DIY Measured Irrigation Training Manual for Smallholders

more crop per drop

Using a control dripper to adjust water usage

Dr Bernie Omodei
Measured Irrigation
5/50 Harvey Street East, Woodville Park SA 5011
Mobile 0403 935277
Email bomodei@measuredirrigation.com.au
Website www.measuredirrigation.com.au

April 2018

CONTENTS

Introduction

The Training Manual is for smallholders using gravity feed drip irrigation on a small plot of land. You can automate your drip irrigation system so that water is pumped automatically from your farm pond (or from a rainwater tank, lake or river) to the header tank. All your plants are irrigated automatically.

The Training Manual will show the smallholder how to use MI (Measured Irrigation) to halve the amount of water needed to produce the same yield.

By automating your drip irrigation system you can leave your plot unattended for weeks. This will allow you to become involved in other activities away from the plot; for example, travelling to the market to sell your produce.

For pressurised drip irrigation systems, you can apply both unpowered MI and the DIY Solar Drip Irrigation Kit without Pump, provided that the drippers being used are non pressure compensating (unregulated).

Definition of Measured Irrigation

Measured irrigation is a drip irrigation scheduling method that implements two fundamental principles:

1. Variations in the application rate for each dripper throughout the year are controlled by the prevailing net evaporation (evaporation minus rainfall).
2. The volume of water emitted by each dripper during an irrigation event is controlled directly without the need to control the flow rate or the duration of the irrigation event.

How large can the plot be?

The Training Manual assumes that the smallholder has already established a gravity feed drip irrigation system. Provided that the drip irrigation system is already working effectively, you can use the a DIY Solar Drip Irrigation Kit and the MI Five Zone Adaptor to automate the irrigation system regardless of the area of your plot of land.

Depending of the duration of the irrigation event and the power requirements of the pump and the solenoid valves, you may need to upgrade the battery to a larger battery, and you may need to upgrade the solar panel to a larger solar panel.

Chapter 1 Unpowered Measured Irrigation

To install unpowered MI, all that is needed is an evaporator and an adjustable dripper.

The **evaporator** is any container with vertical sides, with a surface area of at least 0.05 m^2, and a depth of at least 0.1 m.

Examples of suitable evaporators

Any **adjustable dripper** may be used. An ideal adjustable dripper is the Claber RainJet which can be purchased online from the Measured Irrigation website: www.measuredirrigation.com.au .

Claber RainJet adjustable dripper

1.1 Step by step instructions for installing unpowered MI

Step 1. Draw a level line on the inside of the evaporator about 1.5 cm below the overflow level.

Draw a level line on the inside of the evaporator about 1.5 cm below the overflow level

Step 2. Connect the adjustable dripper to the irrigation system and position the evaporator so that the adjustable drip drips water into the evaporator during irrigation. The adjustable dripper should be at the same level as the irrigation drippers. The adjustable dripper is called the **control dripper**.

The adjustable dripper can be connected to a drip line using a Tee


Cut the drip line so that you can connect the Tee


Connect the Tee


The adjustable drip drips water into the evaporator during irrigation

Step 3. Place a measuring container under one of the irrigation drippers.

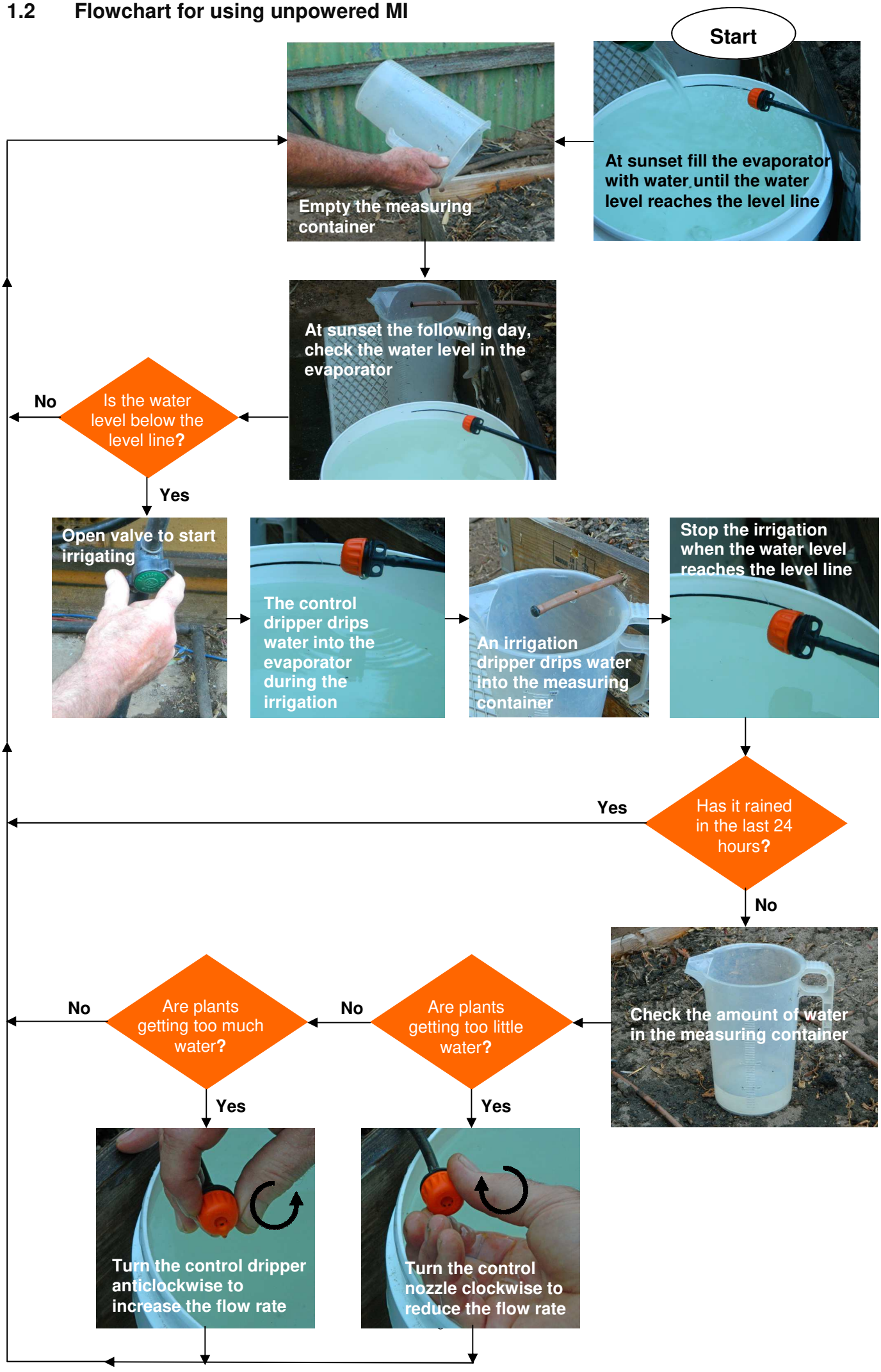

Place a measuring container under one of the irrigation drippers

Step 4. Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers.


Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers

Step 5. You may wish to protect the evaporator to prevent animals drinking the water, but make sure that you do not impede the evaporation (chicken wire is ideal).

1.2 Flowchart for using unpowered MI



If your plants require less frequent watering, you may choose not to irrigate on certain evenings. For example, at sunset one day the water level is below the level line and you decide not to irrigate. At sunset the following day the water level will have fallen even further, and so when you irrigate the irrigation volume will be the sum of the irrigation volumes for both days. Changing the irrigation frequency does not affect the total amount of water use for irrigation during the growing season.

If the garden requires more frequent watering, you may choose to irrigate at the middle of the day as well as at sunset (for example, if the weather is very hot and dry).

Garden beds being irrigated by unpowered MI

Chapter 2 DIY Solar Drip Irrigation Kit without Pump

For some applications the water supply is higher than land to be irrigated, and so the land can be irrigated directly from the water supply. For such applications, a header tank and a pump are not required. The DIY Solar Drip Irrigation Kit without Pump can also be used to upgrade pressurised irrigation systems to fully automated measured irrigation provided that the drippers being used are non pressure compensating.

Using the kit, you can automate your drip irrigation system so that all your plants are irrigated automatically. As well as reading this document, I recommend that you watch the YouTube video with the title DIY Solar Drip Irrigation Kit.

The DIY Solar Drip Irrigation Kit without pump can be purchased online from the Measured Irrigation website: www.measuredirrigation.com.au. All the other parts required may be purchased locally (for example, a solar panel and a battery).

By automating your drip irrigation system you can leave your plot unattended for weeks. This will allow you to become involved in other activities away from the plot; for example, travelling to the market to sell your produce.

The kit uses measured irrigation, a new method of irrigation scheduling that responds to the prevailing weather conditions. This means that you use much less water without affecting the yield.

2.1 Contents of the DIY Solar Drip Irrigation Kit without pump

As well as the User Manual, the kit includes the following components:

waterproof irrigation controller

light sensor

float switch

solenoid valve with fittings to connect to19 mm poly pipe, and 2.5 metres of waterproof electrical cable

12 waterproof connectors for electrical wire

adjustable dripper

The kit does not include:

evaporator
battery
solar panel
extra 2-strand electrical cable.

2.2 Step by step instructions for installing the DIY Solar Drip Irrigation Kit without pump

Step 1. Choose a suitable evaporator.

The **evaporator** is any container with vertical sides, with a surface area of at least 0.05 m^2, and a depth of at least 0.1 m.

Evaporator

Step 2. Install the float switch.

Drill a half inch (13 mm) hole in the side of the evaporator so that the centre of the hole is 3.5 cm lower than the overflow level for the evaporator. Install the float switch so that the float shaft points up.

Drill a hole in the side of the evaporator

Float switch installed on evaporator with float shaft pointing up

Step 3. Install the solenoid valve.

Connect the solenoid valve at ground level to 19 mm poly pipe at both ends. Check the arrow on the bottom of the solenoid valve to ensure that the flow is in the correct direction. Position the solenoid valve so that the cover protects the solenoid from the weather.

Solenoid valve installed at ground level

Step 4. Purchase and install a solar panel (not in kit).

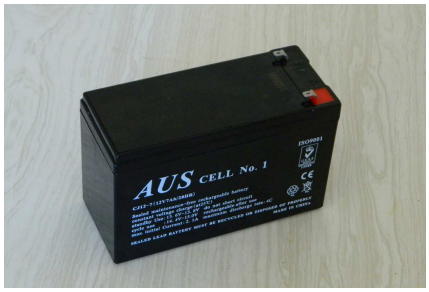
A 12 volt10 watt solar panel should provide all the power required. You may purchase the solar panel either locally or online. You need to find a low cost method of mounting the solar panel. In the southern hemisphere the solar panel should face the sun when the sun is in the north. In the northern hemisphere the solar panel should face the sun when the sun is in the south. The ideal angle of the solar panel changes throughout the year. It is easy to adjust the orientation of the solar panel if it is mounted on a pole as shown.

Solar panel mounted on a pole

Step 5. Purchase a battery (not in kit).

A rechargeable 12 volt lead acid battery is required. You may be able to find a used car battery in good condition. If you buy a new battery then I recommend a sealed lead acid battery with a capacity of at least 7 amp hours.

Note that the solar panel and the battery may be replaced by a 12V 5A power adaptor.



7 amp hour battery

Step 6. Connect the adjustable dripper.

Connect the adjustable dripper to the irrigation system and position the evaporator so that the adjustable dripper drips water into the evaporator during irrigation. The adjustable dripper should be at the same level as the irrigation drippers. The adjustable dripper is called the **control dripper**.

The adjustable dripper can be connected to a drip line using a Tee


Cut the drip line so that you can connect the Tee


Connect the Tee


The adjustable drip drips water into the evaporator during irrigation

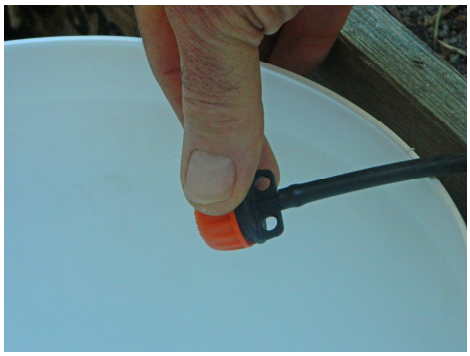
Step 7. Measuring container

Place a measuring container under one of the irrigation drippers.


Measuring container under one of the irrigation drippers

Step 8. Adjust the control dripper.

Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers.


Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers

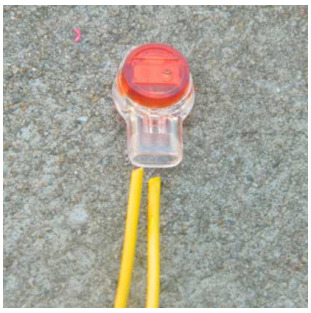
Step 9. You may wish to protect evaporator to prevent animals drinking the water, but make sure that you do not impede the evaporation (chicken wire is ideal).

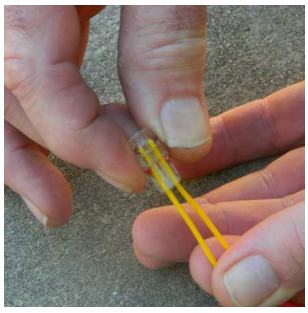
Step 10. Connect the irrigation controller.

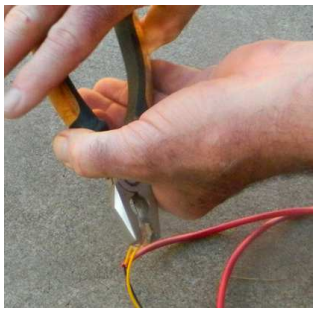
The irrigation controller has 10 colour-coded wires which need to be connected to the various components as follows:

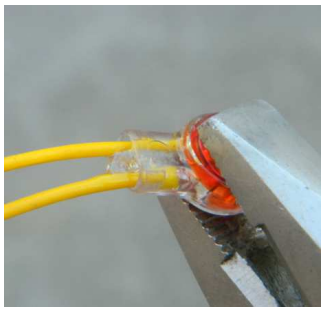
Connect the **red** wire to the positive terminal on the battery.
Connect the **black** wire to the negative terminal on the battery.
Connect the **dark blue** wire to the positive wire form the solar panel.
Connect the **dark green** wire to the negative wire form the solar panel.
Connect the **purple** wire to one of the wires from the float switch on the evaporator.
Connect the **pink** wire to the other wire from the float switch on the evaporator.
Connect the **yellow** wire to the yellow wire from the solenoid valve (already connected in the kit).
Connect the **white** wire to the white wire from the solenoid valve and to the white wire from the light sensor (already connected in the kit).
Connect the **grey** wire to the black wire from the light sensor (already connected in the kit).
Connect the **light blue** wire to the red wire from the light sensor (already connected in the kit).

12 waterproof connectors for electrical wire are provided. There is no need to strip the wires before inserting them into the connector. The connection is made by using a pair of pliers (for example) to push down the red cap so that the gel is squeezed out of the connector.


Wires are not stripped before insertion


Insert wires into connector

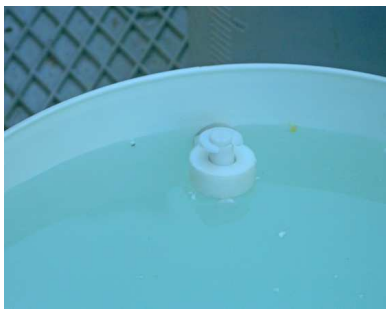

Use pliers to push down the red cap


Gel is squeezed out of connector

Step 10. Fill the evaporator.

Fill the evaporator with water until the water level is just below the float switch.


Fill the evaporator with water until the water level is just below the float switch


Water level just below the float switch

2.3 How to use the DIY Solar Drip Irrigation Kit without pump

The switch on the irrigation controller is a three position switch with UP ON (24 hour operation), CENTRE OFF, DOWN ON (night only operation).

Turn the switch to the ON position (switch up) and the irrigation will start. The irrigation stops automatically when the water level raises the float on the float switch. With the switch in the up position (24 hour operation), the irrigation will start automatically as soon as the water level in the evaporator has fallen below the float switch.

With the switch in the ON night only position (switch down), the irrigation is restricted to dark hours only. If you do not wish to irrigate during the heat of the day, turn the switch to the ON night only position (switch down) so that the irrigation starts automatically at sunset (provided that the water level is below the float switch).

To stop the irrigation at any time, turn the switch to the OFF position.

The switch on the irrigation controller has 3 positions: ON, OFF, ON night only

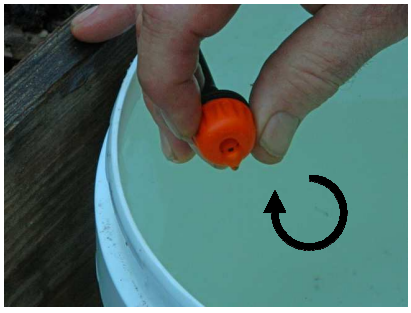
A solar charge controller is located inside the irrigation controller. One of the functions of the solar charge controller is to protect the battery from over discharge. When the battery voltage is less than 12 volts, the solar charge controller isolates the battery so that the pump and solenoid valve stop operating.

2.4 How to use the control dripper to adjust water usage


1. Empty the measuring container before irrigation commences at sunset.


2. Position the measuring container under one of the irrigation drippers so that water drips into the container during the irrigation.


3. After sunrise the following morning, check the amount of water in the measuring container.


4. If your plants are getting too little water, turn the control dripper clockwise to reduce the flow rate of the control dripper.


5. If your plants are getting too much water, turn the control dripper anticlockwise to increase the flow rate of the control dripper.

Chapter 3 DIY Solar Drip Irrigation Kit with Pump

Using the kit, you can automate your drip irrigation system so that water is pumped automatically from your farm pond (or from a rainwater tank, lake or river) to a header tank. All your plants are irrigated automatically. As well as reading this document, I recommend that you watch the YouTube video with the title DIY Solar Drip Irrigation Kit.

The DIY Solar Drip Irrigation Kit with pump can be purchased online from the Measured Irrigation website: www.measuredirrigation.com.au. All the other parts required may be purchased locally (for example, a solar panel and a battery).

By automating your drip irrigation system you can leave your plot unattended for weeks. This will allow you to become involved in other activities away from the plot; for example, travelling to the market to sell your produce.

The kit uses measured irrigation, a new method of irrigation scheduling that responds to the prevailing weather conditions. This means that you use much less water without affecting the yield.

It is assumed that the depth of the farm pond is no more than 4 metres.

Farm pond in Kenya for gravity feed drip irrigation

3.1 Contents of the DIY Solar Drip Irrigation Kit with pump

As well as the User Manual, the kit includes the following components:

waterproof irrigation controller

light sensor

two float switches

solenoid valve with fittings to connect to19 mm poly pipe, and 2.5 metres of waterproof electrical cable

a double pump (two pumps connected in series) with an inlet filter, fittings to connect to 19 mm poly pipe, and 9 metres of waterproof electrical cable

16 waterproof connectors for electrical wire

adjustable dripper

The kit does not include:

evaporator
battery
solar panel
extra 2-strand electrical cable.

3.2 Step by step instructions for installing DIY Solar Drip Irrigation Kit with pump

Step 1. Connect the pump.

Remove the header tank inlet pipe from the farm pond and connect it to the outlet from the pump (note that the outlet from the pump is perpendicular to the shaft of the pump.

WARNING: The inlet and outlet of the pump are fragile, so be careful not to apply force to the inlet or outlet at any time.

Step 2. Install a float switch on the header tank.

Drill a 13 mm (half inch) hole in the side of the header tank so that the hole is about 1 cm lower than the inlet to the header tank. Install one of the float switches on the inside of the header tank so that the float shaft points down.

Float switch on the header tank is lower that the inlet

Float switch on the inside of the header tank with the float shaft pointing down

Step 3. Choose a suitable evaporator.

The **evaporator** is any container with vertical sides, with a surface area of at least 0.05 m^2, and a depth of at least 0.1 m.

Evaporator

Step 4. Install the other float switch on the evaporator.

Drill a half inch (13 mm) hole in the side of the evaporator so that the centre of the hole is 3.5 cm lower than the overflow level for the evaporator. Install the other float switch so that the float shaft points up.

Drill a hole in the side of the evaporator

Float switch installed on evaporator with float shaft pointing up

Step 5. Install the solenoid valve.

Connect the solenoid valve at ground level to 19 mm poly pipe at both ends. Check the arrow on the bottom of the solenoid valve to ensure that the flow is in the correct direction. Position the solenoid valve so that the cover protects the solenoid from the weather.

Solenoid valve installed at ground level

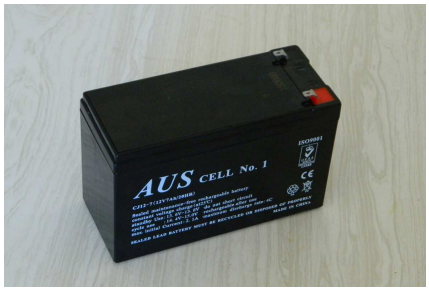
Step 6. Purchase and install a solar panel (not in kit).
A 12 volt 20 watt solar panel should provide all the power required. You may purchase the solar panel either locally or online. You need to find a low cost method of mounting the solar panel. In the southern hemisphere the solar panel should face the sun when the sun is in the north. In the northern hemisphere the solar panel should face the sun when the sun is in the south. The ideal angle of the solar panel changes throughout the year. It is easy to adjust the orientation of the solar panel if it is mounted on a pole as shown.


Solar panel mounted on a pole

Step 7. Purchase a battery (not in kit).

A rechargeable 12 volt lead acid battery is required. You may be able to find a used car battery in good condition. If you buy a new battery then I recommend a sealed lead acid battery with a capacity of at least 7 amp hours.

Note that the solar panel and the battery may be replaced by a 12V 5A power adaptor.



7 amp hour battery

Step 8. Connect the adjustable dripper.

Connect the adjustable dripper to the irrigation system and position the evaporator so that the adjustable dripper drips water into the evaporator during irrigation. The adjustable dripper should be at the same level as the irrigation drippers. The adjustable dripper is called the **control dripper**.

The adjustable dripper can be connected to a drip line using a Tee


Cut the drip line so that you can connect the Tee


Connect the Tee


The adjustable drip drips water into the evaporator during irrigation

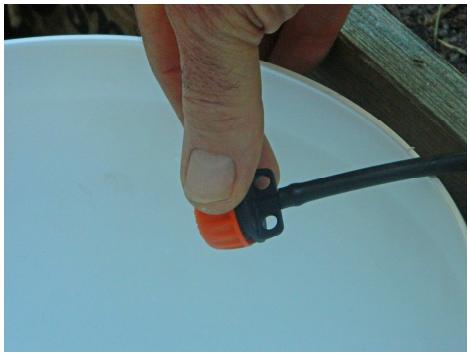
Step 9. Measuring container

Place a measuring container under one of the irrigation drippers.


Measuring container under one of the irrigation drippers

Step 10. Adjust the control dripper.

Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers.



Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers

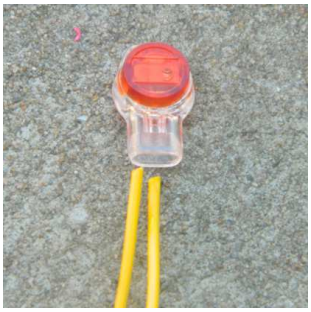
Step 11. You may wish to protect the evaporator to prevent animals drinking the water, but make sure that you do not impede the evaporation (chicken wire is ideal).

Step 12. Connect the irrigation controller.

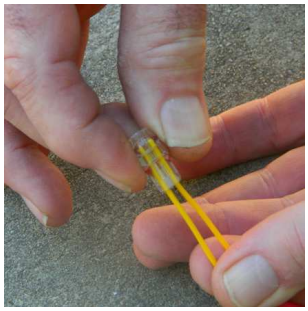
The irrigation controller has 13 colour-coded wires which need to be connected to the various components as follows:

Connect the **red** wire to the positive terminal on the battery.
Connect the **black** wire to the negative terminal on the battery.
Connect the **dark blue** wire to the positive wire form the solar panel.
Connect the **dark green** wire to the negative wire form the solar panel.
Connect the **purple** wire to one of the wires from the float switch on the evaporator.
Connect the **pink** wire to the other wire from the float switch on the evaporator.
Connect the **grey** wire to one of the wires from the float switch on the header tank.
Connect the **brown** wire to the other wire from the float switch on the header tank.
Connect the **yellow** wire to the yellow wire from the solenoid valve (already connected in the kit).
Connect the **white** wire to the white wire from the solenoid valve and to the white wire from the light sensor (already connected in the kit).
Connect the **orange** wire to the yellow wire from the pump.
Connect the **light pink** wire to the white wire from the pump.
Connect the **grey** wire to the black wire from the light sensor (already connected in the kit).
Connect the **light blue** wire to the red wire from the light sensor (already connected in the kit).

16 waterproof connectors for electrical wire are provided. There is no need to strip the wires before inserting them into the connector. The connection is made by using a pair of pliers (for example) to push down the red cap so that the gel is squeezed out of the connector.

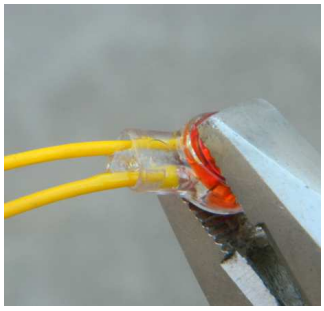


Wires are not stripped before insertion



Insert wires (2 or 3) into connector

Use pliers to push down the red cap

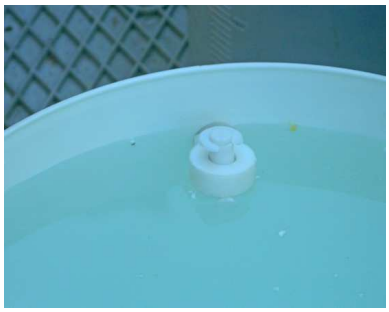


Gel is squeezed out of connector

Step 13. Fill the evaporator.

Fill the evaporator with water until the water level is just below the float switch.

Fill the evaporator with water until the water level is just below the float switch



Water level just below the float switch

Step 14. Submerge the pump in the farm pond

The pump inlet should be at least 15cm above the bottom of the pond to avoid pumping sediment from the bottom of the pond and clogging the inlet filter. If clogging of the filter becomes a problem, you may wish to install a larger filter.

The inlet/outlet manifold on each pump may break if too much force is applied to the pump. If you break the inlet/outlet manifold, a replacement manifold (or a replacement pump) can be purchased online from the Solar Project UK: www.solarproject.co.uk.

The pump is also available from the Measured Irrigation website: www.measuredirrigation.com.au.

3.3 How to use the DIY Solar Drip Irrigation Kit with pump

The switch on the irrigation controller is a three position switch with UP (ON 24 hour operation), CENTRE (OFF), and DOWN (ON night only operation).

Turn the switch to the ON position (switch up) and the irrigation will start. The irrigation stops automatically when the water level raises the float on the float switch. With the switch in the up position (24 hour operation), the irrigation will start automatically as soon as the water level in the evaporator has fallen below the float switch.

With the switch in the ON night only position (switch down), the irrigation is restricted to dark hours only. If you do not wish to irrigate during the heat of the day, turn the switch to the ON night only position (switch down) so that the irrigation starts automatically at sunset (provided that the water level is below the float switch).

To stop the irrigation at any time, turn the switch to the OFF position.

The switch on the irrigation controller has 3 positions: ON, OFF, ON night only

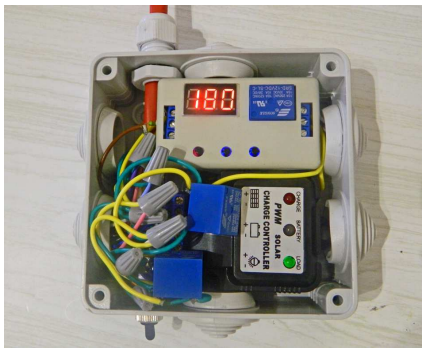
When the water level in the header tank falls below the float switch, the float switch activates a delay timer inside the irrigation controller and 3 minutes later the pump starts working. When the water level reaches the float switch the pump stops automatically.

The operation of the pump is independent of the position of the switch on the irrigation controller.

The delay timer is inside the irrigation controller. You can access the delay timer by removing the four screws and removing the cover. The time delay can be adjusted by pressing the buttons on the delay timer. The delay timer has a 3 digit display for the time delay in seconds (preset to 180 seconds).

To change the time delay, press the middle button to select the digit you wish to change. The digit will flash to indicate that it is ready to be changed. Then press the right hand button to change the digit. When the time delay has been reset press the middle button until no digits are flashing.

Do not press the left hand button.



The delay timer has a 3 digit display for the time delay in seconds

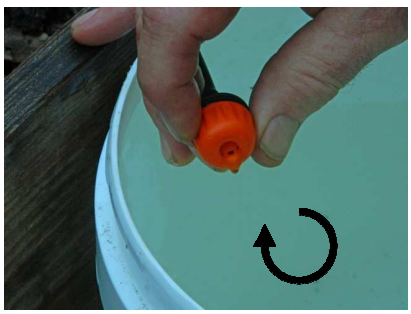
A solar charge controller is located inside the irrigation controller. One of the functions of the solar charge controller is to protect the battery from over discharge. When the battery voltage is less than 12 volts, the solar charge controller isolates the battery so that the pump and solenoid valve stop operating.

3.4 How to use the control dripper to adjust water usage


1. Empty the measuring container before irrigation commences at sunset.


2. Position the measuring container under one of the irrigation drippers so that water drips into the container during the irrigation.


3. After sunrise the following morning, check the amount of water in the measuring container.

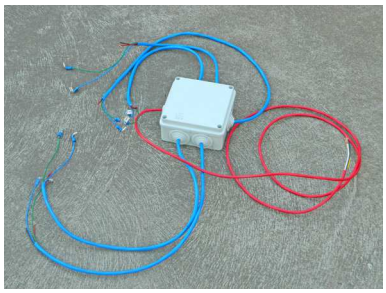

4. If your plants are getting too little water, turn the control dripper clockwise to reduce the flow rate of the control dripper.


5. If your plants are getting too much water, turn the control dripper anticlockwise to increase the flow rate of the control dripper.

Chapter 4 Additional Irrigation Zones

In some applications you may wish to use more than one irrigation zone. For example, different crops may require separate zones. On sloping ground it is preferable to have a number of irrigation zones where each zone is at a different level. For each additional zone you will need an evaporator and an adjustable control dripper.

If you are using a DIY Solar Drip Irrigation Kit (with or without pump) you will need to purchase a **MI Five Zone Adaptor**. You will also need a solenoid valve and a float switch for each additional zone.



MI Five Zone Adaptor

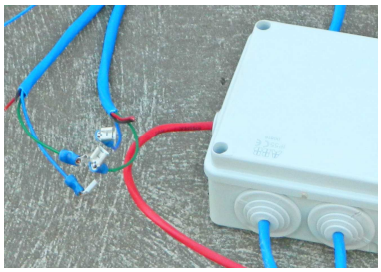
The MI Five Zone Adaptor allows you to irrigate up to five additional zones. Included with the MI Five Zone Adaptor are 5 adjustable drippers and 12 waterproof connectors for electrical wire. The MI Five Zone Adaptor, additional solenoids valves and additional float switches are available from the Measured Irrigation website. www.measuredirrigation.com.au

The MI Five Zone Adaptor has 3 colour-coded wires which need to be connected to the irrigation controller as follows:

Connect the **yellow** wire to the purple wire from the irrigation controller.

Connect the **white** wire to the white wire from the irrigation controller.

Connect the **black** wire to the grey wire from the irrigation controller.



MI Five Zone Adaptor close-

For each additional zone, the MI Five Zone Adaptor has 4 colour-coded wires which need to be connected to the various components as follows:

Connect the **blue** wire with the spade connection to one of the terminals on the solenoid valve for the zone.

Connect the **green** wire with the spade connection to the other terminal on the solenoid valve for the zone.

Connect the **red** wire to one of the wires from the float switch for the zone.

Connect the **black** wire to one of the other wire from the float switch for the zone.

For each additional zone, you will need to adjust the control dripper for the zone to adjust water usage for the zone (see Section 2.4 How to use the control dripper to adjust water usage).

If you are using the MI Five Zone Adaptor, an extra solar panel or an extra battery may be required.

Chapter 5 Soil Moisture

5.1 Soil moisture probe

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, you may need a soil moisture probe is to check the moisture level in the soil at various depths. A very simple soil moisture probe is a length of steel pipe with a long slot. I suggest that the diameter of the pipe be between 30 and 40 mm. An angle grinder can be used to cut a long slot in the steel pipe to that you can inspect the soil inside the pipe. I suggest that the width of the slot be about 13 mm. You can also use the angle grinder to sharpen the edge of the end of the soil moisture probe.

An angle grinder can be used to make a long slot in a length of steel pipe

A suitable soil moisture probe may be purchased online from the Measured Irrigation website www.measuredirrigation.com.au

By checking the moisture level in the soil through the slot in the steel pipe, you can decide whether your plants have been irrigated with too much or too little water. A control dripper may be used to adjust the water usage.

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

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

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

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

5.2 Modified sunset scheduling

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

When you use unpowered MI, 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 and you stop irrigating when the water level reaches the level. This method of irrigation scheduling is called **sunset scheduling**. When you use a DIY Solar Drip Irrigation Kit you are automating sunset scheduling.

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 me moisture in the root zone. If you decide that your plants need irrigating less frequently than daily (for example, once a week), then **modified sunset scheduling** is recommended.

Step by step instructions for 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 a soil moisture probe).

Step 2. Place a measuring container under one of the irrigation 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 a 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 is called the **dripper control volume** and it is the volume of water required to moisten dry soil below a dripper from the surface to the bottom of the root zone. Remember to record the dripper control volume for future reference.

Place a measuring container under one of the irrigation drippers

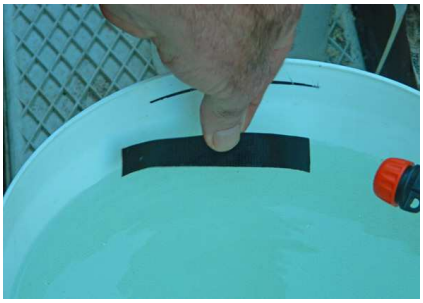
Dripper control volume in measuring container

Step 3. Fill the evaporator with water until the water level reaches the level line (or the float switch).

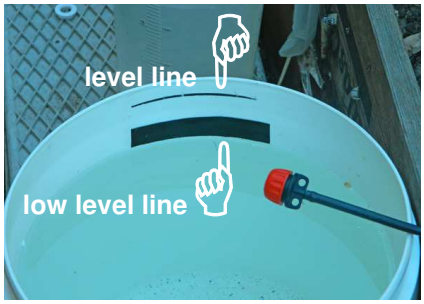
Fill the evaporator with water until the water level reaches the level line

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 a soil moisture probe). While the soil is drying, the water level is 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 (or the float switch) and the low level line is the evaporation required to the dry out the soil from the surface to the bottom of the root zone.

While the soil is drying, the water level is the evaporator is falling due to evaporation



Mark the low level line



Level line and low level line

Step 5. Empty the measuring container and place it below one of the irrigation drippers.
Start irrigating at sunset and stop irrigating when the water level in the evaporator reaches the level line.


Empty the measuring container

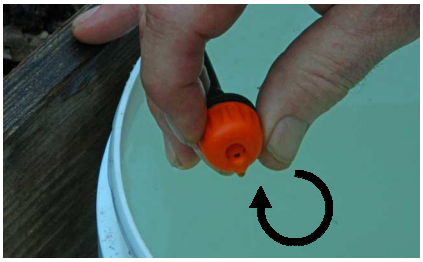

Start irrigating at sunset


Stop irrigating when the water level reaches the level line

If you are using a DIY Solar Drip Irrigation Kit, turn the switch to the ON night only position (switch down) so that the irrigation starts automatically at sunset and stops when the water level reaches the float switch. Turn the switch to the OFF position after the irrigation has stopped.

Step 6. Check the volume of water in the measuring container. If the volume in the measuring container is less than the dripper control volume then the moisture below a dripper is unlikely to have reached the bottom of the root zone. So reduce the flow rate of the control dripper (to increase the duration of the irrigation event) in preparation for the next irrigation. If the volume in the measuring container is more than the dripper control volume then the moisture below a dripper is likely to extend beyond the bottom of the root zone. So increase the flow rate of the control dripper (to decrease the duration of the irrigation event) in preparation for the next irrigation.


Check the volume of water in the measuring container.


If volume in the measuring container is less than the dripper control volume, turn the control dripper clockwise to reduce the flow rate of the control dripper.


If the volume in the measuring container is more than the dripper control volume, turn the control dripper anticlockwise to increase the flow rate of the control dripper.

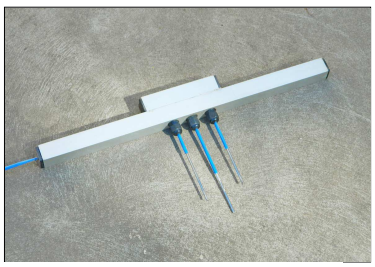
Step 7. Check the water level in the evaporator at sunset each day. When the water level is below the low level line, repeat Steps 5, 6 and 7.

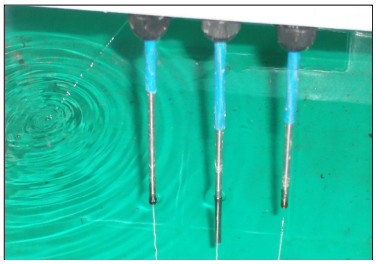
After a few adjustments to the control dripper, the water usage should stabilise at an appropriate level for the plants at their current stage of growth and no further adjustments of the control dripper are required. The volume of water in the measuring container after each irrigation event should be approximately the same as the dripper control volume recorded in Step 2. It is preferable that the above steps are done in a period when there is no rain.

As your crop grows and the water requirement of the crop changes, you may wish to repeat modified sunset scheduling to adjust water usage.

If you are using a DIY Solar Drip Irrigation Kit, then modified irrigation scheduling is not completely automatic. The switch on the irrigation controller needs to be in the OFF position when the water level is below the float switch and above the low level line. However, modified irrigation scheduling can be made completely automatic by replacing the float switch with a three probe level sensor that allows you to set both a high level and a low level.

The **MI Upgrade Kit with Level Sensor** is available from the Measured Irrigation website:
www.measuredirrigation.com.au


Three probe level sensor


High probe right, low probe left

Chapter 6 Troubleshooting and Glossary

6.1 Troubleshooting

Problem	Possible cause	Solution
Pump is not working	The time delay has not elapsed yet (time delay preset to 3 minutes)	Wait for the time delay to elapse or reset the time delay on the delay timer inside the irrigation controller
	Low voltage on the battery (the solar charge controller protects the battery from over discharge)	Recharge battery with a battery charger or the solar panel
	Float switch on the header tank is mounted incorrectly	Make sure that the float shaft is pointing down
	Float switch on the header tank is faulty	Replace the float switch on the header tank
Pump has lost power	One of the pumps in the double pump has become faulty	Replace the faulty pump
	The pump inlet filter has become clogged	Clean the pump filter or replace the filter with a larger filter
Header tank is overflowing	Float switch on the header tank is mounted incorrectly	Make sure that the float shaft is pointing down
	Float switch on the header tank is faulty	Replace the float switch on the header tank
Irrigation not starting when the switch is ON (switch up)	Water level in the evaporator is above the float switch	Wait for water to evaporate or manually remove some water from the evaporator
	Low voltage on the battery (the solar charge controller protects the battery from over discharge)	Recharge the battery with a battery charger or the solar panel
	Float switch on the evaporator is not mounted correctly	Make sure that the float shaft is pointing up
	Float switch on the evaporator is faulty	Replace the float switch on the evaporator
	Insufficient head to operate the solenoid valve	Make sure that the header tank is full. If the problem persists you may wish to replace the solenoid valve with a solenoid valve that can operate with zero pressure (Ehcotech gravity feed solenoid valve is available online)
	Solenoid valve is faulty	Replace the solenoid valve

Irrigation not starting when the switch is ON night only (switch down)	Too much light on the light sensor	Wait until it is dark or cover the light sensor to exclude light
	Water level in the evaporator is above the float switch	Wait for water to evaporate or manually remove some water from the evaporator
	Low voltage on the battery (the solar charge controller protects the battery from over discharge)	Recharge the battery with a battery charger or the solar panel
	Light sensor is faulty	Replace the light sensor
	Float switch on the evaporator is faulty	Replace the float switch on the evaporator
	Insufficient head to operate the solenoid valve	Make sure that the header tank is full. If the problem persists you may wish to replace the solenoid valve with a solenoid valve that can operate with zero pressure (Ehcotech gravity feed solenoid valve is available online)
	Solenoid valve is faulty	Replace the solenoid valve
Irrigation not stopping when the water level reaches the float switch	Float switch on the evaporator is not mounted correctly	Make sure that the float shaft is pointing up
	Float switch on the evaporator is faulty	Replace the float switch on the evaporator
Irrigation stopping before the water level in the evaporator reaches the float switch	Low voltage on the battery (the solar charge controller protects the battery from over discharge)	Recharge the battery with a battery charger or the solar panel
	Solar panel has not fully charged the battery between irrigation events	If this is a regular problem, you may need a bigger solar panel
	A fully charged battery cannot meet the demands of your irrigation system	If this is a regular problem, you may need a bigger battery
Pump stopping before the water level in the header tank reaches the float switch	Low voltage on the battery (the solar charge controller protects the battery from over discharge)	Recharge the battery with a battery charger or the solar panel
	Solar panel has not fully charged the battery between irrigation events	If this is a regular problem, you may need a bigger solar panel
	A fully charged battery cannot meet the demands of your irrigation system	If this is a regular problem, you may need a bigger battery
Header tank is empty	Pump is not powerful enough for your irrigation system	If this is a regular problem, you may need a more powerful pump
Unable to irrigate at sunset on a particular day (unpowered MI)	Prior commitments such as an travelling interstate	Irrigate with more water at sunset on the previous day by allowing the water level to rise above the level line
Variable depth of the wetting front (modified sunset scheduling)	Non-uniform soil composition	Perform multiple trials with a soil moisture probe and choose the wetting front depth that is deep enough to ensure that almost all your plants get enough water

6.2 Glossary

Control dripper An adjustable dripper that drips water into the evaporator during irrigation.

Dripper control volume The volume of water the a dripper needs to emit to moisten the soil below the dripper from the surface to the bottom of the root zone.

Evaporator Any container with vertical sides, with a surface area of at least 0.05 m^2, and a depth of at least 0.1 m. Water evaporates from the evaporator depending on the prevailing weather conditions.

Level line For unpowered MI, a horizontal line on the inside of the evaporator about 1.5 cm below the overflow level. Irrigation is stopped when the water level reaches the level line.

Low level line For modified sunset scheduling, a horizontal line marked on the inside of the evaporator below the level line. The gap between the level line (or float switch) and the low level line is the evaporation required to dry out the soil from the surface to the bottom of the root zone. Irrigation starts at sunset after the water level in the evaporator has fallen below the low level line.

MI Five Zone Adaptor The MI Five Zone Adaptor allows a DIY Solar Drip Irrigation Kit (with or without pump) to irrigate an additional five irrigation zones.

Modified sunset scheduling Modified sunset scheduling is measured irrigation with irrigation at sunset provided that the water level in the evaporator has fallen below the low level line on the inside of the evaporator.

Non pressure compensating drippers Pressurised drip irrigation often uses pressure compensating drippers whereby the flow rate is uniform for a range of pressures (typically 100kPa to 300kPa). For MI the drippers should not be pressure compensating. Such drippers are called non pressure compensating drippers.

Sunset scheduling Sunset scheduling is measured irrigation with irrigation at sunset each day provided that the water level in the evaporator has fallen below the level line (or float switch).