Agri About

www.agriabout.com

Sustainable agriculture for the future

November 2025

No 151

Artificial Intelligence
Reshaping South African Farming

Climate-resilient food production

Harmonizing South Africa's Seed System

Hemp vs dagga: zoning of cannabis regions

Law on Sustainable Soil Management

The concept of Low Flow-rate irrigation

Fanie Vorster
ARC-Natural Resources and Engineering – Agricultural Engineering Campus

Also known as Continuous irrigation, this form of drip irrigation could push the limits in irrigation precision and water use efficiency.

As cost of agricultural resources continue to rise, efficiency in every aspect of modern farming, is becoming increasingly important. Therefore, in specific circumstances implementation of low-flow irrigation technology could help irrigation farmers increase their system's water use efficiency.

The main aim with low-flow irrigation technology, is to supply the water in the active root zone, and at the same rate as that the plants are using it.

Figure 1: Low-flow drip irrigation is an option for orchards

The benefits of Low-flow irrigation technology are:

- Reduced water, energy and fertilizer use on a given area.
- Greater efficiency in the placement of water and nutrients in the crop rootzone.
- Better control of irrigation depth and lateral water movement in the soil, resulting in better utilization of especially soil with lower potential, for example sandy or rocky soil.
- The water and nutrients are distributed very efficiently beneath each dripper. This has the effect of increasing the wetted area from where it is available for use by the plant.
- Leaching of nutrients below the root zone is limited.
- The system is designed in such a way that the whole farm or a group of blocks is irrigated at the same time.
- Increased water use efficiency could enable the farmer to increase the total area irrigated with the available water, provided additional irrigable land is available.
- Automation of the irrigation system is relatively simple.
- The longer duration per irrigation session on a specific area has the effect that the hydraulic performance of the irrigation system is better than that of a conventional drip irrigation system where standing time is much shorter.
- It can be used to do deficit irrigation.
- Provides the possibility of managing specific nutrient applications in critical growth stages of the crop better.
- Less fertilizer is used with fertigation through a low flow drip irrigation system than compared with fertigation by means of a conventional drip irrigation system with a high dripper delivery rate.
- The main benefit lies therein that low-flow drip irrigation provides the possibility to sustain crop production while less resources are used. Increased crop quality or yield is a bonus.
- It requires less labour for management and operation per hectare than conventional systems.

The main differences between Low-flow or Continuous irrigation and Conventional drip irrigation:

	Conventional drip	**Low – flow drip**
Dripper flow rate	1.6 – 4 litre/hour	0.4 – 0.7 litre/hour
Number of shifts per day	Several	One
Standing time to deliver water demand	Less than 1 hour to 12 hours	12 hours to 14 hours adapted to cater for climatic, soil type and soil moisture conditions and crop growth stage
Cycle length	3 – 7 days	Daily
Configuration	Total area divided into different blocks; each block irrigated separately	Whole area or groups of blocks irrigated simultaneously

Factors to take into consideration when considering changing to a Low-flow irrigation system:

- It requires more precision in the design-, management and operation than conventional drip irrigation systems.
- Soil and water analysis are required before the system is designed.
- More advanced filtration and backflush management is required. For example, the primary filtration could be done with a high-capacity self-cleaning type disc or mesh filter that requires minimal maintenance, with a 100-micron filtration grade or else a sand media filter with a check filter. The secondary filtration could be done with a disc or screen filter, also with a 100-micron filtration grade.
- Precision control in dosing of fertilizer is necessary.
- The maximum dripper pipeline length should be restricted to ensure that the flushing velocity at the downstream end of the pipe is not less than 0.5m/second.
- Most important is to monitor what the water is doing below the soil surface on a

regular basis, for example weekly, to make timely adjustments regarding the irrigation application time.

- It will be necessary to dose Hydrogen Peroxide into the system while in operation at predetermined concentrations.
- More applicable to higher value crops due to higher initial infrastructure costs.

What happens to the water below the soil surface

There are mainly three movements that water can make in the soil – vertical movement under influence of gravity, horizontal movement, which is mainly capillary, and surface wetness which lead to run-off. With conventional drip irrigation where delivery rates are typically from 1.6 - 4 litre/hr, it is difficult to control the infiltration depth of the water, because the water delivery could be at a greater rate than what the soil can handle. Typically, run-off or wetness on the soil surface occurs and/or some of the water can infiltrate deeper than the active root-zone.

More frequent and shorter irrigation cycles could be used to mitigate the problem. In practice this could in some cases boil down to using a pulsed standing time of less than one hour at a time. However, the danger exists that the subsoil could become oversaturated with water and anaerobic. Management of such short irrigation events is not practical and hydraulic performance of irrigation systems is decreased due to losses during the time pipelines fill and drain.

Crops experience stress from oversaturated and poor aeration in the subsoil. Water draining past the crop rootzone into the subsoil, carry nutrients out of reach the crop roots as well as contaminates the groundwater.

With low-flow irrigation, better control of the depth that irrigation water infiltrates into the soil is possible. It is also possible to have better control of the air-water ratio in the soil. As management tool, weekly measurements of the soil moisture status in various locations din the irrigated area should be done. This should be done at least at 3 different depths beneath the soil surface and can give a good indication of how irrigation should be adapted to more optimal conditions for the crop in the next week. In addition, profile holes can be dug to observe how the water spreads horizontally and vertically beneath the drippers.

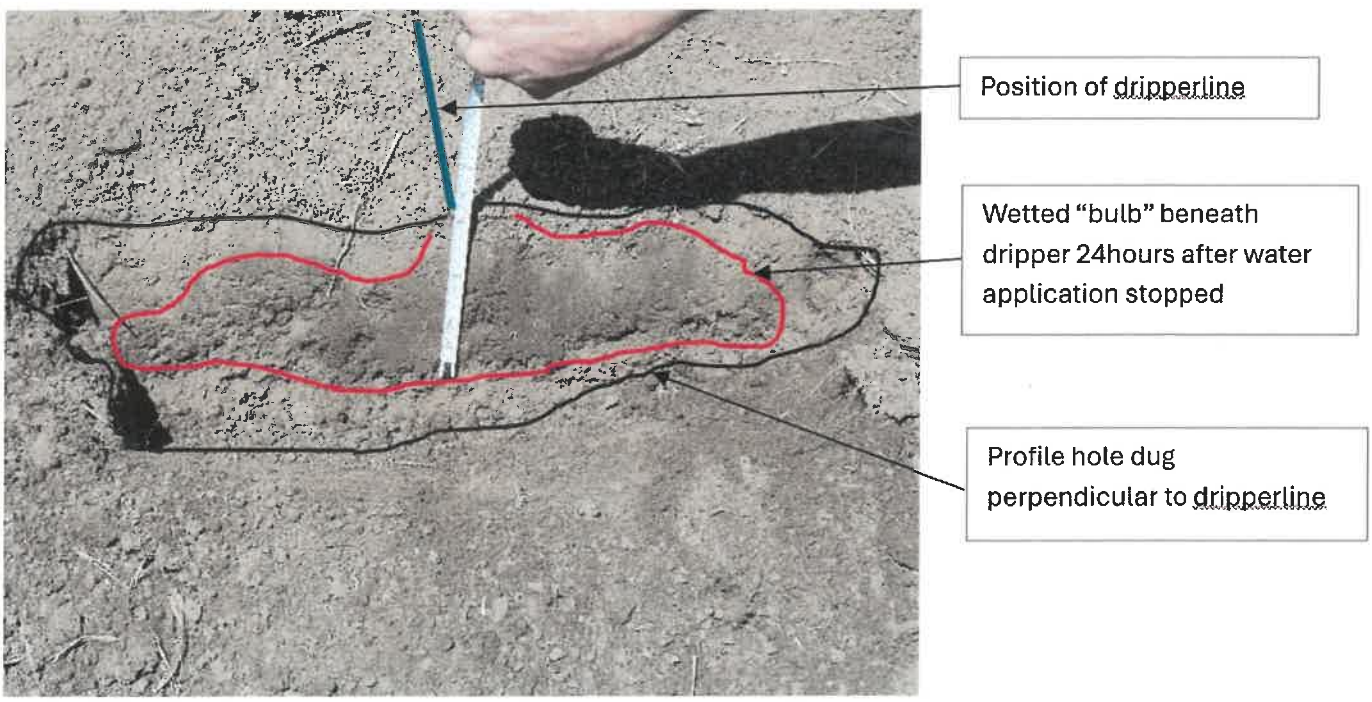

Figure 2: Profile hole dug 24 hours after water application stopped, reveals movement of water beneath a dripper

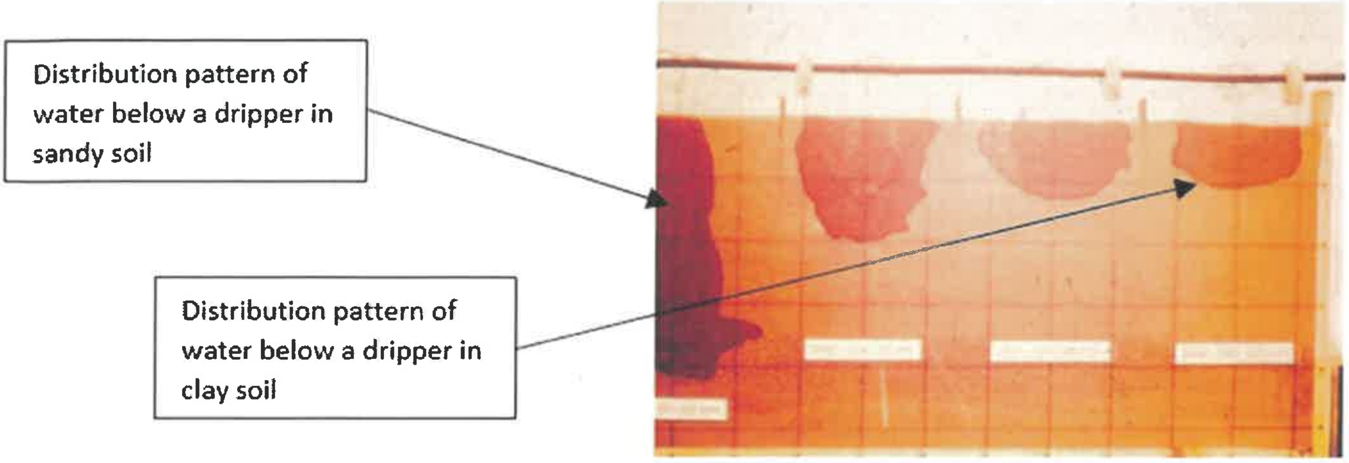

Figure 3: Visual representation of the water distribution in different soil types

Typically, the wetted pattern beneath a dripper could be in the form of an onion bulb (in an ideal soil). The characteristics of the soil, and the flowrate of the dripper is what determines the form and dimensions of this "bulb". The soil in Figure 2 could have a layer that restricts infiltration. A general rule is that sandy soil has a deep, narrow wetted area, while in clay soil the wetted area is wider and shallow.

However, dripper flowrate plays a significant role in the way water moves in the soil. When the flowrate is relatively high (>1 litre/hr), as in conventional drippers, vertical movement of the water beneath the dripper is dominant. With low-flowrate drippers, which deliver water at extremely low rates (<1 litre/hr), horizontal movement of water in the soil beneath the dripper is more dominant.

Water can be lost for use by the crops through different mechanisms. These mechanisms are evaporation, deep infiltration out of the crop root zone into the subsurface water table and surface run-off. However, this does not imply that this water is totally lost. It is just being used to sustain other functions in the water cycle, but it is not available for use by the irrigated plants.

To increase crop water use efficiency, losses due to evaporation and deep infiltration should be addressed. It is essential that the application rate of the irrigation water should not exceed the infiltration rate of the soil. The duration of irrigation sessions should be such that the crop root zone be wetted to field capacity. The soil characteristics determines the water holding capacity of the soil. Irrigation must be done without the soil being saturated to the point that water holding capacity is exceeded and run-off or infiltration deeper than the root zone occur.

Irrigation scheduling is management of irrigation timing and duration to optimize crop water use efficiency. The optimal depletion of the water that is readily available to the plant for each growth stage, is determined beforehand during system design. The "in-time" soil water content is the difference between the field capacity and the allowable soil water depletion. During each irrigation cycle, enough water is applied to return the soil water status to field capacity again.

Importantly, with use of low flow drip irrigation and the precision irrigation technology that is associated with it, regular measurement of soil moisture status and the water requirement of the plants must be taken into consideration for weekly irrigation planning purposes.
The depth that irrigation water infiltrates, can be controlled more accurately with Low-flow irrigation. Therefore, it has the effect that water is used more efficiently, and the soil is better aerated.

However, success with innovative technologies depends on their correct application.
Inquiries: VorsterS@arc.agric.za