



Surface irrigation – Key factors to consider when improving furrow

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Head ditch

- Consistently deliver sufficient water at an appropriate head.
- Maintain a constant flow rate, as fluctuations will cause variable flow rates out of the siphons affecting infiltration, uniformity and application efficiency .
- Maintain adequate freeboard (minimum of 0.15 m); and
- Conduct regular maintenance (de-silting & weed control).

Tail drain

- Designed for rapid removal of storm waters to prevent in-field waterlogging.
- Deep enough to prevent water backing up but sufficiently shallow to prevent erosion between the furrow and drain.

Siphons

- Flow rate into the head ditch must equal flow rate out of all the siphons.
- If the flow rate into the head ditch is greater than the flow rate out of all the siphons the water can overtop the head ditch.
- If flow rate out of the siphons exceeds flow rate into the head ditch, the water level in the head ditch will drop and cause siphons to stop.



Manage flow rate and cutoff times to maximise application efficiency and distribution uniformity to reduce runoff, deep drainage and loss of nutrients.

- Careful rotobuck placement. The person starting the siphons should build the roto bucks as they are the individual on the shovel if there are any breakouts.
- Siphon size – check internal diameter and length. It should be the same. Imperial sized siphons are specified according to their internal diameter and metric siphons according to their outside diameter. Internal diameter of metric siphons also varies between manufacturers – mixing these pipes causes variation in flow rate and can have significant effect on total water applied over an irrigation.
- Siphon placement - operate under submerged



flow conditions, ie discharge under water level in the furrow stream (Figure 2).

- Siphons must be placed perpendicular to the head ditch to avoid flow variations and uneven watering;
- Placement of the siphon outlet is critical. Small vertical changes in the outlet level can reduce the flow rate into the siphon. See the video: <https://www.youtube.com/watch?v=wsWKV4kSzn8>
- By submerging the siphon in the furrow stream (Figure 2) it will ensure consistent placement across all siphons to assist evenness of flow rates.
- A submerged siphon will have a greater flow rate than one that is not as there is reduced head levels. This is displayed in Figure 2.

Irrigation scheduling

- Decide when and how much water to apply to maximise crop productivity.
- Plant, weather and soil-based monitoring is



Siphon flow meter

available. Use a range of tools and indicators that you are comfortable with, however keeping a close eye on weather forecasts and visual inspection of the crop is still vital.

- Use Electromagnetic Induction (EM or EMI) surveying, in conjunction with soil sampling to

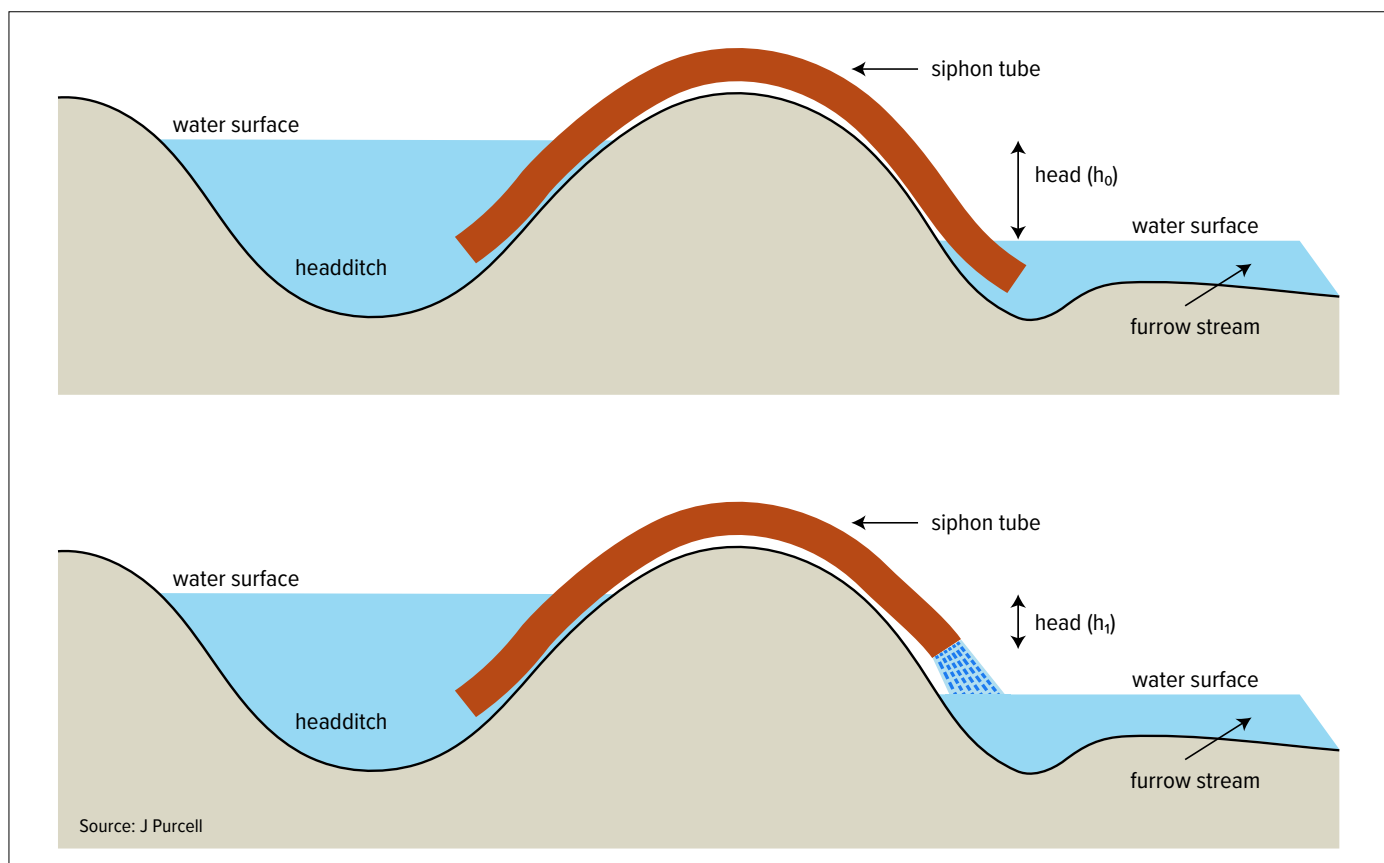


Figure 2 – Difference in head for different siphon placement.

map soil variations across fields and farms. It indicates texture changes and the data can be analysed to produce maps of similar soil types. This can then be used to locate the “majority” soil type within a field.

- Use EM soil survey to site soil moisture probes in the majority soil type in a representative area of the field.

Water Application

- Relatively small management changes may increase water use efficiency significantly.
- **Infiltration opportunity time** is the length of time that water is present on the soil surface for infiltration to take place. To achieve the best performance, the opportunity time for an irrigation should equal the amount of time necessary to apply the required depth of water.
- Manage **flow rate** and **cutoff times** to maximise **application efficiency** and **distribution uniformity** to reduce runoff, deep drainage and loss of nutrients.
- **Inflow rate** typically has the largest influence of any variable that can be managed by the irrigator (Table 1).
- It has a major impact on performance due to the speed of water advance down the field. A faster advance is typically more desirable on high infiltration soils.
- Along with inflow rate, **time to cutoff** is a key variable easily managed by the irrigator. In fact, it is typical for these two variables to be managed together. Increased inflow rate is likely to result in excessive tailwater unless time to cutoff is managed accordingly.
- When inflow rate is increased, more precise control is typically required as it becomes easier to adversely affect performance when the inflow rate is high.
- **Application efficiency** relates the amount of water applied in an irrigation to the amount of water available to the crop for use. A high

Table 1: Effect of surface irrigation variables on irrigation performance

Variable	Influenced by	Impact on Performance	Comments
Soil infiltration characteristic	Usually cannot be influenced	***	High infiltration soil – slow water advance & rapid recession
Inflow rate	Management & design	***	High flow rate – fast water advance rate, increased tailwater runoff
Time to cut-off	Management	***	Determines total opportunity time and deep percolation loss
Length of field	Design	**	High efficiency & uniformity can be difficult on long fields
Application depth (deficit)	Management	**	Irrigating to a deficit which is very small or very large may reduce performance.
Field slope	Design	*	Steep slope – increases rate of water advance & recession
Surface roughness	Usually cannot be influenced	*	Rough surface – slower advance
Furrow dimension and shape	Design & management	*	Furrow shape has little impact

*** More impact * less impact

(adapted from the National Centre for Engineering in Agriculture SIRMOD training manual)

efficiency means that most of the water applied has remained in the root zone available for plant use. Low efficiency means much of the water has not reached or has moved out of the root zone and gives no benefit.

- **Distribution uniformity** is a measure of how evenly water has been applied. Low distribution uniformity is caused by an uneven opportunity time along the length of the furrow. This results in parts of a field being under-watered and over-watered. Running water longer to ensure sufficient water for the whole field is the most common cause of waterlogging to significant areas of a field; and
- Plan to have water on and off a field in no more than 8 hours to minimise waterlogging, deep drainage and runoff.

Irrigation Evaluation

- It is important to objectively evaluate your surface irrigation system performance, rather than simply increasing the inflow rate without making any objective measurements.

Further information:

Waterpak Chapter 5.3 Surface irrigation performance and operation <http://crdc.com.au/sites/default/files/pdf/Cotton-WATERpak-2013-.pdf>

ProWater Surface Irrigation Performance <https://www.dpi.nsw.gov.au/agriculture/water/irrigation/introduction-to-irrigation-management-evaluating-your-surface-irrigation-system>



Siphons discharging at different levels.

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