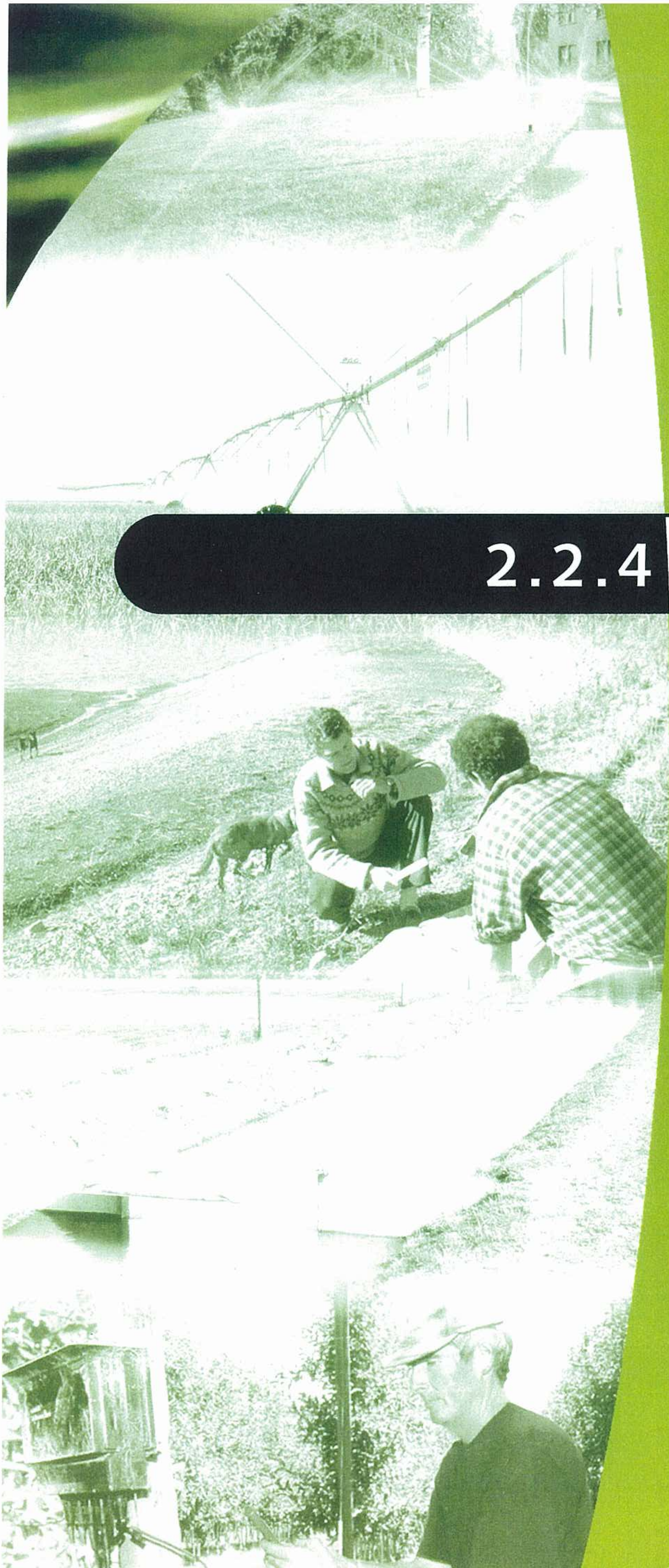
2.2.4 TRAVELLING IRRIGATORS



How to operate rotary boom irrigators

Rotary booms are normally winch-driven irrigators that drag a hose behind them and are similar in many respects to linear boom irrigators except that the boom rotates and the rotating motion of the boom usually drives the winch.

Most rotary boom irrigators are simple to operate and maintain. Some basic steps for operating a typical rotary boom are given below. The precise instructions for operating rotary booms will vary for each brand of machine. The operator's manual *must* be consulted to ensure safe operation of a rotary boom irrigator.

Setting up your irrigator

1. Position the irrigator at the required starting position towards the end of the paddock, in line with the anchor point and facing in the direction of travel. It should be just to one side of the line to the hydrant.
2. Tow the hose trailer in front and on the hydrant side of the irrigator. Set the trailer for releasing the hose and pull the hose back behind the irrigator and plug it into the irrigator. The hose should form a loop two - four metres in diameter behind the irrigator, the size of the loop depending on the size of the hose. Don't make the loop too big.
3. Make sure the irrigator is in the stop position and disengage the wire rope reel lock.
4. Connect the wire rope onto the back of the trailer and pull out both hose and wire rope at the same time.
5. Don't travel too fast. Start to slow down when the loop in the hose is becoming small and stop before the end is reached. Take the end of the hose out of the reel by hand and connect it to the hydrant.
6. Continue on with the wire rope until the anchor end is reached. Be careful to slow down about 20 m before reaching the anchor end to allow the winch drum to slow down. Sudden stops can cause over-run and tangle the rope.
7. Connect the wire to the anchor or the tractor, if it is used as the anchor. Leave the trailer out of the way, preferably along a fence line.
8. Make sure that the rope stop is clamped securely to the rope to stop the irrigator in the correct location. Be aware of and allow for obstructions such as fences, trees or other objects.
9. Turn on the hydrant valve and start the pump.

Moving to the next run

Follow these steps when moving your irrigator to another run.

1. Turn off the hydrant.
2. Release the hose pressure (usually from a valve on the hydrant take-off).
3. Disconnect the hose from the hydrant and the irrigator. It is best to leave the hose as straight as possible for purging. Fold the hose end over after you disconnect it to stop it ponding.
4. Tow the irrigator to the next starting position. If you are moving the irrigator a long distance it is best to wind up the hose onto the trailer and connect the trailer to the back of the irrigator if possible. It saves making two trips.

Winding up the hose

Hose trailers vary in design. Most trailers have PTO operated purge pumps fitted.

1. Connect the hose to the purge pump outlet and start PTO at the correct speed (usually 540 rpm).
2. Run the pump until most of the water is expelled. This may take five minutes or more. If possible try to have the hose on a down-sloping paddock to make discharging the water easier. However, that may not be possible, depending on irrigator runs. Undulating ground can make it difficult so just try to remove as much as possible.
3. Connect the hose to the centre of the reel as per manufacturers instructions. Make sure that the hose is not twisted. Wind some of the hose onto the reel by hand (about two turns) to ensure everything is right, then attach the PTO reel in the hose. For safety reasons, it is best to remain on the tractor when winding in the hose and be ready to stop if something goes wrong.
4. Just before the end of the hose gets to the trailer, stop and disconnect the PTO and hand wind the last bit if necessary.

How to calculate the depth of water applied

It is important to understand the relationship between irrigator flow, run length and travel speed to work out how much water the irrigator will apply. The depth of water applied is determined by:

1. Water flow rate (m^3/hr)
2. Effective wetted width of irrigator (m)
3. Run length (m)
4. Travel speed (m/hr).

The flow rate and wetted width are assumed to be constant for a particular run. The depth of water applied is then determined by the system speed.

Depth of water applied can be calculated from Tables 1a and 1b below for a 24 hour run. Table 1a provides application depths for flow rates from 10-80 m^3/h, while Table 1b provides application depths for flow rates from 60-200 m^3/h. Applications other than a 24-hour irrigation run can be calculated from this value. To use the table, follow these three steps:

1. Find the water flow in m^3/h on the top of the chart that most closely matches your system flow.
2. Find the wetted width and corresponding run length that most closely matches your system in the left column. The wetted width is the boom length plus the end spray distance or the irrigator lane spacing.
3. The intersection of these numbers is the depth of water applied, in millimetres per 24 hours.

Example

1. Irrigator flow rate: 180 m^3/hr
2. Wetted width 100 m
   Run length 600 m
3. Depth applied in 24 hours 72 mm (from table)
4. To determine the application depth for irrigation other than 24 hours – carry out the following calculation:

$$\text{Depth of water applied} = \frac{\text{Actual run time x depth applied (from chart)}}{24}$$

Example

Actual irrigation time = 22 hours

$$\text{Depth of water applied} = \frac{22\text{ hrs} \times 72\text{ mm}}{24\text{ hrs}}$$

$$= 66\text{ mm}$$

Table 1a: Water applied mm/day (10-80 m^3/hr)

				Flow Rate								
				10	20	30	40	50	60	70	80	m^3/h
Wetted width		**Run length**		37	73	110	147	184	220	257	294	gpm
m	ft	m	ft									Area (ha)
20	66	200	656	**60**	**120**							**0.4**
25	82	200	656	**48**	**96**	**144**						**0.5**
30	98	200	656	**40**	**80**	**120**	**160**					**0.6**
30	98	300	984	**27**	**53**	**80**	**107**	**133**				**0.9**
35	115	300	984	**23**	**46**	**69**	**91**	**114**	**137**			**1.1**
40	131	300	984	**20**	**40**	**60**	**80**	**100**	**120**	**140**		**1.2**
40	131	400	1311	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**1.6**
45	148	400	1311	**13**	**27**	**40**	**53**	**67**	**80**	**93**	**107**	**1.8**
50	164	400	1311	**12**	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**2.0**

Table 1b: Water applied mm/day (60-200 m^3/h)

				Flow rate								
				60	80	100	120	140	160	180	200	m^3/hr
Wetted width		**Run length**		220	294	367	440	514	587	661	734	gpm
m	ft	m	ft									Area (ha)
60	197	400	1311	**60**	**80**	**100**	**120**					**2.4**
70	230	400	1311	**51**	**69**	**86**	**103**	**120**				**2.8**
70	230	500	1639	**41**	**55**	**69**	**82**	**96**	**110**	**123**		**3.5**
80	262	500	1639	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**	**4.0**
90	295	500	1639	**32**	**43**	**53**	**64**	**75**	**85**	**96**	**107**	**4.5**
100	328	500	1639	**29**	**38**	**48**	**58**	**67**	**77**	**86**	**96**	**5.0**
90	295	600	1967	**27**	**36**	**44**	**53**	**62**	**71**	**80**	**89**	**5.4**
100	328	600	1967	**24**	**32**	**40**	**48**	**56**	**64**	**72**	**80**	**6.0**
110	361	600	1967	**22**	**29**	**36**	**44**	**51**	**58**	**65**	**73**	**6.6**
90	295	700	2295	**23**	**30**	**38**	**46**	**53**	**61**	**69**	**76**	**6.3**
100	328	700	2295	**21**	**27**	**34**	**41**	**48**	**55**	**62**	**69**	**7.0**
110	361	700	2295	**19**	**25**	**31**	**37**	**44**	**50**	**56**	**62**	**7.7**
100	328	800	2623	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**	**8.0**
110	361	800	2623	**16**	**22**	**27**	**33**	**38**	**44**	**49**	**54**	**8.8**

Travel speed

It is often necessary to change travel speed of the irrigator to ensure that the irrigator reaches the end of a run when it should. The required irrigator travel speed in m/hr for the desired run time can be found in Table 2 below.

1. Find the run length in the left column of the table that most closely matches your system.
2. Find the hours per run column that most closely matches the desired run time.
3. The intersection of these two variables is the irrigators travel speed in metres per hour.

Example

1. Run length 600 m
2. Desired run time 21 hours
3. Travel speed (from table) 28.6 m/hr
4. A speed for an alternative run time can be estimated from the speed found in the table if the actual run time is not listed in the table.

$$\text{Required travel speed} = \frac{\text{required run time} \times \text{travel speed from Table 2}}{\text{run time from Table 2}}$$

Example

Required run time is 22 hours.

The closest travel time in Table 2 to the 22 hours required is 21 hours, which gives a travel speed of 28.6 m/hr.

$$\text{Required travel speed} = \frac{21 \times 28.6}{22}$$

$$= 27.3 \text{ m/hr}$$

Note: Different system designs may allow speeds higher or lower than the typical limits given in the table. Consult your dealer for limits or speed ranges for individual system designs.

Table 2: Travel speed (metres/hour)

Run length		**Hours per run**						
m	ft	11	13	15	17	19	21	23
200	656	**18.2**	**15.4**	**13.3**	**11.8**	**10.5**	**9.5**	**8.7**
300	984	**27.3**	**23.1**	**20.0**	**17.6**	**15.8**	**14.3**	**13.0**
400	1311	**36.4**	**30.8**	**26.7**	**23.5**	**21.1**	**19.0**	**17.4**
500	1639	**45.5**	**38.5**	**33.3**	**29.4**	**26.3**	**23.8**	**21.7**
600	1967	**54.5**	**46.2**	**40.0**	**35.3**	**31.6**	**28.6**	**26.1**
700	2295	**63.6**	**53.8**	**46.7**	**41.2**	**36.8**	**33.3**	**30.4**
800	2623	**72.7**	**61.5**	**53.3**	**47.1**	**42.1**	**38.1**	**34.8**

Speed Control

Speed control of rotary boom irrigators is usually achieved by one or more of four methods.

- Adjusting the number of drive cams engaged
- Changing the angle of the drive nozzles (end nozzles)
- Changing the size of drive nozzle
- Increasing the operating pressure.

Changing the number of cams engaged is normally used for coarse travel speed adjustments on the larger rotating booms. Changing the angle of drive nozzles (one or both) is used for fine adjustment. The closer to 90 degrees that the angle of the jet is to the boom, the faster the rotation.

Smaller machines may not have any cam adjustment. Most travel speed adjustments are carried out by changing the angle of the drive nozzles – up into the air for slow speed and perpendicular to the boom rotation angle for fast speeds.

Normally, the size of nozzles remains fixed to provide a specified capacity, but if pump capacity allows, larger nozzles may be fitted for higher speeds. Be aware that if a pump does not have the capacity to operate the system at the recommended pressure, fitting larger nozzles may slow the rotation speed down.

If the irrigator has an independent drive system such as a turbine drive or Pelton wheel drive, refer to the sheet on linear booms for information on how to change travel speed.

Caution: Speeds or timing should not be adjusted when the irrigator is operating.

Measuring travel speed

The easiest way of determining irrigator travel speed is to measure the time it takes for the irrigator to move a known distance.

Place two poles or pegs in the ground a known distance, say five metres apart, close to the path the irrigator will follow. Measure the time it takes for the irrigator to move from one pole to the next. The travel speed is calculated as follows.

Travel speed =

$$\frac{60 \text{ x distance travelled}}{\text{Time taken in minutes}} \text{ (metres/hour)}$$

Example

Distance between poles	= 5 metres
Time taken to move 5 metres	= 10 minutes
Travel speed	= $\frac{60 \text{ x } 5}{10}$
	= 30 metres/hour

Application rate

Rotary boom irrigators have large wetted footprints (the area that is actually being wetted under the irrigator) compared to boom irrigators. It means that water is usually applied to the soil at rates that the soil can absorb water. Although not normally an issue with rotary boom irrigators, under some circumstances, particularly soils with very low application rates, problems with surface redistribution and runoff can arise.

See Section 3.1.4 for instructions on how to calculate application rate and on advice on what to do about excessive rates.

Safety

Power wires and poles are a dangerous hazard and great care must be taken when moving booms around them. The boom should be kept at least four metres away from any live wires. If you take the irrigator under power lines, travel very slowly. On some systems, the front wheels may be taken off an irrigator to lower the front of the boom while passing under lines. Then when the chassis is directly under the power line the front of the irrigator can be raised to lower the back of the boom.

A tractor frame should be mounted to any tractor used to move a rotating boom irrigator to protect the tractor driver from being hit by the moving boom.

Care should be taken at all times when working around the irrigator as it is operating. Stay clear of the tyres, wire rope and do not climb onto the irrigator when it is operating. Do not change speed when machine is operating.

December 2001

How to operate hose reel irrigators

Hard hose guns wind a hard polythene hose onto a reel. The hose is used to supply water to a gun carriage in the field. The hose reel is mounted on a stationary frame (the irrigator) at the end of a paddock or close to a hydrant. The gun carriage and gun is connected to the end of the hose.

Most hard hose guns are similar in principle and easy to operate. Some basic steps for operating a gun are given below. However, the precise instructions for operating hard hose guns will vary for each brand of machine. The operators manual ***must*** be consulted to ensure safe operation of the irrigator.

General operation

1. Transport the irrigator into a position where the ground is firm and level (ensure everything is locked into position when travelling).
2. The reel can be swivelled so that it is facing in the desired direction. Once this is done relock it into position. Disengage the gearbox.
3. Lower the sprinkler carriage to the ground and connect a tractor to it, usually by a chain. For the larger machines, do not underestimate the size of tractor needed.
4. Disengage the reel lock and apply enough brake tension to avoid any backlash while the hose is being pulled out.
5. If the hose is full of water, i.e. it has not been purged, keep the feed hose disconnected from the hydrant so that the water can run out as the hose is towed out. Ensure the feed hose is free of kinks and that it is straight.
6. Drive slowly to pull the hose out. Watch the system to ensure that everything is functioning correctly. It is important that the hose is pulled out perpendicular to the reel.
7. Stop unwinding when around 3/4 of a turn of hose remains on the reel.
8. Connect the feed hose to the hydrant while ensuring that there are no folds and that it is straight.
9. Engage gearbox and disengage the brake.
10. The water must be turned on slowly so that the water pressure build up in the system is not rapid, otherwise damage may occur.
11. Engage the drive.
12. Check that everything is functioning correctly.

Emptying the hose

It is important when the irrigator is to be transported over a large distance, or at the end of the season, that the hose is emptied. Some systems are fitted with a compressor that can be used to purge the hose, while for others, rewinding the hose with the Power take-off (PTO) is an effective way of emptying the water out of the hose.

Winter storage

1. Empty the hose and ensure that it is loose on the reel.
2. Turn the reel backwards.
3. Drain the water from the turbine.
4. Remove pressure gauges and store inside.
5. Store in a dry covered place.

How to calculate the depth of water applied

It is important to understand the relationship between irrigator flow, run length and gun carriage speed to work out how much water the irrigator will apply. The depth of water applied is determined by:

1. Water flow rate (m^3/hr)
2. Lane spacing of irrigator (m)
3. Run length (m)
4. Gun carriage speed (m/hr).

The flow rate and lane spacing are assumed to be constant for a particular run. Note that lane spacing rather than diameter of throw of the gun is used, as most guns require overlap between runs for good uniformity. The depth of water applied is then determined by the irrigator speed.

Depth of water applied can be calculated from Tables 1a and 1b below for a 24 hour run. Applications other than a 24-hour irrigation run can be calculated from this value. To use the table, follow these three steps:

1. Find the water flow in m³/h on the top of the chart that most closely matches your system flow.
2. Find the lane spacing and corresponding run length that most closely matches your system in the left column.
3. The intersection of these numbers is the depth of water applied, in millimetres per 24 hours.
4. To determine the application depth for a run other than 24 hours – use the following calculation:

Actual run time = 12 hours

$\frac{12 \text{ hrs}}{24 \text{ hrs}} \times 86 \text{ mm} = 43 \text{ mm water applied}$

Example

Irrigator flow rate:	100 m³/hr
Lane spacing	70 m
Run length	400 m
Depth applied in 24 hours	86 mm (from table)

Table 1a: Water applied mm/day (10-80 m³/hr)

				Flow Rate								
				10	20	30	40	50	60	70	80	m³/hr
Lane spacing		**Run length**		37	73	110	147	184	220	257	294	GPM
m	**ft**	**m**	**ft**									Area (ha)
20	66	200	656	60	120							0.4
25	82	200	656	48	96	144						0.5
30	98	200	656	40	80	120	160					0.6
30	98	300	984	27	53	80	107	133				0.9
35	115	300	984	23	46	69	91	114	137			1.1
40	131	300	984	20	40	60	80	100	120	140		1.2
40	131	400	1311	15	30	45	60	75	90	105	120	1.6
45	148	400	1311	13	27	40	53	67	80	93	107	1.8
50	164	400	1311	12	24	36	48	60	72	84	96	2.0

Table 1b: Water applied mm/day (60-200 m³/hr)

				Flow rate								
				60	80	100	120	140	160	180	200	m³/hr
Lane spacing		**Run length**		220	294	367	440	514	587	661	734	GPM
m	**ft**	**m**	**ft**									Area (ha)
60	197	400	1311	60	80	100	120					2.4
70	230	400	1311	51	69	86	103	120				2.8
70	230	500	1639	41	55	69	82	96	110	123		3.5
80	262	500	1639	36	48	60	72	84	96	108	120	4.0
90	295	500	1639	32	43	53	64	75	85	96	107	4.5
100	328	500	1639	29	38	48	58	67	77	86	96	5.0

Travel speed

It is often necessary to change travel speed of the irrigator to ensure that the irrigator reaches the end of a run when it should. On some systems, computerised control will allow speed and application depth to be easily changed. On others, the required irrigator travel speed in m/hr for the desired run time can be found in Table 2 below.

1. Find the run length in the left column of the table that most closely matches your system.
2. Find the hours per run column that most closely matches the desired run time.
3. The intersection of these two variables is the irrigators travel speed in metres per hour.

Run length	400 m
Desired run time	11 hours
Travel speed (from table)	36.4 m/hr

4. A speed for an alternative run time can be estimated from the speed found in the table if the actual run time is not listed in the table.

Example: Desired run time 12 hours.

$$36.4 \text{ m/h} \times \frac{11 \text{ Hours}}{12 \text{ Hours}} = 33.4 \text{ m/hr}$$

Table 2: Travel speed (metres/hour)

Run length		**Hours per run**						
m	ft	11	13	15	17	19	21	23
200	**656**	18.2	15.4	13.3	11.8	10.5	9.5	8.7
300	**984**	27.3	23.1	20.0	17.6	15.8	14.3	13.0
400	**1311**	36.4	30.8	26.7	23.5	21.1	19.0	17.4
500	**1639**	45.5	38.5	33.3	29.4	26.3	23.8	21.7

Note: Different system designs may allow speeds higher or lower than the typical limits given in the table. Consult your dealer for limits or speed ranges for individual system designs. Speeds or timing should not be adjusted when the irrigator is operating.

Changing speed

Hard hose irrigators are usually turbine-driven and have different methods of changing reel travel speed. Most use a gearbox for coarse control and a bypass for fine control. By changing the flow of water through the bypass, different flows through the turbine can be achieved. The more the bypass is opened, the lower the speed. The more the bypass is closed, the higher the speed and the more pressure loss that will occur through the turbine.

The best efficiency is obtained by altering the speed through the gearbox and fine-tuning with the turbine control. Making large adjustments on the drive control uses up pressure to achieve the desired travel speeds.

Wind

Because of the high trajectory of the water stream and high pressure, hard hose guns are affected by wind more than most irrigator types, particularly in areas without shelter belts.

If wind is blowing predominantly from one side, adjust the position of the gun to compensate. If wind is a regular occurrence, it may be necessary to use closer lane spacing (50-60% of the diameter of throw) and use a gun with a flat trajectory.

Irrigating with circular patterns

Usually, hard hose guns use a part-circle sprinkler, with the jet discharging away from the irrigator. This is to prevent the irrigator and the ground around the irrigator from being watered. These machines are heavy and it is difficult to tow them through soft ground. However, a semi-circular watering pattern means that the area at the start of the run will not be fully watered. The main methods of overcoming this problem are:

- The gun is allowed to over-shoot the run at start. This is acceptable if the paddock over the fence can be irrigated. It is not recommended if roads or other public areas are located at the ends of the run.
- The gun carriage is started a distance approximately equal to the throw of the gun from the end fence (to prevent overthrow). The gun is left stationary for about half the time the gun would take to move a distance equal to the gun throw and then put into gear. As it is operating on a half-circle behind the irrigator, it can travel to the irrigator at the finish of the run. The disadvantage of operating on a half circle is that average application rates are doubled.
- Starting the gun to prevent over-shoot and accepting that the end will be under-watered.

None of these methods are ideal, and compromise is often needed.

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How to Operate Travelling Gun Irrigators

Travelling guns are normally winch-driven irrigators that drag a hose behind them and are similar in many respects to boom irrigators.

Most travelling guns are similar in principle. Some basic steps for operating a travelling gun are given below. However, the precise instructions for operating travelling guns will vary for each brand of machine. The operators manual *must* be consulted to ensure safe operation of a travelling gun irrigator.

Setting up the irrigator

The following steps should be taken to ensure safe operation of your travelling gun irrigator. The instructions are based on the system having a hose reel mounted on the irrigator and the hose is wound on to the reel irrigator end first (hydrant end last). If a separate hose trailer is being used and the hose is wound on to the reel in the opposite way, i.e. hydrant end first, follow the instructions on laying out and rewinding the hose given for the linear boom irrigator (Sheet 2).

1. Place the irrigator beside the hydrant in a position that ensures when the hose is laid out along the run, it will be on the same side as the hydrant. This makes sure that the hose is not laid over the path of the wire rope, avoiding damage to the hose.
2. Disengage the clutch on the reel and manually unwind approximately 5-10 metres of hose from the reel beside the hydrant to ensure that no stress will be applied to the hydrant when the hose is being laid out. Connect the hose to the hydrant.
3. Tow the irrigator heading towards the paddock at the end opposite the anchor and lay out the hose on the same side of the lane as the hydrant.
4. Position the irrigator at the end of the paddock, in line with the anchor point and facing in the direction of travel. It should be just to one side of the line to the hydrant. Connect the hose to the irrigator inlet.
5. Engage the hand-brake or ensure that around 10 metres of hose is trailing behind the irrigator to act as a brake, preventing over-run of the sprinkler.
6. Hook the wire rope to the end of the tractor and tow it to the anchor at the far end of the field. Make sure the rope stop is firmly fastened in the correct location.
7. Engage the drive mechanism of the irrigator as per the manufacturers instructions.
8. Point the gun nozzle in a suitable direction to minimise damage on the crop due to inadequate stream break-up as the pressure is building up.
9. Open up the hydrant valve.
10. Start the pump. The irrigator will automatically start moving as the pressure builds up.

Rewinding the hose

Follow these steps when moving your irrigator to another run.

1. Turn off the hydrant and disconnect the hose.
2. Detach the irrigator from the anchor.
3. Connect the irrigator to the tractor and connect the Power take-off (PTO) shaft.
4. Slacken the hose by reversing the irrigator.
5. Fit the hose to the purge coupling and then move the irrigator forward to take the slack out of the hose.
6. The water can be purged from the hose by engaging the PTO shaft and running the purge pump at the recommended rpm.
7. Insert the hose end into the centre of the reel, checking that it is not twisted and any slack wound on.
8. The tractor PTO is connected to the hose reel drive and the hose is wound on at a slow speed. Remain on the tractor and ensure everyone is clear of the PTO shaft and revolving wheel and be prepared to stop as required.
9. Stop reeling before the hose end comes over the trailer roller, otherwise you run the risk of damage.

How to calculate the depth of water applied

It is important to understand the relationship between irrigator flow, run length and travel speed to work out how much water the irrigator will apply. The depth of water applied is determined by:

1. Water flow rate (m^3/h)
2. Lane spacing of irrigator (m)
3. Run length (m)
4. Travel speed (m/hr).

The flow rate and lane spacing are assumed to be constant for a particular run. Note that lane spacing rather than diameter of throw of the gun is used, as most guns require overlap between runs for good uniformity. The depth of water applied is then determined by the irrigator speed.

Depth of water applied can be calculated from Tables 1a and 1b below for a 24 hour run. Applications other than a 24-hour irrigation run can be calculated from this value. To use the table, follow these three steps:

1. Find the water flow in m^3/h on the top of the chart that most closely matches your system flow.
2. Find the lane spacing and corresponding run length that most closely matches your system in the left column.
3. The intersection of these numbers is the depth of water applied, in millimetres per 24 hours.

Example

Irrigator flow rate:	100 m^3/hr
Lane spacing	80 m
Run length	500 m
Depth applied in 24 hours	60 mm (from table)

4. To determine the application depth for a run other than 24 hours – do the following calculation:

Actual run time = 12 hours

$\frac{12\ \text{hrs}}{24\ \text{hrs}} \times 60\ \text{mm} =$ 30 mm water applied

Table 1a: Water applied mm/day (10-80 m^3/hr)

				Flow Rate								
				10	20	30	40	50	60	70	80	m^3/hr
Lane spacing		**Run length**		37	73	110	147	184	220	257	294	GPM
m	**ft**	**m**	**ft**									Area (ha)
20	66	200	656	**60**	**120**							**0.4**
25	82	200	656	**48**	**96**	**144**						**0.5**
30	98	200	656	**40**	**80**	**120**	**160**					**0.6**
30	98	300	984	**27**	**53**	**80**	**107**	**133**				**0.9**
35	115	300	984	**23**	**46**	**69**	**91**	**114**	**137**			**1.1**
40	131	300	984	**20**	**40**	**60**	**80**	**100**	**120**	**140**		**1.2**
40	131	400	1311	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**1.6**
45	148	400	1311	**13**	**27**	**40**	**53**	**67**	**80**	**93**	**107**	**1.8**
50	164	400	1311	**12**	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**2.0**

Table 1b: Water applied mm/day (60-200 m^3/hr)

				Flow rate								
				60	80	100	120	140	160	180	200	m^3/hr
Lane spacing		**Run length**		220	294	367	440	514	587	661	734	GPM
m	ft	m	ft									Area (ha)
60	197	400	1311	**60**	**80**	**100**	**120**					**2.4**
70	230	400	1311	**51**	**69**	**86**	**103**	**120**				**2.8**
70	230	500	1639	**41**	**55**	**69**	**82**	**96**	**110**	**123**		**3.5**
80	262	500	1639	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**	**4.0**
90	295	500	1639	**32**	**43**	**53**	**64**	**75**	**85**	**96**	**107**	**4.5**
100	328	500	1639	**29**	**38**	**48**	**58**	**67**	**77**	**86**	**96**	**5.0**
90	295	600	1967	**27**	**36**	**44**	**53**	**62**	**71**	**80**	**89**	**5.4**
100	328	600	1967	**24**	**32**	**40**	**48**	**56**	**64**	**72**	**80**	**6.0**
110	361	600	1967	**22**	**29**	**36**	**44**	**51**	**58**	**65**	**73**	**6.6**
90	295	700	2295	**23**	**30**	**38**	**46**	**53**	**61**	**69**	**76**	**6.3**
100	328	700	2295	**21**	**27**	**34**	**41**	**48**	**55**	**62**	**69**	**7.0**
110	361	700	2295	**19**	**25**	**31**	**37**	**44**	**50**	**56**	**62**	**7.7**

Travel speed

It is often necessary to change the travel speed of the irrigator to ensure that the irrigator reaches the end of a run when it should. The required irrigator travel speed in m/hr for the desired run time can be found in Table 2 below.

1. Find the run length in the left column of the table that most closely matches your system.
2. Find the hours per run column that most closely matches the desired run time.
3. The intersection of these two variables is the irrigators travel speed in metres per hour.

   Run length 600 m
   Desired run time 21 hours
   Travel speed (from table) 28.6 m/hr

4. A speed for an alternative run time can be estimated from the speed found in the table if the actual run time is not listed in the table.

   Example: Desired run time 22 hours.

   $$28.6 \text{ m/hr} \times \frac{21 \text{ Hours}}{22 \text{ Hours}} = 27.3 \text{ m/hr}$$

Table 2: Travel speed (metres/hour)

Run length		Hours per run						
m	ft	11	13	15	17	19	21	23
200	**656**	18.2	15.4	13.3	11.8	10.5	9.5	8.7
300	**984**	27.3	23.1	20.0	17.6	15.8	14.3	13.0
400	**1311**	36.4	30.8	26.7	23.5	21.1	19.0	17.4
500	**1639**	45.5	38.5	33.3	29.4	26.3	23.8	21.7
600	**1967**	54.5	46.2	40.0	35.3	31.6	28.6	26.1
700	**2295**	63.6	53.8	46.7	41.2	36.8	33.3	30.4
800	**2623**	72.7	61.5	53.3	47.1	42.1	38.1	34.8

Note: Different system designs may allow speeds higher or lower than the typical limits given in the table. Consult your dealer for limits or speed ranges for individual system designs. Speeds or timing should not be adjusted when the irrigator is operating.

Travel speed

The method used to adjust travel speed depends on the design of the drive system. For piston-driven systems, travel speed is controlled by the flow of water through the drive cylinder. To control flow, some systems use a nozzle, a gate valve or both. The speed can be altered by varying the size of the nozzle or by adjusting the gate valve. A larger nozzle has less restriction on the water, therefore the travel speed will be greater. Fine speed adjustments can be made with the gate valve.

It is important to not rely solely on the gate valve for controlling the irrigator speed as inadequate break-up of the water may occur.

For turbine-drive systems, adjustment of the bypass flow is the most common method of speed control.

Wind

Because of the high trajectory of the water stream and high pressure, guns are affected by wind more than most irrigator types, particularly in areas without shelter belts.

If wind is blowing predominantly from one side, adjust the position of the irrigator run to compensate. If wind is a regular occurrence, it may be necessary to use closer lane spacing (50-60% of the diameter of throw) and use a gun with a flat trajectory.

Irrigating with circular patterns

A gun waters a circular area unless a part-circle unit is fitted. A circular watering pattern means that the area at each end of the run will not be fully watered. The main methods of overcoming this problem are:

- The gun is allowed to over-shoot the run at each end. This is acceptable if the paddock over the fence can be irrigated. It is not recommended if roads or other public areas are located at the ends of the run.
- Starting and stopping the gun to prevent over-shoot and accepting that the ends will be under-watered.
- The gun is operated in a half circle and the irrigator positioned a distance approximately equal to the throw of the gun from the end fence (to prevent overthrow). The irrigator is left stationary for about half the time the gun would take to move a distance equal to the gun throw and then put into gear. As it is operating on a half-circle behind the irrigator, it can travel to the fence line at the finish of the run. The disadvantage of operating on a half circle is that average application rates are doubled.
- The gun is operated in a full circle and the irrigator positioned a distance approximately equal to the throw of the gun from the end fence (to prevent overthrow). The irrigator is left stationary for about the same time the gun would take to move a distance equal to the gun throw and then put into gear. It means that the half circle in front of the irrigator is over-watered. It is also necessary to stop the irrigator travel in a similar process at the finish of the run.

None of these methods are ideal, and compromise is often needed.

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How to Operate Linear Boom Irrigators

The precise instructions for operating linear booms will vary for each brand of machine. The operators manual *must* be consulted to ensure safe operation of a linear boom irrigator. However, the basic steps that should be similar for most booms, are listed below.

Setting up the Irrigator

1. Position the irrigator at the end of the paddock, in line with the anchor point and facing in the direction of travel. It should be just to one side of the line to the hydrant.
2. Tow the hose trailer in front and on the hydrant side of the irrigator. Set the trailer for releasing the hose and pull the hose back behind the irrigator and plug it into the irrigator. The hose should form a loop 2-4 metres in diameter behind the irrigator, the size of the loop depending on the size of the hose. Don t make the loop too big.
3. Make sure the irrigator is in the stop position and disengage the wire rope reel lock.
4. Connect the wire rope onto the back of the trailer and pull out both hose and wire rope at the same time.
5. Don t travel too fast. Start to slow down when the loop in the hose is becoming small and stop before the end is reached. Take the end of the hose out of the reel by hand and connect to the hydrant.
6. Continue on with the wire rope until the anchor end is reached. Be careful to slow down about 20m before reaching the anchor end to allow the winch drum to slow down. Sudden stops can cause over-run and tangle the rope.
7. Connect the wire to the anchor or the tractor if it is used as the anchor. Leave the trailer out of the way, preferably along a fence line.
8. Make sure that the rope stop is clamped securely to the rope to stop the irrigator in the correct location. Be aware of and allow for obstructions such as fences, trees or other objects.
9. Turn on the hydrant valve and start the pump.

Moving to the Next Run

Follow these steps when moving your irrigator to another run.

1. Turn off the hydrant.
2. Release the hose pressure (usually from a valve on the hydrant take-off).
3. Disconnnect the hose from the hydrant and the irrigator. It is best to leave the hose as straight as possible for purging. Fold the hose end over after you disconnect it to stop it puddling.
4. Tow the irrigator to the next starting position. If you are moving the irrigator a long distance it is best to wind up the hose onto the trailer and connect the trailer to the back of the irrigator if possible. It saves making two trips.

Winding up the hose

Hose trailers vary in design. Most trailers have PTO operated purge pumps fitted.

1. Connect the hose to the purge pump outlet and start PTO at the correct speed (usually 540 rpm).
2. Run the pump until most of the water is expelled. This may take 5 minutes or more. If possible try to have the hose on a down-sloping paddock to make discharging the water easier. However, that may not be possible, depending on irrigator runs. Undulating ground can make it difficult so just try to remove as much as possible.
3. Connect the hose to the centre of the reel as per manufacturers instructions. Make sure that the hose is not twisted. Wind some of the hose onto the reel by hand (about two turns) to ensure everything is right, then attach the PTO reel in the hose. For safety reasons, it is best to remain on the tractor when winding in the hose and be ready to stop if something goes wrong.
4. Just before the end of the hose gets to the trailer, stop and disconnect the PTO and hand wind the last bit if necessary.

How to calculate the depth of water applied

It is important to understand the relationship between irrigator flow, run length and travel speed to work out how much water the irrigator will apply. The depth of water applied is determined by:

1. Water flow rate (m^3/hr)
2. Wetted width of irrigator (m)
3. Run length (m)
4. Travel speed (m/hr).

The flow rate and wetted width are assumed to be constant for a particular run. The depth of water applied is then determined by the system speed.

Depth of water applied can be calculated from Tables 1a and 1b below for a 24 hour run. Applications other than a 24-hour irrigation run can be calculated from this value. To use the table, follow these three steps:

1. Find the water flow in m^3/hr on the top of the chart that most closely matches your system flow.
2. Find the wetted width and corresponding run length that most closely matches your system in the left column. The wetted width is the boom length plus the end spray distance or the irrigator lane spacing.
3. The intersection of these numbers is the depth of water applied, in millimetres per 24 hours.

Example

1. Irrigator flow rate:	180 m^3/hr
2. Wetted width	100 m
Run length	600 m
3. Depth applied in 24 hours	72 mm (from table)

4. To determine the application depth for a run other than 24 hours — do the following calculation:

Actual run time = 22 hours

$$\frac{22\ \text{hrs}}{24\ \text{hrs}} \times 72\ \text{mm} = 66\ \text{mm water applied}$$

Table 1a: Water applied mm/day (10-80 m^3/hr)

				Flow Rate								
				10	20	30	40	50	60	70	80	m^3/hr
Wetted width		**Run length**		37	73	110	147	184	220	257	294	GPM
m	ft	m	ft									Area (ha)
20	66	200	656	**60**	**120**							**0.4**
25	82	200	656	**48**	**96**	**144**						**0.5**
30	98	200	656	**40**	**80**	**120**	**160**					**0.6**
30	98	300	984	**27**	**53**	**80**	**107**	**133**				**0.9**
35	115	300	984	**23**	**46**	**69**	**91**	**114**	**137**			**1.1**
40	131	300	984	**20**	**40**	**60**	**80**	**100**	**120**	**140**		**1.2**
40	131	400	1311	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**1.6**
45	148	400	1311	**13**	**27**	**40**	**53**	**67**	**80**	**93**	**107**	**1.8**
50	164	400	1311	**12**	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**2.0**

Table 1b: Water applied mm/day (60-200 m^3/h)

				Flow rate								
				60	80	100	120	140	160	180	200	m^3/hr
Wetted width		**Run length**		220	294	367	440	514	587	661	734	GPM
m	ft	m	ft									Area (ha)
60	197	400	1311	**60**	**80**	**100**	**120**					**2.4**
70	230	400	1311	**51**	**69**	**86**	**103**	**120**				**2.8**
70	230	500	1639	**41**	**55**	**69**	**82**	**96**	**110**	**123**		**3.5**
80	262	500	1639	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**	**4.0**
90	295	500	1639	**32**	**43**	**53**	**64**	**75**	**85**	**96**	**107**	**4.5**
100	328	500	1639	**29**	**38**	**48**	**58**	**67**	**77**	**86**	**96**	**5.0**
90	295	600	1967	**27**	**36**	**44**	**53**	**62**	**71**	**80**	**89**	**5.4**
100	328	600	1967	**24**	**32**	**40**	**48**	**56**	**64**	**72**	**80**	**6.0**
110	361	600	1967	**22**	**29**	**36**	**44**	**51**	**58**	**65**	**73**	**6.6**
90	295	700	2295	**23**	**30**	**38**	**46**	**53**	**61**	**69**	**76**	**6.3**
100	328	700	2295	**21**	**27**	**34**	**41**	**48**	**55**	**62**	**69**	**7.0**
110	361	700	2295	**19**	**25**	**31**	**37**	**44**	**50**	**56**	**62**	**7.7**
100	328	800	2623	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**	**8.0**
110	361	800	2623	**16**	**22**	**27**	**33**	**38**	**44**	**49**	**54**	**8.8**

Travel speed

It is often necessary to change the travel speed of the irrigator to ensure that the irrigator reaches the end of a run when it should. The required irrigator travel speed in m/hr for the desired run time can be found in Table 2 below.

1. Find the run length in the left column of the table that most closely matches your system.
2. Find the hours per run column that most closely matches the desired run time.
3. The intersection of these two variables is the irrigators travel speed in metres per hour.

   1. Run length 600 m
   2. Desired run time 21 hours
   3. Travel speed (from table) 28.6 m/hr

4. A speed for an alternative run time can be estimated from the speed found in the table if the actual run time is not listed in the table.

Example: **Desired run time 22 hours.**

$$28.6 \text{ m/hr} \times \frac{21 \text{ Hours}}{22 \text{ Hours}} = 27.3 \text{ m/hr}$$

Note: Different system designs may allow speeds higher or lower than the typical limits given in the table. Consult your dealer for limits or speed ranges for individual system designs.

Table 2: Travel speed (metres/hour)

Run length		Hours per run						
m	ft	11	13	15	17	19	21	23
200	656	**18.2**	**15.4**	**13.3**	**11.8**	**10.5**	**9.5**	**8.7**
300	984	**27.3**	**23.1**	**20.0**	**17.6**	**15.8**	**14.3**	**13.0**
400	1311	**36.4**	**30.8**	**26.7**	**23.5**	**21.1**	**19.0**	**17.4**
500	1639	**45.5**	**38.5**	**33.3**	**29.4**	**26.3**	**23.8**	**21.7**
600	1967	**54.5**	**46.2**	**40.0**	**35.3**	**31.6**	**28.6**	**26.1**
700	2295	**63.6**	**53.8**	**46.7**	**41.2**	**36.8**	**33.3**	**30.4**
800	2623	**72.7**	**61.5**	**53.3**	**47.1**	**42.1**	**38.1**	**34.8**

Speed Control

Irrigators have different methods of changing travel speed. Many utilize a gearbox for coarse control and a bypass for fine control. By changing the flow of water through the bypass, different flows through a turbine or Pelton wheel can be achieved. The more the bypass is opened, the lower the torque and speed. The more the bypass is closed, the higher the torque and speed and the more pressure loss that will occur through the drive system.

The best efficiency is obtained by altering the speed through the gearbox and fine-tuning with the turbine control. Making large adjustments on the drive control uses up pressure to achieve the desired travel speeds. Speeds or timing should not be adjusted when the irrigator is operating.

Rather than turbine or Pelton wheels, other systems utilize a piston or bellows drive. Speed adjustments are made by changing the rate of flow to the piston or by regulating the flow on the exhaust of the piston.

Application rate

Linear boom irrigators can have small wetted footprints (the area that is actually being wetted under the irrigator) compared to other irrigators. This is particularly true for irrigators using low pressure nozzles that have limited throw. It often means that water is applied to the soil at rates faster than the soil can absorb water. Under some circumstances, this can cause problems with surface redistribution and runoff.

See Section 3.1.4 for instructions on how to calculate application rate and on advice on what to do about excessive rates.

Safety

Power wires and poles are a dangerous hazard and great care must be taken when moving booms around them. The boom should be kept at least four metres away from any live wires. If you take the irrigator under power lines, travel very slowly. On some systems, the front wheels may be taken off an irrigator to lower the front of the boom while passing under lines. Then when the chassis is directly under the power line the front of the irrigator can be raised to lower the back of the boom.

A tractor frame should be mounted to any tractor used to move a linear boom irrigator to protect the tractor driver from being hit by the moving boom.

Care should be taken at all times when working around the irrigator as it is operating. Stay clear of the tyres, wire rope, roller chains and belts and do not climb onto the irrigator when it is operating. Do not change gears when machine is operating.

How to operate centre-pivots

Centre-pivots today are highly sophisticated irrigation machines. They are often fitted with very capable control systems that provide the ability to apply a wide range of depths of water. On some systems, it is possible to "dial up" the depth of water required. On others, a more manual approach is taken.

Calculation of application depth

The depth of water applied is determined by:
1. Pivot water flow (m^3/hr)
2. Irrigator length (m)
3. Pivot speed (m/hr).

The water flow and irrigator length are assumed constant for a particular system. The depth of water applied is determined by the system speed.

Water applied over a 24-hour rotation can be calculated from Table 1 below. Applications other than the 24-hour rotation can be calculated from this value. To use the table, follow these four steps:

1. Find the pivot flow in m^3/h on the top of the chart that most closely matches your system design. This is the maximum flow rate corresponding to the irrigator length, with everything running - pivot plus corner and end gun, if fitted.
2. Find the irrigator length that most closely matches your system in the left column. The irrigator length is the pivot length plus corner length plus the end gun throw distance.
3. The intersection of these two variables is the depth applied, in millimetres, for a 24-hour revolution.
4. To determine the depth applied for a rotation time other than 24 hours, divide the actual rotation time (in hours) by 24 and multiply by the 24-hour depth.

Example

Pivot flow	400 m^3/hr
Pivot length	700 m (includes corner and end gun if fitted)
Rotation time	24 h (for all values in table)
Depth of water applied	6.2 mm (from table)

If actual rotation time is 3 days;

Depth applied =

$$\frac{\text{actual rotation time in hours} \times \text{depth applied in 24 hrs}}{24}$$

$$= \frac{3 \times 24 \times 6.2}{24} = 18.6 \text{ mm}$$

Table 1: Depth applied, millimetres per 24 hour revolution

Irrigator length		Maximum flow through pivot										
		50	100	150	200	250	300	350	400	450	500	m^3/hr
		184	367	551	734	918	1101	1285	1468	1652	1835	gpm
m	**ft**											**Hectares**
100	328	**38.2**	**76.4**	**114.6**								**3.1**
150	492	**17.0**	**34.0**	**50.9**	**67.9**	**84.9**	**101.9**					**7.1**
200	656	**9.5**	**19.1**	**28.6**	**38.2**	**47.7**	**57.3**	**66.8**	**76.4**	**85.9**	**95.5**	**12.6**
250	820	**6.1**	**12.2**	**18.3**	**24.4**	**30.6**	**36.7**	**42.8**	**48.9**	**55.0**	**61.1**	**19.6**
300	984	**4.2**	**8.5**	**12.7**	**17.0**	**21.2**	**25.5**	**29.7**	**34.0**	**38.2**	**42.4**	**28.3**
350	1148	**3.1**	**6.2**	**9.4**	**12.5**	**15.6**	**18.7**	**21.8**	**24.9**	**28.1**	**31.2**	**38.5**
400	1311	**2.4**	**4.8**	**7.2**	**9.5**	**11.9**	**14.3**	**16.7**	**19.1**	**21.5**	**23.9**	**50.3**
450	1475		**3.8**	**5.7**	**7.5**	**9.4**	**11.3**	**13.2**	**15.1**	**17.0**	**18.9**	**63.6**
500	1639		**3.1**	**4.6**	**6.1**	**7.6**	**9.2**	**10.7**	**12.2**	**13.8**	**15.3**	**78.5**
550	1803		**2.5**	**3.8**	**5.1**	**6.3**	**7.6**	**8.8**	**10.1**	**11.4**	**12.6**	**95.0**
600	1967		**2.1**	**3.2**	**4.2**	**5.3**	**6.4**	**7.4**	**8.5**	**9.5**	**10.6**	**113.1**
650	2131			**2.7**	**3.6**	**4.5**	**5.4**	**6.3**	**7.2**	**8.1**	**9.0**	**132.7**
700	2295			**2.3**	**3.1**	**3.9**	**4.7**	**5.5**	**6.2**	**7.0**	**7.8**	**153.9**
750	2459			**2.0**	**2.7**	**3.4**	**4.1**	**4.8**	**5.4**	**6.1**	**6.8**	**176.7**
800	2623					**3.0**	**3.6**	**4.2**	**4.8**	**5.4**	**6.0**	**201.1**

Optimum rotation time

Because centre-pivots have the ability to be operated over a wide range of speeds, the depth of water applied can be varied over a wide range. In the example given above, the depth of water applied in 24 hours is 6.2 mm, but the rotation may be adjusted to 48 hours applying 12.4 mm, 72 hours applying 18.6 mm, 96 hours applying 24.8 mm, or whatever is desired.

The optimum depth of water to apply depends on several factors:

- Purpose of the irrigation, i.e. is it for germination, replacing soil moisture deficits, applying chemicals or fertiliser
- Application rate compared to the soil infiltration rate
- Soil water deficit
- Crop critical deficit
- Management policy relative to risk
- Whether the pivot is fixed in one position or moved over several positions.

Generally, after an initial wetting up period, small depths of water are applied for germination. Commonly 24-hour rotations are used.

For applying chemicals or fertiliser through the irrigator, or if the irrigator is being used to wash in fertiliser such as urea, fast rotation times are also used.

If the system is being used for normal irrigation, slower rotation times are often used. Many farmers have found that three - five day rotations are optimum. Although the 'little and often' principle is often quoted for irrigation, applying too little too often results in higher overall losses from evaporation in the air and evaporation from the crop-soil surface.

Maximum applications should be limited to the soil moisture deficit and the systems should be managed to apply water as efficiently as possible and to utilise rainfall as much as possible.

Application rate

Application rate is the rate in mm/hr that the pivot applies water to the ground surface. The longer the pivot, the higher the application rate at the end of the pivot because the end of a pivot covers the largest area. If the application rate exceeds the soil infiltration rate, ponding and surface redistribution of water can occur, lowering application efficiency and overall irrigator performance.

Usually, soils can infiltrate water at higher rates when water is first applied (so long as surface sealing is not a problem) and the rate drops off as more water is applied. If pivots with high application rates are being used, it is usually better to apply small depths of water to take advantage of the higher initial soil infiltration rates. (See Section 3.1.4 Sheet 5 for more details).

Application rate at the outside edge of a pivot can be calculated as follows.

Circumference of pivot = 6.28 x length of pivot (metres)

$$\text{Travel speed} = \frac{\text{Circumference}}{\text{Rotation time in hours}} \text{ (metres/hour)}$$

Wetted width = diameter of throw of sprinklers (metres)

$$\text{Time to apply water} = \frac{60 \times \text{wetted width}}{\text{Travel speed}} \text{ (minutes)}$$

$$\text{Application rate} = \frac{60 \times \text{depth of water applied}}{\text{Time to apply water}} \text{ (mm/hr)}$$

Example

Length of pivot	=	600 metres
Rotation time	=	2 days (48 hours)
Sprinkler throw	=	18 metres
Depth of water applied	=	10 mm
Circumference of pivot	=	6.28 x 600
	=	3768 metres

$$\text{Travel speed} = \frac{3768}{48} = 78.5 \text{ metres/hour}$$

Wetted width = 18 metres

$$\text{Time to apply water} = \frac{60 \times 18}{78.5} = 14 \text{ minutes}$$

$$\text{Application rate} = \frac{60 \times 10}{14} = 43 \text{ mm/hr}$$

The approximate application rate can be calculated for any distance from the centre of a pivot by replacing the length of the pivot with the required distance.

The calculated application rate should be compared to the soil infiltration characteristics to find out if application rate exceeds infiltration rate. On open free-draining soils, application rates of up to 40 mm/hr have been found to be acceptable for centre-pivot irrigation. On tight, poor draining soils, much lower rates should be used.

If ponding is a serious problem, it may be necessary to apply less water more often, increase the wetted width of the sprinklers by fitting boom-backs or use sprinklers with larger throws.

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How to automate travelling irrigators

Travelling irrigators cover a wide range of types, ranging from travelling booms, travelling guns, centre-pivots and linear moves. Some of these systems such as centre-pivots incorporate a high level of automation and control, while others rely on a significant amount of manual control. Automating manually controlled irrigators is often required to improve irrigation performance.

What is automation?

Automation of travelling irrigators generally refers to the use of a control system to stop and turn off an irrigator at the end of a run. On systems with one pump and one irrigator, the pump should also be turned off. On systems with multiple irrigators and possibly multiple pumps, the pump operation must be controlled to accommodate the change in duty without damage to pumps and mainlines.

Automation can also refer to the process of remotely starting irrigators, particularly remote starting of pumps.

Why automate?

For convenience and practicality, most travelling irrigator systems are designed to operate over a fixed number of hours per day, with a preference not to shift them more than once per day. For example, a travelling boom is often designed to finish a run in 23 hours, with one hour available for shifting. Although most travelling irrigators are designed to stop at the end of a run, many do not turn the water off and remain irrigating in a stopped position until turned off manually. On well-planned irrigation systems with equal-length runs, determining stop times is relatively straight forward. However, on systems where run lengths vary or irrigator travel speed varies or different speeds are used to apply varying depths of water, a precise stop time is difficult to determine. Over-watering or under-watering at the ends of runs is common. Automated stops makes it possible to increase application efficiency and irrigation performance.

Once an irrigator has been shifted, most farmers find returning to a pump shed to restart a pump very inconvenient. To be able to do this from the irrigator is something many farmers find desirable and remote starting is one method of achieving this.

Methods

Two main methods are used to control stop times - time clocks on pumps and automatic valves on irrigators.

Time clocks

The most common method is a time clock, which is usually mounted on the pump control panel and turns the pump off after a preset time. Both mechanical clocks and electronic clocks (perhaps linked to pump controllers) can be used.

The advantages of a time clock are:

- Relatively low cost
- Easy to operate
- Convenient
- Reliably turns the pump off.

The disadvantages are:

- Difficult to determine correct operating time on systems with variable runs or speeds
- Turns the system off regardless of irrigator position
- Sudden pump stoppage may cause water hammer
- Difficult to control system with multiple irrigators.

Automatic valves

Automatic valves are usually mounted on the irrigator in the main supply line. They are actuated by the same system that stops the irrigator motion at the end of a run.

The advantages of an automatic valve are:

- Stops the water being discharged through the system at the end of the run
- Through a pressure build-up, this will result in pump being turned off
- Shutoff speed can be controlled, reducing problems with water hammer
- Ensures that the full run is watered
- Relatively easy to operate
- More convenient when operating multiple irrigators.

The disadvantages are:

- Usually more expensive than a time clock
- Time system shuts down will vary and will not be totally predictable
- System requires pressure or flow switches at pump to turn pump off

- More difficult to get extra watering at end of run, eg for rotary boom or gun
- More complicated to maintain and adjust
- Less reliable than time clocks.

Automated starting

There are many ways of restarting (or stopping) pumps from in the field but most involve hard wiring, radio links or cell phone links. The degree of sophistication available is only limited by a farmer s budget.

Usually, hard wiring between the irrigator and the pump shed is impractical and expensive due to the distances involved but is often used on fixed centre-pivots and sometimes on movable pivots where the number of hydrants is small. It is usually a very reliable method of communication.

Radio links have been used for many years and if used over distances not exceeding about 2-3 km can be installed relatively cheaply. Using higher powered radios for longer distances may require a licence with associated additional costs. The lower cost systems can be prone to interference from other radio sources, which can result in unwanted stoppages.

Digital technology involving cell phones is being increasingly used for remote control. It offers a level of sophistication and control that has not been previously available.

Multiple irrigator systems

On systems with more than one irrigator on a common mainline, it is common for individual irrigators to reach the ends of their runs at different times. Extra precautions must be taken to ensure that when one irrigator turns off, the supply is maintained at the required pressure to operate other irrigators without exposing the mainline and pumps to excessive pressures. Methods used to achieve this are pressure regulating valves and pressure or flow switches at pump headworks and variable frequency drives on pump motors. These methods are described in Section 3.4.3.

Precautions

It is vital that any system that involves valve closures be correctly designed, installed and commissioned with appropriate backup, as failure of these devices can result in serious damage to pump or system components. This is particularly important for pump shutdown systems such as pressure regulating valves, pressure switches and flow switches. It is also vital that systems utilising remote pump starting be appropriately protected and graduated starts or surge control is recommended. All protection systems (eg. low water / high pressure) must be functional for any remote start system.