformity

- Christiansen's Coefficient of Uniformity (CU) – compares depth for one catch can position to the average depth for all catch cans.

For centre pivots the modified Heermann and Hein uniformity co-efficient must be used (CUHH). This calculation weights the catch can results relative to their position.

- CP&LM machines should be able to perform with a DU or CUHH of 90 per cent or greater.

Note that for LEPA systems the emitter discharges measured will be used for uniformity calculations instead of the catch can measurements.

Emitter flow rate

- *Emitter flow rate = Container volume ÷ Time taken to fill*

Compare the test results with the flow specified for each emitter in the manufacturer's specifications. Variations help to explain any poor uniformity and maybe due to worn sprinklers, faulty pressure regulators, emitters in wrong position, incorrect emitters fitted, overall flow rate too high or low, etc.

Pressure measurements

- Compare the test results with the pressure specified for each emitter in the manufacturer's specifications.
- For pressure regulators to work properly, the pressure above a regulator should be at least 35 kPa (5 psi) higher than the specified pressure.
- Excessive pressure at the end of the machine is costing you money! While the pressure needs to be greater than the value of the regulator, it should not be significantly higher as this pressure is being generated for no reason. Don't forget that the pressure at the end of the machine will vary if you are operating on a hill.

System capacity

- *System capacity = Pump flow rate (L/day) ÷ Field irrigated area (m²) = Pump flow rate (ML/day) x 100 ÷ Field irrigated area (ha)*
Compare this to the machine specifications and/or peak daily crop water use.

Travel speed

- *Travel speed = Distance travelled during test ÷ Time taken during test*
Compare this to the speed specified on the control panel or operating schedule.

Average application rate

- *Average Application Rate (AAR) = Emitter Flow Rate ÷ Sprinkler Wetted Area*
Compare this to the soil's infiltration rate. If it is substantially larger, you will need to implement strategies to hold water on the surface (cracks, cultivation, furrow dykes, stubble retention).

Comparing system capacity, travel speed and average application depth

Often average application depth and system capacity are confused. If the machine has a system capacity of 12 mm per day, and it is set to a speed that has it covering the entire field, non-stop, in exactly one day, then it will apply 12 mm of water.

If the machine is slowed down by exactly half, it will take two days to cover the whole field and will be applying a depth of 24 mm water.

For lateral move systems

- *Application depth (mm) = System capacity (mm/day) ÷ [Field length (m) ÷ Travel speed (m/day)]*

For centre pivot systems

- *Application depth (mm) = System capacity (mm/day) ÷ [Field circumference (m) ÷ Travel speed at circumference (m/day)]*