

# Measured Irrigation for Smallholders

## more crop per drop



Measured irrigation evaporator

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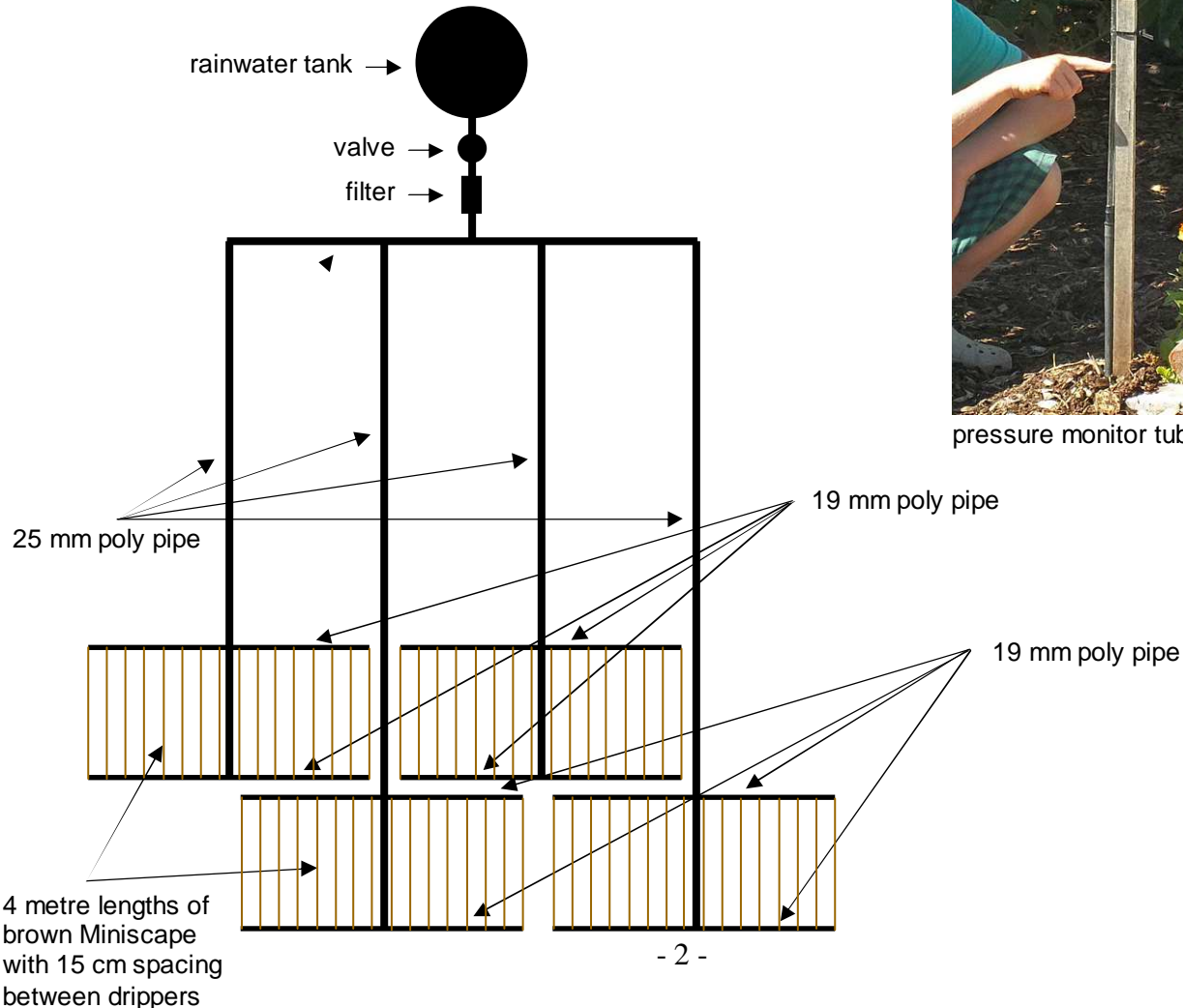
## Gravity feed drip irrigation

Many smallholders use gravity feed drip irrigation to irrigate a small garden (less than an acre). When the water source is a rainwater tank or a pond, gravity feed irrigation is preferable to pressurised irrigation because you don't need an expensive pump and you don't have the ongoing cost of electricity for the pump.

Gravity feed drip irrigation is easy to install on level or sloping ground provided you understand some important gravity feed principles:

1. Always use unregulated (non pressure compensating) drippers or drip line (drip tube or drip tape). For example, Netafim Miniscape (Landline 8) or Netafim Bioline.
2. All the drippers in a zone should be at approximately the same level.
3. The water source should be at least half a metre higher than all the drippers in the garden. If the water source becomes less than half a metre higher than the drippers in a zone, then to maintain uniformity it becomes increasingly important to keep the drippers at exactly the same level and to ensure that there is no frictional head loss between drippers.
4. Frictional head loss can be accommodated by designing your irrigation system appropriately. For example, if you are using Miniscape with 15cm spacing between the drippers, each dripper should be no more than 3 metres away from its water supply from the poly pipe. Frictional head loss in the poly pipe can be reduced by either increasing the diameter of the poly pipe or by replacing a single line of poly pipe with multiple parallel line of poly pipe (see the plan view below).
5. On sloping ground you need to use multiple irrigation zones such that the drippers in each zone are at approximately the same level. Each zone should have its own valve so that the irrigation of any zone is independent of the irrigation in all the other zones.
6. The water pressure should be approximately the same for all the drippers in a zone. The pressure variation between any 2 drippers in a zone can be monitored by connecting a pressure monitor tube near each dripper. A pressure monitor tube is clear vertical tube open at the top so that you can monitor the water level in the tube. Pressure monitor tubes may be purchased from the Measured Irrigation website [www.measuredirrigation.com.au](http://www.measuredirrigation.com.au)

**Plan view of a single zone gravity feed drip irrigation system.**



pressure monitor tube

# Upgrading gravity feed drip irrigation to Measured Irrigation

The most commonly used irrigation scheduling method is programmed scheduling and this method wastes a lot of water because it does not respond to the prevailing weather conditions. By upgrading from programmed irrigation scheduling to measured irrigation scheduling, water usage may be reduced by 50% or more without affecting the yield (see the Research Report: Improvement in crop yield per litre using Measured Irrigation, available from the Measured Irrigation website [www.measuredirrigation.com.au](http://www.measuredirrigation.com.au)). The cost of the upgrade is negligible (the cost of a bucket and a steel pipe). Pressurised drip irrigation systems can also be upgraded.

## Measured irrigation evaporator

The evaporator is any container with vertical sides and with a suitable surface area of evaporation.

Draw a level line on the inside of the evaporator about 3 cm below the overflow level.



Level line on inside of evaporator

Position the evaporator in the garden, preferably exposed to full sun.

Position a dripper so that it will drip water into the evaporator. This dripper is called the control dripper and it should be at the same level as the other drippers in the garden.

The volume of water delivered by each dripper in your garden during an irrigation event is the same as the volume of water delivered to the evaporator by the control dripper.

Check the water level in the evaporator at sunset each day.

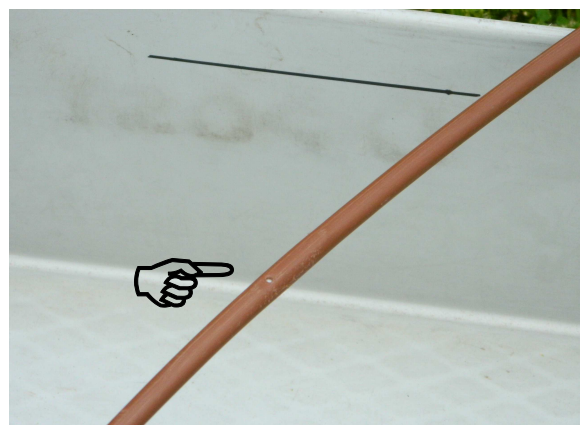
If the water level is below the level line, start irrigating.

Stop irrigating when the water level reaches the level line.

If the garden requires less frequent watering, you may choose not to irrigate on certain evenings. If the garden requires more frequent watering, you may choose to irrigate during the day as well as at sunset (for example if the weather is very hot and dry).



The evaporator may simply be a bucket



Control dripper will drip water into the evaporator



Water level below level line



Start irrigating at sunset



Stop irrigating when the water level reaches the level line



## How to adjust water usage

The amount of water that your plants need will depend on many factors in addition to the weather. For example, as the plants grow and become bigger they will need more water. Plants growing in sandy soil will need more water than plants growing in heavy soil.

To take account of all these additional factors, I recommend that you use a length of steel pipe to check the moisture level in the soil. I suggest that the diameter of the pipe be between 30 and 40 mm. An angle grinder can be used to cut some slots in the steel pipe so that you can inspect the soil inside the pipe. I suggest that the width of the slots be about 13 mm. You can also use the angle grinder to sharpen the edge of the end of the soil moisture probe.

A suitable soil moisture probe may be purchased from the Measured Irrigation website [www.measuredirrigation.com.au](http://www.measuredirrigation.com.au)



An angle grinder can be used to make some slots in a length of steel pipe



Early in the morning after irrigation the night before, hammer the steel pipe into the soil near a dripper



Remove the steel pipe from the soil and use the slots to inspect the moisture level in the soil and the position of the wetting front

By checking the moisture level in the soil through the slots in the steel pipe, you can decide whether the plants have been irrigated the night before with too much or too little water.

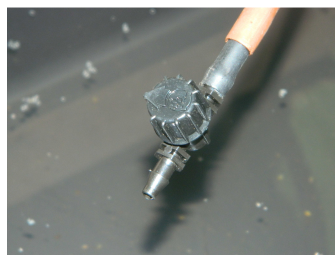
Early in the morning after irrigation the night before, hammer the steel pipe into the soil near a dripper so that the slots face the dripper.

Remove the steel pipe from the soil and use the slots to inspect the moisture level in the soil and the position of the wetting front. You may wish to use the slots to remove some soil from the pipe and to squeeze the soil sample between your fingers.

You may wish to place a measuring container under one of the drippers so that you can measure the volume of water emitted by the dripper during an irrigation event.

An easy way to adjust your water usage is to use an adjustable dripper for your control dripper. Increase the flow rate to reduce your water usage, and reduce the flow rate to increase your water usage. To help you make an appropriate adjustment, it is recommended that the irrigation be running while the adjustment is being made.

A suitable adjustable control dripper may be purchased from the Measured Irrigation website [www.measuredirrigation.com.au](http://www.measuredirrigation.com.au)



Adjustable dripper used as control dripper



Increase the flow rate of the adjustable control dripper to reduce water usage

## Sunset scheduling

Check the water level in the evaporator at sunset each day, and if the water level is below the level line, start irrigating. Stop irrigating when the water level reaches the level line.

After irrigation at sunset on 3 or more consecutive days without rain, use the soil moisture probe at sunrise to check the moisture level in the soil below one of the drippers. If the moisture in the soil extends below the maximum depth of the root zone, too much water is being used so increase the flow rate of the adjustable control dripper. If the moisture in the soil does not reach the maximum depth of the root zone, not enough water is being used so decrease the flow rate of the adjustable control dripper. After another 3 or more consecutive days without rain, repeat the process until no further adjustments are required. The water usage should stabilise at an appropriate level for the plants at their current stage of growth.

As your crop grows and the water requirement of the crop changes, you may wish to repeat the process of adjusting the water usage.

## Modified sunset scheduling

### Adjusting water usage to take account of soil type and the depth of the root zone.

For sunset scheduling, you check the water level in the evaporator at sunset each day, and if the water level is below the level line, you start irrigating. For plants with deep roots or for plants in clay soils, it is preferable to irrigate with more water less frequently to enable the water to reach the bottom of the root zone. Between irrigation events the soil near the surface is allowed to dry out, but there should still be moisture in the root zone. If you decide that your plants need irrigating less frequently than daily (for example, once a week), then the following irrigation scheduling method is recommended. This irrigation scheduling method is called **modified sunset scheduling**.

- Step 1. Allow the soil to dry out over several days until the soil is dry between the surface and the bottom of the root zone (use the soil moisture probe).
- Step 2. Place a measuring container under one of the drippers to collect the water and start irrigating at sunset. During the course of the irrigation, regularly check the depth of the moisture below various drippers (use the soil moisture probe). Stop the irrigation as soon as the moisture is close to the bottom of the root zone. Record the volume of water in the measuring container. This will be called the dripper control volume and it is the volume of water required to moisten the soil below a dripper as far as the bottom of the root zone when the soil is dry.
- Step 3. Fill the evaporator with water until the water level reaches the level line.
- Step 4. Allow the soil to dry out over several days until the soil is dry between the surface and the bottom of the root zone (use the soil moisture probe). While the soil is drying, the water level in the evaporator is falling due to evaporation. Mark a line on the inside of the evaporator corresponding to the water level. This line is called the low level line. The gap between the level line and the low level line is the evaporation required to dry out the soil from the surface to the bottom of the root zone.
- Step 5. Empty the measuring container and place it below one of the drippers. Start irrigating at sunset when the water level in the evaporator is below the low level line. Stop irrigating when the water level in the evaporator reaches the level line.
- Step 6. Check the volume of water in the measuring container. If the volume is less than the dripper control volume then the moisture below the dripper is unlikely to have reached the bottom of the root zone. So reduce the flow rate of the adjustable control dripper (to increase the duration of the irrigation event) in preparation for the next irrigation. If the volume is more than the control volume then the moisture below the dripper is likely to have extended beyond the bottom of the root zone. So increase the flow rate of the adjustable control dripper (to decrease the duration of the irrigation event).
- Step 7. Check the water level in the evaporator at sunset each day. When the water level is below the low level line, repeat Steps 5, 6 and 7.

After a few adjustments to the adjustable dripper, the water usage should stabilise at an appropriate level for the plants at their current stage of growth. The volume of water in the measuring container after each irrigation event should be approximately the same as the dripper control volume recorded in Step 2.

As your crop grows and the water requirement of the crop changes, you may wish to repeat the process of adjusting the water usage.

## **Measured irrigation on sloping ground**

One sloping ground you will need to organise your plants into a number of zones so that the plants within each zone are at approximately the same level. Each zone should have its own evaporator, adjustable control dripper and inlet valve. The irrigation in any zone is independent of the irrigation in all the other zones.