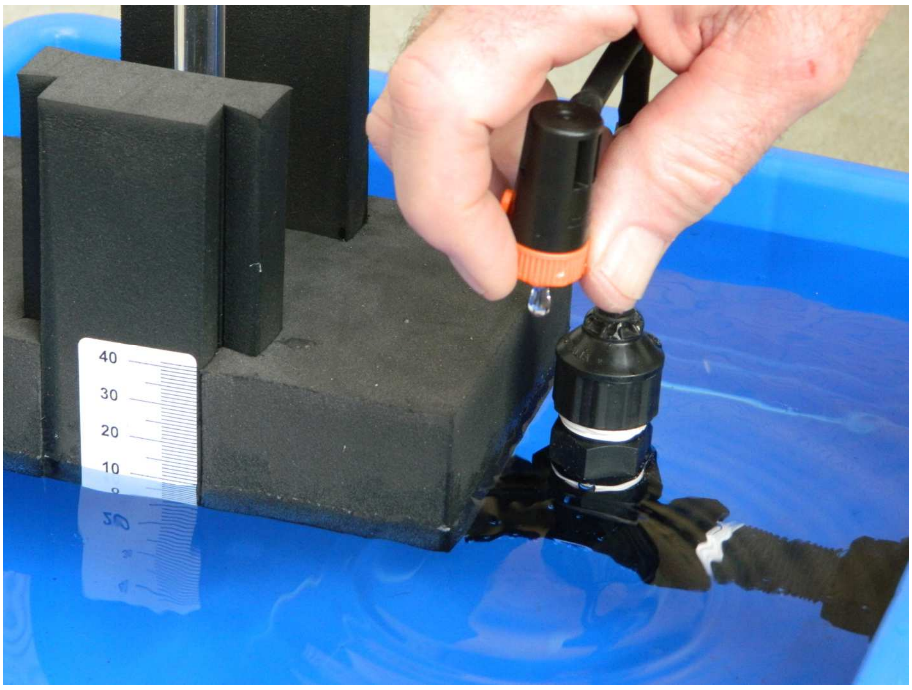
Unpowered Measured Irrigation Training Manual for Smallholders

more crop per drop



Using a control dripper to adjust water usage

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For solar-powered measured irrigation, see the
DIY Solar Measured irrigation Training Manual for Smallholders

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Chapter 1. Introduction to Unpowered Measured Irrigation (MI)

Definition of measured irrigation

Measured irrigation is an irrigation scheduling method that satisfies the following two conditions:

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

It is assumed that the smallholder has already established a drip irrigation system (either pressurised or gravity feed) on a garden or a small plot of land. Provided that the drip irrigation system is already working effectively, you can automate the irrigation system for any size plot so that all your plants are irrigated automatically. Provided you have a continuous water supply, you can leave your garden unattended for weeks on end. This will allow you to become involved in other activities away from the garden; for example, travelling to the market to sell your produce.

Measured irrigation is 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.

Chapter 2. Unpowered Manual Measured Irrigation

2.1 Introduction to manual measured irrigation

It is assumed that a smallholder is using drip irrigation (either pressurised or gravity feed) on a garden or a small plot of land.

To install manual measured irrigation, 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. Examples of an adjustable dripper are Claber 91214 adjustable dripper and Claber 91225 adjustable dripper.

Claber 91214 adjustable dripper

Claber 91225 adjustable dripper

Claber 912014 adjustable dripper can be purchased from the Online Shop at the Measured Irrigation website.

2.2 How to make a precision adjustable dripper

Adjustable drippers do not normally indicate the flow rate when you adjust the dripper. Furthermore, some adjustable drippers to do deliver a consistent flow rate for a particular setting of the adjustable dripper at a particular pressure. You can avoid such problems by making your own precision adjustable dripper using a combination of non-adjustable drippers.

You can make your precision adjustable dripper using three Netafim Miniscape (Landline 8) drippers and three Netafim Bioline (Landline purple) drippers (see Section 1.4). Each dripper should have a separate control valve so that you can adjust the precision adjustable dripper by selectively turning the control valves off or on. The precision adjustable dripper can be adjusted to deliver the following flow rate at 100 kPa:

2 lph, 4 lph, 6 lph, 8 lph, 10 lph, 12 lph, 14 lph, 16 lph. 18 lph, 20 lph, 22 lph, 24 lph, 26 lph, 28 lph, 30 lph

Precision adjustable dripper with 3 Netafin Miniscape drippers and 3 Netafim Bioline drippers.

You can also make your precision adjustable dripper using Netafim Landline 12 drippers. By using three drippers with a flow rate of 1 lph (at 100 kPa) and three drippers with a flow rate of 4 lph (at 100 kPa), the precision adjustable dripper can be adjusted to deliver the following flow rate at 100 kPa:

1 lph, 2 lph, 3 lph, 4 lph, 5 lph, 6 lph, 7 lph, 8 lph, 9 lph, 10 lph, 11 lph, 12 lph, 13 lph, 14 lph, 15 lph

If you have a pressurised irrigation system with pressure compensating drippers, you should make your own precision adjustable dripper using a combination of pressure compensating drippers with different flow rates.

2.3 Instructions for installing manual measured irrigation

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

Draw a 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.

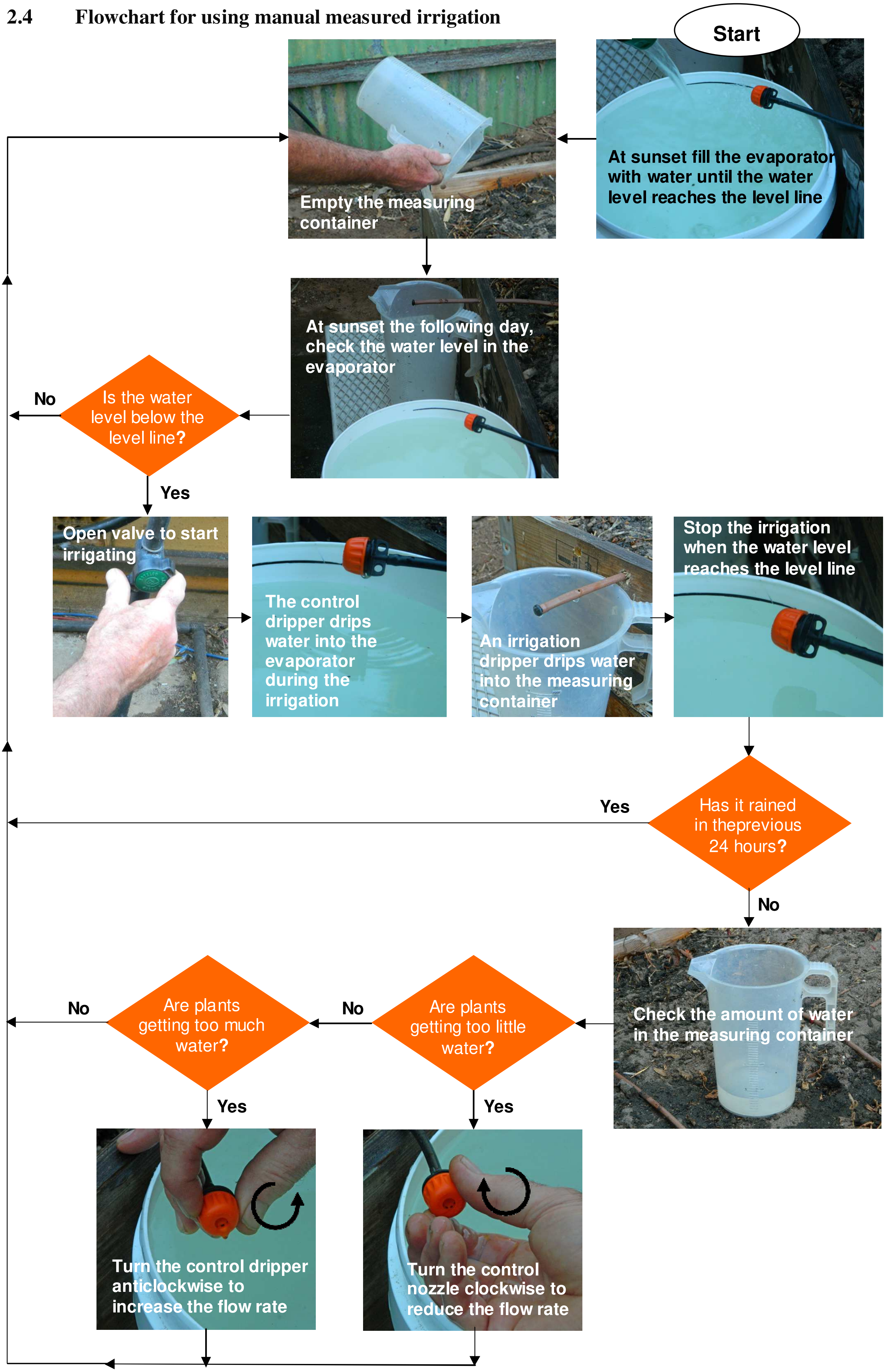
Place a measuring container under one of the irrigation drippers

Step 4. Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers. Make sure that there is no air in the tube connected to the control dripper.

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).

2.4 Flowchart for using manual measured irrigation



If you have a pressurised irrigation system with pressure compensating drippers, you should replace the adjustable control dripper with a precision adjustable dripper made from a combination of pressure compensating drippers (see Section 2.2). You can alter the water usage by either adjusting the precision adjustable dripper or changing the surface area of evaporation.

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 high level 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 used 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).

Manual measured irrigation can be used for sprinkler irrigation as well as drip irrigation.

Garden beds being irrigated by manual MI

Chapter 3. Unpowered Measured Irrigation Controller (UMIC)

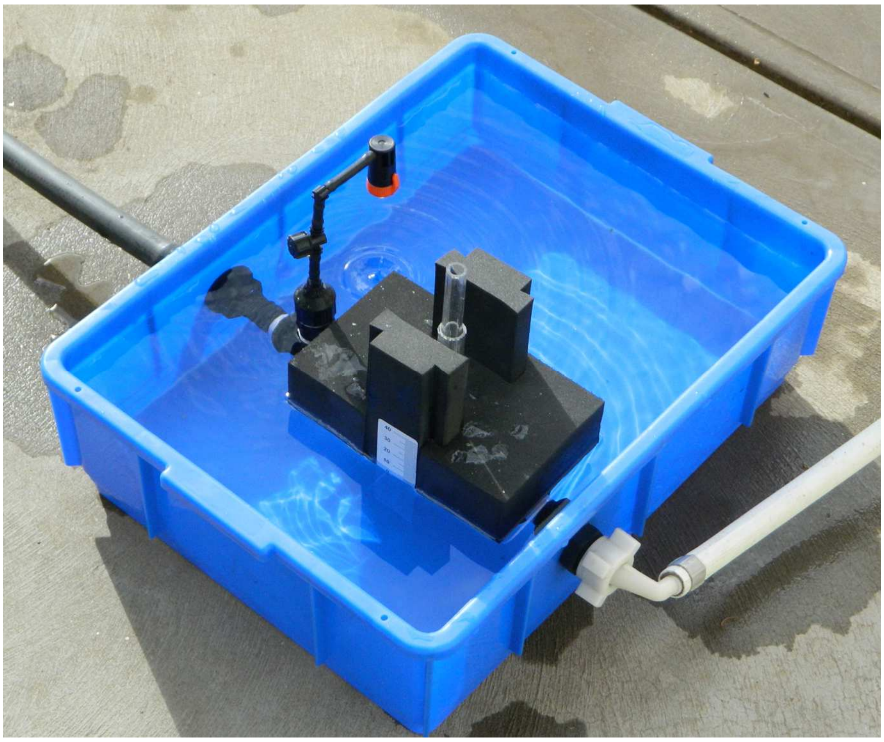
3.1 Introduction to Unpowered Measured Irrigation Controller (UMIC)

It is assumed that a smallholder is using drip irrigation (either pressurised or gravity feed) on a garden or a small plot of land. Using the Unpowered Measured Irrigation Controller (UMIC), you can upgrade your drip irrigation system so that all your plants are irrigated automatically. The water supply pressure should be at least 10 kPa (1 metre head). Provided you have a continuous water supply to UMIC, you can leave your garden unattended for weeks on end. This will allow you to become involved in other activities away from the garden; for example, travelling to the market to sell your produce.

It is recommended that you watch the YouTube video Unpowered Measured Irrigation Controller.

UMIC can be used for sprinkler irrigation as well as drip irrigation.

The Unpowered Measured Irrigation Controller (UMIC) can be purchased from the Online Shop at the Measured Irrigation website https://www.measuredirrigation.com/shop-1.



Measured irrigation is 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.

All of the plants in the three photos below are being irrigated automatically by one UMIC.

How large can the plot be?

It is assumed that the smallholder has already established a drip irrigation system. Provided that the drip irrigation system is already working effectively, you can use one or more UMIC's to automate the irrigation system for any size plot. For irrigation systems that require a large flow rate, you can use a Hi-flow Unpowered Measured Irrigation Controller (HUMIC, see Chapter 4) or you can use a Smart Solenoid Irrigation Controller (see Chapters 5 and 6).

3.2 Instructions for installing the Unpowered Measured Irrigation Controller (UMIC)

Installing the Unpowered MI Controller is incredibly simple. Start with any drip irrigation application, either pressurised or gravity feed. Before installing the controller, it is assumed that the irrigation is operated manually by opening and closing the main valve.

Step 1. Position the evaporator in a suitable location so that the evaporation matches the evaporation in your garden.

Step 2. Connect the water supply to the inlet of the UMIC (the inlet is on the opposite side to the adjustable control dripper).

Step 3. Connect the UMIC outlet (next to the adjustable control dripper) to the irrigation zone.

Step 4. Position the float shaft so that it points vertically up. Be very careful when adjusting the float shaft to avoid placing any stress on the fragile plastic float shaft. Position the adjustable control dripper so that it will drip water into the evaporator during the irrigation.

Float shaft must be vertical

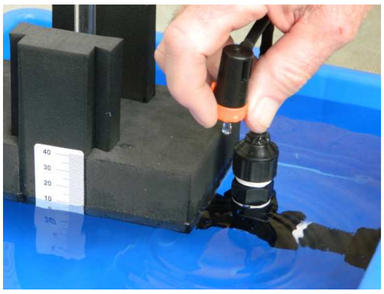
Step 5. For gravity feed application you may need to adjust the height of the evaporator so that the control dripper is at the same level as the irrigation drippers. Use a spirit level to ensure that the evaporator is horizontal. Then use the spirit level to ensure that the float shaft is vertical. The float shaft must be vertical so that there is minimal friction between the float and the float shaft.

Step 6. Slide the float over the float shaft so that the clear tube attached to the float is uppermost

Slide the float over the float shaft

Step 7. Turn on the water supply and the irrigation should start. The adjustable control dripper drips water into the evaporator.

Step 8. Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers.



Adjust the control dripper

Step 9. Fill the evaporator with water until the float jumps up as the magnetic valve closes.

Step 10. The float falls as water slowly evaporates from the evaporator. When the float reaches the low level, the irrigation starts automatically. The float rises as the control dripper drips water into the evaporator. When the float reaches the high level the irrigation stops automatically. The cycle continues indefinitely.

The irrigation starts when the float reaches the low level

The irrigation stops when the float reaches the high level

Step 11. Adjust the control dripper to suit the water requirements of your plants

Step12. 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).

UMIC is completely automatic and does not need any electricity. Furthermore, it is a smart controller because the water usage for each dripper is controlled by the prevailing weather conditions. In fact, the water usage (litres per week for example) is directly proportional to the net evaporation rate (that is, evaporation minus rainfall). You can adjust the water usage by adjusting the control dripper. You can adjust the irrigation frequency by adjusting the slides on the float.

Most irrigation controllers need to be programmed and so they cannot respond to an unexpected heat wave. UMIC responds to an unexpected heat wave. If the evaporation rate doubles then so does the water usage.

When it rains water enters the evaporator and delays the start of the next irrigation.

If your plants need more water, rotate the control dripper clockwise.
If your plants need less water, rotate the control dripper anticlockwise.

Replace the water and clean the UMIC regularly to remove algae and other contaminants.

Because UMIC is so simple, there are fewer things to go wrong.

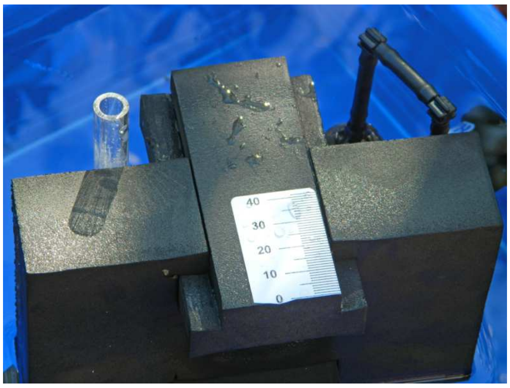
If you have a pressurised irrigation system with pressure compensating drippers, then you should replace the adjustable control dripper with a precision adjustable dripper made from a combination of pressure compensating drippers (see Section 2.2). You can alter the water usage by either adjusting the precision adjustable dripper or changing the surface area of evaporation.

3.3 How to adjust irrigation frequency for UMIC

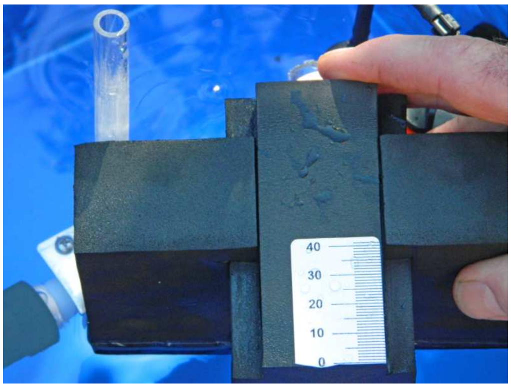
To increase the options for the irrigation frequency, the UMIC is provided with two floats, a large float and a small float.

Large float and small float

The float has two slides that can be moved up or down in order to adjust the irrigation frequency.



20 mm gap between the bottom of the float and the bottom of the slides

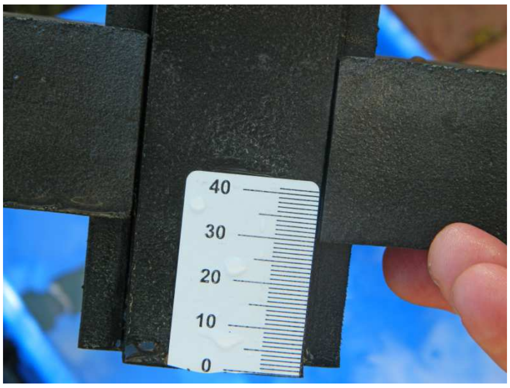


40 mm gap between the bottom of the float and the bottom of the slides

The following table shows the irrigation frequency for various positions of the slides for both the large float and the small float. The irrigation frequency is controlled by the net evaporation from the evaporator between irrigation events.

UMIC Table 1. Irrigation frequency

Gap in mm between the bottom of the float and the bottom of the slides	Net evaporation in mm between irrigation events with large float	Net evaporation in mm between irrigation events with small float
Slides removed	8	15
0	7	11
10	7	11
20	7	12
25	8	12
30	8	23
35	8	26
40	26	30
45	30	34
50	35	37
55	40	40
60	45	43



If the gap between the bottom of the large float and the bottom of the slides is 30 mm, then 8 mm of water has to evaporate between irrigation events.

Provided that the water level in the evaporator is between the low level and the high level, you can start the irrigation manually at any time by pressing the float down.

For example, you may wish to irrigate at sunset each day assuming that the water level is between the low level and the high level at sunset. Simply push the float down at sunset to start irrigating.

You can delay the next irrigation or stop the irrigation at any time by removing the float. The irrigation cannot start again until the float is replaced.

It is important to realise that when you adjust the irrigation frequency by adjusting the slides, the water usage (litres per week for example) does not change. Both the irrigation frequency and the water usage are directly proportional to the net evaporation rate.

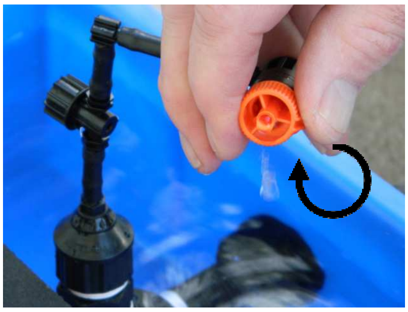
3.4 How to adjust water usage for UMIC

Adjusting water usage by adjusting the control dripper

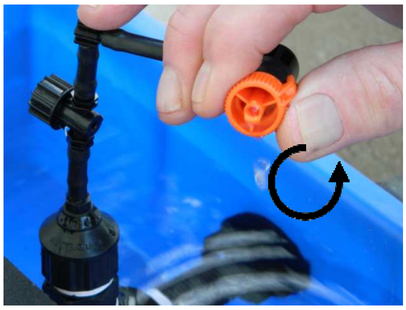
The term **water usage** refers to the number of litres per week (or litres per month) used by the irrigation system.

1. Position an empty measuring container under one of the irrigation drippers so that water drips into the container during the irrigation event.

2. At the end of the irrigation event check the amount of water in the measuring container. You may also wish to check the moisture in the soil.



3. If your plants are not getting enough water, turn the control dripper clockwise to reduce the flow rate of the control dripper.



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

changing the water usage does not change the irrigation frequency

changing the irrigation frequency does not change the water usage

This is important because it means that the water usage and the irrigation frequency can be adjusted independently.

Adjusting water usage by adjusting the surface area

You can also adjust the water usage by adjusting the surface area of evaporation.

To increase the water usage, select one or more containers with vertical sides and connect the containers to the UMIC evaporator. One way to connect containers is to drill in hole in the side of each container and to insert a rubber grommet into each hole. Insert a barbed connector into each grommet, and then use a length of flexible tube to connect the containers. The water level will be same in all containers and the surface area of evaporation is increased.

You can decrease the water usage by decreasing the surface area of evaporation (for example, by placing full bottles of water in the evaporator).

Pressure compensating drippers

If you have a pressurised irrigation system with pressure compensating drippers, then you should replace the adjustable control dripper with a precision adjustable dripper made from a combination of pressure compensating drippers (see Section 2.2). You can alter the water usage by either adjusting the precision adjustable dripper or changing the surface area of evaporation.

3.5 UMIC flow rate

UMIC can be used for pressures ranging from 10 kPa to 800 kPa.

The maximum UMIC flow rate is greater than 1500 lph (at 800 kPa).

The maximum UMIC flow rate when the input pressure is 100 kPa is greater than 500 lph.

The following table shows the maximum UMIC flow rate for gravity feed input pressures ranging from 10 kPa (1 metres head) to 20 kPa (2 metres head).

UMIC Table 2. Flow rate

Input pressure in kPa	Maximum UMIC flow rate in lph
10	206
11	221
12	235
13	248
14	260
15	272
16	283
17	293
18	303
19	312
20	321

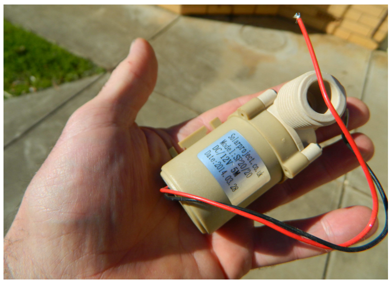
For some drip irrigation applications you may need more than one UMIC to provide an adequate flow rate from the drippers. Subdivide your irrigation application into the same number of zones as the number of UMIC's so that each zone has approximately the same water requirement. Within each zone the drippers should be at approximately the same level. For each zone install a UMIC as described in Section 3.2.

3.6 Key features of UMIC

1. UMIC is completely automatic
2. No electricity is needed (no batteries, no solar panels, no computers, and no electronics)
3. UMIC is a smart irrigation controller – the irrigation is controlled by the prevailing weather conditions rather than a program
4. You can adjust the water usage by adjusting the control dripper
5. You can adjust the irrigation frequency by adjusting the slides on the float
6. Two floats are provided to increase your options for setting the irrigation frequency
7. Adjusting the control dripper does not change the irrigation frequency
8. Adjusting the float does not change the water usage
9. UMIC can be used for both gravity feed and pressurised irrigation
10. The irrigation frequency and the water usage are directly proportional to the net evaporation rate
11. Respond appropriately when there is an unexpected heat wave
12. When it rains, water enters the evaporator and delays the start of the next irrigation
13. The water usage is independent of the water supply pressure
14. UMIC uses much less water without affecting the yield
15. UMIC is incredibly simple and low tech and so there are fewer things to go wrong
16. Provided you have a continuous water supply, you can leave your irrigation application unattended for weeks on end
17. UMIC is low cost with free delivery to any postal address in the world (see the Online Shop at the Measured Irrigation website https://www.measuredirrigation.com/shop-1)

3.7 Using a solar pump to fill a header tank

You can use a solar panel and a small submersible pump to automatically pump water from your farm pond (or from a rainwater tank, lake or river) to a header tank. The pump should be protected by a DC voltage converter (or voltage regulator).



Submersible baby pump

An ideal pump including a DC voltage converter is available from the Online Shop at the Measured Irrigation website
https://www.measuredirrigation.com/shop-1

The pump is also available from Solar Project UK
http://www.solarproject.co.uk/page2.html

This brilliant submersible baby pump is 12 volt 14 watt.

A 20 watt solar panel is required to operate the pump via the voltage converter without using a battery. You may need more than one pump to fill the header tank. For each additional pump you will require an additional 20 watt solar panel.

There is a major advantage of using multiple baby pumps compared with a single pump of equivalent power. If one of the pumps fails, the remaining pumps can continue to operate while you replace the broken pump.

The pumps will operate whenever there is sufficient direct sunlight on the solar panels. The overflow from the header tank should be returned to the farm pond.

When you submerge the pump (or pumps) in the farm pond, you should attach a filter to the inlet to the pumps. The inlet to the filter should be at least 15cm above the bottom of the pond to avoid clogging the filter with the sediment on the bottom of the pond.

How many pumps do you need?

If the head is less than 3.25 metres, then all the pumps should be connected in parallel. The flow rate with two pumps will be twice the flow rate of one pump. The flow rate with three pumps will be three times the flow rate of one pump, and so forth.

If the head is greater than 3.25 metres and you need a second pump, then the second pump should be connected in series with the first pump to create a **double pump.** If additional pumping is still required, you will need two additional pumps connected in series to create a second double pump. The second double pump should be connected in parallel with the first double pump.

Two pumps connected in series to create a double pump. A filter is connected to the inlet of the first pump.

When the head is at the critical level of 3.25 metres, two pumps connected in parallel have the same flow rate as two pumps connected in series, namely 520 lph

If you want to use fewer solar panels to provide sufficient power for your pumps, you will need to use a suitable battery and solar charge controller. The solar panels will then charge the battery during sunlight hours and the battery will be used to provide the power to the pumps as required.

For solar-unpowered measured irrigation, see the **DIY Solar Measured irrigation Training Manual for Smallholders.**

Chapter 4. Hi-flow Unpowered Measured Irrigation Controller (HUMIC)

4.1 Introduction to Hi-flow Unpowered Measured Irrigation Controller (HUMIC)

The Unpowered Measured Irrigation Controller (UMIC) has a limited flow rate because the magnetic valve is quite small. HUMIC uses a much larger magnetic valve. HUMIC uses an Irritrol 2400 Series solenoid valve with 25mm BSP inlet and outlet. The water supply pressure should be between 69 kPa and 1034 kPa (10 – 150 psi). The maximum flow rate for HUMIC is 6800 lph (at 1034 kPa). Provided you have a continuous water supply to HUMIC, you can leave your irrigation application unattended for weeks on end.

HUMIC can be used for sprinkler irrigation as well as drip irrigation.

The Hi-flow Unpowered Measured Irrigation Controller (HUMIC) can be purchased from the Online Shop at the Measured Irrigation website https://www.measuredirrigation.com/shop-1.

Hi-flow Unpowered Measured Irrigation Controller (HUMIC)

Unpowered Irritrol solenoid valve

How large can the plot be?

It is assumed that you have already established your irrigation system. Provided that the irrigation system is already working effectively, you can use one or more HUMIC's to automate the irrigation system for any size plot. For irrigation systems that require a very large flow rate, you can use a Smart Solenoid Irrigation Controller (see Chapters 5 and 6).

4.2 Instructions for installing the Hi-flow Unpowered Measured Irrigation Controller (HUMIC)

Installing the Hi-flow Unpowered MI Controller is incredibly simple. Start with any pressurised irrigation application. Before installing the controller, it is assumed that the irrigation is operated manually by opening and closing the main valve.

Step 1. Position the evaporator in a suitable location so that the evaporation matches the evaporation in your garden.

Step 2. Connect the water supply to the inlet of the HUMIC (the inlet is on the opposite side to the adjustable control dripper).

Step 3. Connect the HUMIC outlet (next to the adjustable control dripper) to the irrigation zone.

Step 4. Position the float over the solenoid and use the two wing-nuts to secure the aluminium bar that prevents the float from jumping off the solenoid when the irrigation stops.

Position the float over the solenoid

Use the two wing-nuts to secure the aluminium bar

Step 5. Turn on the water supply and the irrigation should start. The adjustable control dripper drips water into the evaporator.

Step 6. Fill the evaporator with water until the float jumps up as the solenoid valve closes.

Fill the evaporator

Step 7. The float falls as water slowly evaporates from the evaporator. When the float reaches the low level, the irrigation starts automatically. The float rises as the control dripper drips water into the evaporator. When the float reaches the high level the irrigation stops automatically. The cycle continues indefinitely.

The irrigation starts when the float reaches the low level

The irrigation stops when the float reaches the high level

Step 8 Adjust the control dripper to suit the water requirements of your plants

Step 9. 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).

Replace the water and clean the HUMIC regularly to remove algae and other contaminants.

Because the HUMIC is so simple, there are fewer things to go wrong.

4.3 How to adjust irrigation frequency for UMIC

To increase the options for the irrigation frequency, HUMIC is provided with the following float components:

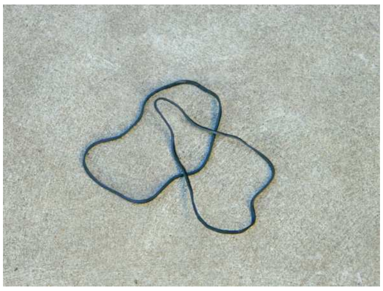

Float with magnet (1 provided)


Float without magnet (2 provided)


Half float (2 provided)


Full slide (2 provided)


Cut slide (2 provided)


UV resistant rubber bands

The following images show the irrigation frequency for various float assemblies. The irrigation frequency is controlled by the net evaporation from the evaporator between irrigation events.

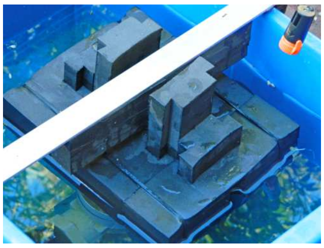

13mm net evaporation between irrigation events (zero gap between magnet and bottom of full slides)

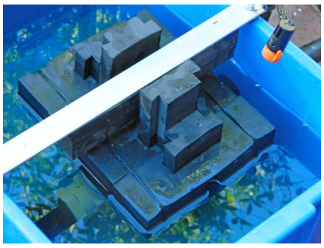

19mm net evaporation between irrigation events (zero gap between magnet and bottom of full slides)

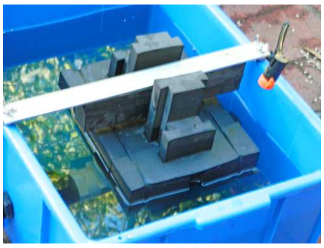

23mm net evaporation between irrigation events (zero gap between magnet and bottom offull slides)


26mm net evaporation between irrigation events (20mm gap between magnet and bottom of full slides)


31mm net evaporation between irrigation events (zero gap between magnet and bottom of cut slides)


37mm net evaporation between irrigation events (10mm gap between magnet and bottom of cut slides)


44mm net evaporation between irrigation events (15mm gap between magnet and bottom of cut slides)


48mm net evaporation between irrigation events (20mm gap between magnet and bottom of cut slides)

Provided that the water level in the evaporator is between the low level and the high level, you can start the irrigation manually at any time by pressing the float down.

For example, you may wish to irrigate at sunset each day assuming that the water level is between the low level and the high level at sunset. Simply push the float down at sunset to start irrigating.

You can delay the next irrigation or stop the irrigation at any time by removing the float. The irrigation cannot start again until the float is replaced.

It is important to realise that when you adjust the irrigation frequency by adjusting the float, the water usage (litres per week for example) does not change. Both the irrigation frequency and the water usage are directly proportional to the net evaporation rate.

4.4 How to adjust water usage for the HUMIC

Adjusting water usage by adjusting the control dripper

If your plants are not getting enough water, turn the control dripper clockwise to reduce the flow rate of the control dripper. If your plants are getting too much water, turn the control dripper anticlockwise to increase the flow rate of the control dripper

changing the water usage does not change the irrigation frequency

changing the irrigation frequency does not change the water usage

This is important because it means that the water usage and the irrigation frequency can be adjusted independently.

Adjusting water usage by adjusting the surface area

You can also adjust the water usage by adjusting the surface area of evaporation.

To increase the water usage, select one or more containers with vertical sides and connect the containers to the HUMIC evaporator. One way to connect containers is to drill in hole in the side of each container and to insert a rubber grommet into each hole. Insert a barbed connector into each grommet, and then use a length of flexible tube to connect the containers. The water level will be same in all containers and the surface area of evaporation is increased.

You can decrease the water usage by decreasing the surface area of evaporation (for example, by placing full bottles of water in the evaporator).

Pressure compensating drippers

If you have a pressurised irrigation system with pressure compensating drippers, then you should replace the adjustable control dripper with a precision adjustable dripper made from a combination of pressure compensating drippers (see Section 2.2). You can alter the water usage by either adjusting the precision adjustable dripper or changing the surface area of evaporation.

4.5 Key features of HUMIC

1. HUMIC is completely automatic
2. No electricity is needed (no batteries, no solar panels, no computers, and no electronics)
3. HUMIC is a smart irrigation controller – the irrigation is controlled by the prevailing weather conditions rather than a program
4. You can adjust the water usage by adjusting the control dripper
5. You can adjust the irrigation frequency by adjusting the float
6. Adjusting the control dripper does not change the irrigation frequency
7. Adjusting the float does not change the water usage
8. The irrigation frequency and the water usage are directly proportional to the net evaporation rate
9. If there is an unexpected heat wave, HUMIC will respond appropriately
10. When it rains, water enters the evaporator and delays the start of the next irrigation
11. The water usage is independent of the water supply pressure
12. HUMIC uses much less water without affecting the yield
13. HUMIC is incredibly simple and low tech and so there are fewer things to go wrong
14. Provided you have a continuous water supply, you can leave your irrigation application unattended for weeks on end

Chapter 5. DIY Smart Irrigation Controller

5.1 Introduction to the DIY Smart Irrigation Controller

I will show you how to convert a solenoid valve into an unpowered smart irrigation controller. An irrigation controller is called smart when the irrigation scheduling is controlled by the prevailing weather conditions. Many solenoid valves have a separate cylindrical solenoid that screws into the valve. Some suitable solenoid valves are shown below. Almost any non-latching solenoid valve used for irrigation can be converted into an unpowered smart irrigation controller. If you have a latching solenoid valve, you will need to replace the latching solenoid with a non-latching solenoid. If you have a large scale irrigation application you will need to use a high flow solenoid valve. For example, the Irritrol 200B Series is available with 1”, 1½” or 2” connections.

A cylindrical solenoid screws into the solenoid valve

Toro solenoid valve

Orbit solenoid valve

Irritrol 2500 Series

Irritrol 2400/2600 Series

Irritrol 200B Series with 1”, 1½” or 2” connections

This Do It Yourself project may become a time-saving, water-saving, money-saving game changer for poor landholders.

It is recommended that watch the YouTube video DIY Smart Irrigation Controller.

Components of the DIY Smart Irrigation Controller

Components of the DIY Smart Irrigation Controller

To complete the project you will need the following components:
(unless specified, all pipes and pipe fittings are 15mm BSP)

- a non-latching solenoid valve
- an adjustable irrigation dripper
- a galvanised cross
- two galv pipes 500mm long
- two galv pipes 200mm long
- a galv pipe 300mm long
- two galv tees
- two galv nipples
- a poly cap
- a poly cut-off riser, 15mm female x 15mm male
- two galvanised flanges
- eight galvanised nuts and bolts
- a small platform for supporting the counter weights
- a large platform for supporting the evaporator
- one or more evaporators (an evaporator is any container with vertical sides)
- two 20 litre water containers
- a ferrite ring magnet assembly or a rare earth disc magnet assembly

Ferrite ring magnet assembly on the left
Rare earth disc magnet assembly on the right

Ferrite ring magnet option

The ferrite ring magnet assembly has the following components:

- a ferrite ring magnet 32mm ID, 70mm OD, 15mm thick. The OD and thickness can vary provided that the magnet is strong enough to activate the plunger in the solenoid valve.
- a galvanised reducing socket 32mm x 20mm
- a poly or galvanised reducing nipple 20mm x 15mm
- a 75mm length of 13mm straight poly pipe

Components of the ferrite ring magnet assembly

The ferrite ring magnet slides over the solenoid. This option is only appropriate when there is 25mm clearance around the solenoid. When the magnet is in the low position, the magnet lifts the plunger inside the solenoid and opens the valve. When the magnet is in the high position, the plunger is released and the valve closes.

When the magnet is in the low position, the magnet lifts the plunger inside the solenoid and opens the valve

When the magnet is in the high position, the plunger is released and the valve closes

Rare earth disc magnet option

The rare earth disc magnet assembly has the following components:

- a rare earth disc magnet 25.4mm (1 inch) diameter, 12.7mm (½ inch) thick
- a galvanised nipple
- a poly cut-off riser, 15mm female x 15mm male

Components of the rare earth disc magnet assembly

The rare earth disc magnet is positioned directly above the solenoid. When the magnet is in the low position, the magnet lifts the plunger inside the solenoid and opens the valve. When the magnet is in the high position, the plunger is released and the valve closes.

When the magnet is in the low position, the magnet lifts the plunger inside the solenoid and opens the valve

When the magnet is in the high position, the plunger is released and the valve closes

5.2 How to assemble the DIY Smart Irrigation Controller

I will now give you step by step instructions for assembling the DIY Smart Irrigation Controller.

Step 1 Assemble the balance bar by screwing the two 500mm pipes and the two 200mm pipes into the cross.

Step 2 Screw the tees onto the ends of the balance bar.

Step 3 Screw the 300mm pipe into one of the tees and then screw the cap onto the pipe.

Step 4 Screw one nipple into the tee connected to the 300mm pipe and screw other nipple into the other tee.

Step 5 Use 4 bolts to connect one flange to the centre of one of the platforms. Connect the other flange to the centre of the other platform.

Step 6 Screw the large platform onto the nipple opposite the 300mm pipe. Screw the small platform onto a nipple at the other end of the balance bar.

Step 7 (ferrite ring magnet assembly)

Screw the reducing nipple into the galvanised reducing socket. Insert the 75mm length of 13mm straight poly pipe into the reducing socket so that the end of the poly pipe is 10mm inside the reducing socket. Use contact adhesive to securely attach the ferrite ring magnet to the reducing socket.

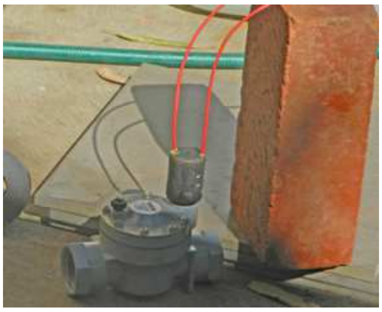
Step 7 (rare earth disc magnet assembly)

Cut the poly cut-off riser so that it is 28mm long. Screw the cut-off riser onto the galvanised nipple. Attach the rare earth disc magnet to the galvanised nipple (no adhesive is required because the rare earth magnet is so strong).

Step 8 Screw the ferrite ring magnet assembly or the rare earth disc magnet assembly onto the nipple opposite the small platform.

Step 8 Use the two water containers to support the balance bar. Stabilise the containers by filling them with water. The height of the balance bar should be about 330mm.

Step 9 Cut off the two electrical wires connected to the solenoid (remember that the irrigation controller is unpowered)



Step 10 Install the solenoid valve and position the balance bar so that when the magnet assembly is in the high position, the balance bar is level and the top of the solenoid is directly below the magnet assembly.

Step 11 Place the evaporator on the large platform and add water until the depth is at least 20mm.

Step 12 Place counter weights on the small platform until the magnet assembly falls from the high position to the low position thus opening the valve.

Step 13 Slowly add water to the evaporator until the magnet assembly rises from the low position to the high position.

Step 14 (ferrite ring magnet assembly)
When the ferrite ring magnet assembly is in the high position, the top of the solenoid should be 10mm inside the ring magnet. Attach a poly cut-off riser to the 300mm pipe to increase the length of the pipe as required. Make fine adjustments by screwing or unscrewing the ring magnet assembly, the 300mm pipe, the cut-off riser, or the cap.

When the ferrite ring magnet assembly is in the high position, the top of the solenoid should be 10mm inside the ring magnet

Step 14 (rare earth disc magnet assembly)
When the rare earth disc magnet assembly is in the high position, the top of the solenoid should be 20mm below the magnet. Attach a poly cut-off riser to the 300mm pipe to increase the length of the pipe as required. Make fine adjustments by screwing or unscrewing the disc magnet assembly, the 300mm pipe, the cut-off riser, or the cap.

When the rare earth disc magnet assembly is in the high position, the top of the solenoid should be 20mm below the magnet

Step 15 Connect the inlet of the solenoid valve to the water supply, and connect the outlet of the solenoid valve to the irrigation application. Turn on the water supply.

Step 16 Position the adjustable dripper so that it will drips water into the evaporator during the irrigation.

Step 17 Water slowly evaporates from the evaporator until the weight of the water in the evaporator is light enough for the magnet assembly to fall and the irrigation starts automatically.

Step 18 Water drips into the evaporator until the weight of the water in the evaporator is heavy enough for the magnet assembly to rise and the irrigation stops automatically. The cycle continues indefinitely.

Step 19 The irrigation controller should be protected from birds and other animals.

Designing the balance bar

Depending on your application and your choice of magnet assembly, you may wish to use different lengths of pipe for the balance bar. To reduce the weight of water required to open and close the valve, you can increase the length of the pipe connected to the large platform, and/or decrease the length of the pipe connected to the small platform.

Buying the components for the DIY Smart Irrigation Controller

The DIY Smart Irrigation Controller is Do-It-Yourself and so you can minimise the cost by using locally sourced components. It will be even cheaper if you can find suitable used complements.

Some of the components are available in kit form from the Online Shop at the Measured Irrigation website https://www.measuredirrigation.com/shop-1

Two kits are available with free delivery to any postal address in the world.

DIY Smart Irrigation Controller Kit with ferrite ring magnet assembly

The components of the kit are:

- an adjustable irrigation dripper
- two galvanised flanges
- a poly cap
- a poly cut-off riser, 15mm female x 15mm male
- a ferrite ring magnet assembly

DIY Smart Irrigation Controller Kit with rare earth disc magnet assembly

The components of the kit are:

- an adjustable irrigation dripper
- two galvanised flanges
- a galvanised cross
- a poly cap
- a poly cut-off riser, 15mm female x 15mm male
- a rare earth disc magnet assembly

5.3 How to adjust the irrigation frequency for the DIY Smart Irrigation Controller

You can adjust the irrigation frequency by using an evaporator with a different surface area for evaporation. In fact the irrigation frequency is directly proportional to the surface area of the evaporator. For example, if you double the surface area you double the irrigation frequency. If you use a smaller evaporator you reduce the irrigation frequency.

Use a smaller evaporator to reduce the irrigation frequency

Another way to adjust the irrigation frequency is to change the ratio of the lengths of the two pipes used to make the balance bar. For example, if you reduce the length of the pipe connecting the tee to the small platform, the irrigation frequency will increase.

If you are using the rare earth disc magnet assembly you can increase the irrigation frequency by inserting spacers (coins for example) between the solenoid and the magnet. The spacers should be made from a material that is not attracted to the magnet. Note that the thickness of the spacers should not prevent the magnet from lifting the plunger when the magnet is in the low position.

Spacer on top of the solenoid

If you are using a particular evaporator, you will find that the irrigation frequency for the rare earth disc magnet assembly is significantly less than the irrigation frequency for the ferrite ring magnet assembly.

You can start the irrigation manually at any time by pressing the counter weights down. For example, if you want the irrigation to start at sunset each day, simply push the counter weights down at sunset.

5.4 How to adjust the water usage for the DIY Smart Irrigation Controller

If you decide that your plants are not getting enough water, then turn the control dripper clockwise to increase the water usage.

If you decide that your plants are getting too much water, then turn the control dripper anticlockwise to decrease the water usage.

If you have a pressurised irrigation system with pressure compensating drippers, you should replace the adjustable control dripper with a precision adjustable dripper made from a combination of pressure compensating drippers (see Section 2.2).

If you adjust the irrigation frequency by changing the lengths of the pipes in the balance bar, the water usage will also change. However, when you adjust the water usage by adjusting the control dripper, the irrigation frequency does not change. It is therefore recommended that you adjust the irrigation frequency before you adjust the water usage.

5.5 Key features of the DIY Smart Irrigation Controller

1. Completely automatic
2. No electricity is needed (no batteries, no solar panels, no computers, and no electronics)
3. You can adjust the water usage by adjusting the control dripper
4. You can adjust the irrigation frequency by changing the evaporator
5. Use for both gravity feed and pressurised irrigation
6. The irrigation frequency and the water usage are directly proportional to the net evaporation rate (that is, evaporation minus rainfall
7. Responds appropriately when there is an unexpected heat wave
8. When it rains, water enters the evaporator and delays the start of the next irrigation
9. Water usage is independent of the water supply pressure
10. Uses much less water without affecting the yield
11. It is incredibly simple and low tech and so there are fewer things to go wrong
12. Provided you have a continuous water supply, you can leave your irrigation application unattended for weeks on end
13. The DIY Smart Irrigation Controller is Do-It-Yourself and so you can minimise the cost by using locally sourced components. It will be even cheaper if you can find suitable used complements.
14. Use for any size irrigation application provided that the solenoid valve has a large enough flow rate.

Chapter 6. Smart Solenoid Irrigation Controller (SSIC)

6.1 Introduction to Smart Solenoid Irrigation Controller

In Chapter 5 we presented a Do-It-Yourself approach to making your own smart irrigation controller. In this chapter we introduce the Smart Solenoid Irrigation Controller, a product can be ordered from the Online Shop at the Measured Irrigation website: https://www.measuredirrigation.com/shop-1

The Smart Solenoid Irrigation Controller enables you to transform any non-latching irrigation solenoid into a smart irrigation controller. The critical component of the SSIC is a rare earth disc magnet 25.4mm (1 inch) diameter and 12.7mm (½ inch) thick. If you have a latching solenoid valve, you will need to replace the latching solenoid with a non-latching solenoid.

SSIC can be used for sprinkler irrigation as well as drip irrigation.

Smart Solenoid Irrigation Controller

6.2 How to assemble and install the SSIC

Step 1 Screw the threaded pipes into the cross.

Step 2 Screw the small platform into the tee above the magnet, and screw the large platform into the other tee.

Step 3 Position the magnet so that it is above the solenoid. The SSIC pivots on the caps on the two pipes below the elbows. Make sure that the caps have a secure footing so that the pivot points are fixed. Use poly cut-off risers and lengths of galvanised pipe to ensure that the magnet is 20mm above the solenoid. Screw or unscrew the connections to make fine adjustments.

Position the magnet so that it is above the solenoid

Step 4 Place the evaporator on the large platform and add water until the depth is at least 20mm.

Step 5 Turn on the water supply to the solenoid valve.

Add water to the evaporator until the depth is a least 20mm

Step 6 Place counter weights on the small platform until the magnet falls from the high position to the low position. The solenoid valve opens and the irrigation starts. House bricks make good counter weights. If the solenoid valve does dot open you should cut off the two electrical wires connected to the solenoid. This will allow the magnet to get closer to the solenoid.

The magnet falls from the high position to the low position

The solenoid valve opens and the irrigation starts

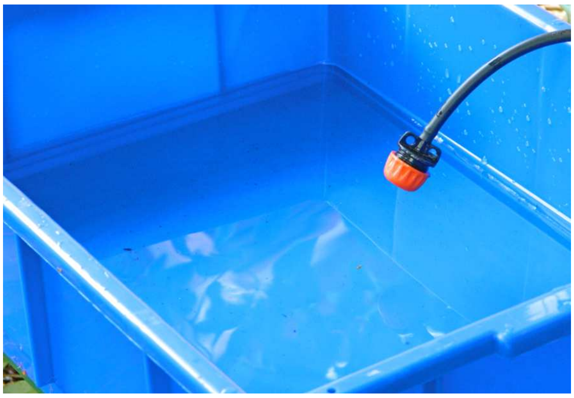
Step 7 Slowly add water to the evaporator until the magnet rises from the low position to the high position. The solenoid valve closes and the irrigation stops. If the solenoid valve does not close, screw the connections until the magnet is sufficiently far away from the solenoid for the solenoid valve to close.

The solenoid valve closes and the irrigation stops

The solenoid valve closes and the irrigation stops

Step 8 Position the adjustable dripper so that it will drips water into the evaporator during the irrigation.

Step 9 Water slowly evaporates from the evaporator until the weight of the water in the evaporator is light enough for the magnet to fall from the high position to the low position and the irrigation starts automatically.



Position the adjustable dripper so that it will drips water into the evaporator

Water slowly evaporates from the evaporator until the weight of the water in the evaporator is light enough for the magnet to fall from the high position to the low position

Step 10 Water drips into the evaporator until the weight of the water in the evaporator is heavy enough for the magnet to rise from the low position to the high position and the irrigation stops automatically. The cycle continues indefinitely.

Water drips into the evaporator

The weight of the water in the evaporator is heavy enough for the magnet to rise from the low position to the high position

Step 11 The evaporator should be protected from birds and other animals. You may need to use somehing to prevent rainwater collecting in the depressions in the platforms

Adjusting the overflow level

When it rains water enter the evaporator and delays the start of the next irrigation. If there is sufficient rain the evaporator will eventually overflow. If the overflow level is too high, the delay before the next irrigation may be unacceptably long. The overflow level can be adjusted as follows:

1. Drill a hole near the bottom of the evaporator.
2. Insert a rubber grommet into the hole.
3. Insert a barbed elbow into the hole.
4. Connect a short length of poly pipe to the barbed elbow.
5. Rotate the elbow so that the end of the poly pipe is set at the desired overflow level.

Rotate the elbow so that the end of the poly pipe is set at the desired overflow level

Securing the pivot points for the balance bar

One way to secure the pivot points for the balance bar is to use two 20 litres water containers. Disconnect the two 150 mm pipes from the balance bar and replace them with the two 300mm pipes. Support the balance bar with the water containers and use two saddle clamps to attach the 300 pipes to the top of the water containers. Fill the containers with water. Depending on the application, you may wish to replace the 200mm pipe connecting the small platform to the cross with a longer pipe.

Secure the pivot points with two 20 litre water containers

6.3 How to adjust the irrigation frequency for SSIC

You can adjust the irrigation frequency by using an evaporator with a different surface area of evaporation. In fact the irrigation frequency is directly proportional to the surface area of the evaporator. For example, if you double the surface area you double the irrigation frequency. If you use a smaller evaporator you reduce the irrigation frequency.


Use a larger evaporator to increase the irrigation frequency


Use a smaller evaporator to reduce the irrigation frequency

You can increase the irrigation frequency by inserting spacers (coins for example) between the solenoid and the magnet. Before inserting the spacers you should cut off the two electrical wires connected to the solenoid. The spacers should be made from a material that is not attracted to the magnet. Note that the thickness of the spacers should not prevent the magnet from lifting the plunger when the magnet is in the low position. See Section 5.3.

You can start the irrigation manually at any time by pressing the counter weights down. For example, if you want the irrigation to start at sunset each day, simply push the counter weights down at sunset.

6.4 How to adjust the water usage for SSIC


If you decide that your plants are not getting enough water, then turn the control dripper clockwise to increase the water usage.


If you decide that your plants are getting too much water, then turn the control dripper anticlockwise to decrease the water usage.

If you have a pressurised irrigation system with pressure compensating drippers, you should replace the adjustable control dripper with a precision adjustable dripper made from a combination of pressure compensating drippers (see Section 2.2).

When you adjust the irrigation frequency by changing the evaporator, the water usage will also change. However, when you adjust the water usage by adjusting the control dripper, the irrigation frequency does not change. Therefore, it is recommended that you adjust the irrigation frequency before you adjust the water usage.

6.5 Key features of SSIC

1. Completely automatic
2. No electricity is needed (no batteries, no solar panels, no computers, and no electronics)
3. You can adjust the water usage by adjusting the control dripper
4. You can adjust the irrigation frequency by changing the evaporator
5. Adjusting the control dripper does not change the irrigation frequency
6. Changing the evaporator does not change the water usage
7. The irrigation frequency and the water usage are directly proportional to the net evaporation rate (that is, evaporation minus rainfall
8. Responds appropriately when there is an unexpected heat wave
9. When it rains, water enters the evaporator and delays the start of the next irrigation
10. Water usage is independent of the water supply pressure
11. Uses much less water without affecting the yield
12. It is incredibly simple and low tech and so there are fewer things to go wrong
13. Provided you have a continuous water supply, you can leave your irrigation application unattended for weeks on end
14. Can be used for any irrigation application that uses a non-latching solenoid valve.

Chapter 7. Measured irrigation using pressurised compensating drippers

The current trend in drip irrigation applications is to use pressure compensating drippers whereby the flow rate from the drippers is relatively constant for water pressure in the range 100 kPa to 300 kPa. If you are designing a measured irrigation system from scratch, it is preferable to use non pressure compensating drippers rather than pressure compensating drippers. If your drip irrigation system already uses pressure compensating drippers, it will be expensive to replace all the pressure compensating drippers with non pressure compensating drippers. There are, however, some situations where you can upgrade the irrigation system to measured irrigation without replacing the pressure compensating drippers.

Option 1. Replace the control dripper with a pressure compensating dripper (or a combination of pressure compensating drippers)

You can alter the water usage by changing the combination of pressure compensating drippers. You can replace the adjustable control dripper with a precision adjustable dripper made from a combination of pressure compensating drippers (see Section 2.2).

After you have replaced the control dripper with a combination of pressure compensating drippers, you can adjust the water usage by changing the surface area of evaporation (this method should not be used for the DIY Smart Irrigation Controller or the Smart Solenoid Irrigation Controller). You can increase the water usage by increasing the surface area of evaporation by using a larger container for the evaporator. In the case of UMIC (or HUMIC), select one or more containers with vertical sides and connect the containers to the UMIC evaporator. One way to connect containers is to drill in hole in the side of each container and to insert a rubber grommet into each hole. Insert a barbed connector into each grommet, and then use a length of flexible tube to connect the containers. The water level will be same in all containers and the surface area of evaporation is increased.

You can decrease the water usage by decreasing the surface area of evaporation (for example, by using a smaller container for the evaporator or by placing full bottles of water in the evaporator).

Option 2. Connect a pressure regulator to the water supply

Pressure compensating drippers require a minimum pressure of 100 kPa. The pressure regulator should ensure that all the pressure compensating drippers have a minimum pressure of 100 kPa. You may wish to check the flow rate of the dripper that is likely to have the lowest flow rate.

Chapter 8. Soil moisture and measured irrigation scheduling

8.1 Soil moisture probe

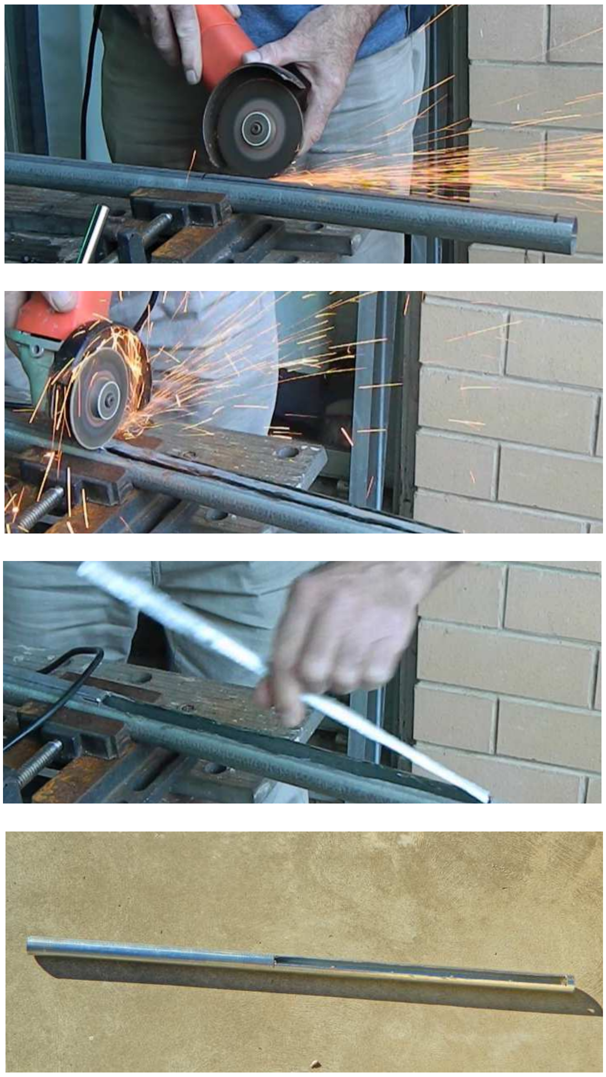
The amount of water that your plants need will depend on many factors in addition to the weather. For example, as the plants grow and become bigger they will need more water. Plants growing in sandy soil will need more water than plants growing in heavy soil.

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 15 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 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 not enough water. A control dripper may be used to adjust the water usage.

Hammer the steel pipe into the soil near a dripper so that the slot faces 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.



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

Hammer the steel pipe into the soil near a dripper so that the slot faces 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.

8.2 Introduction to measured irrigation scheduling

Irrigation scheduling should take account of soil type and the depth of the root zone.

When you use manual measured irrigation, you check the water level in the evaporator at sunset each day, and if the water level is below the high level, you start irrigating. You stop irrigating when the water level reaches the high level. This method of irrigation scheduling is called **sunset scheduling**. The major advantage of irrigating at sunset is that there are less evaporative losses compared with irrigating during the heat of the day.

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 **root zone scheduling** is recommended.

There are two ways to implement root zone scheduling. The first way is to use an adjustable dripper as the control dripper (see Section 8.3). The second way is to use an irrigation dripper as the control dripper and to select an evaporator with the correct surface area (see Section 8.4).

8.3 Root zone scheduling using an adjustable dripper

The following steps can be applied to any irrigation zone, regardless of the size of the zone.

Step 1. How much water is needed?

Allow the soil to dry out over several days until the soil is dry between the surface and the bottom of the root zone.

Place a measuring container under one of the drippers to collect the water and start irrigating just before sunset.

While irrigating, check the moisture level in the soil by hammering the steel pipe into the soil near a dripper. Stop irrigating when the position of the wetting front is near the bottom of the root zone.

The volume of water in the measuring container is the amount of water that each dripper should deliver during the irrigation event. It is called the **dripper control volume** and it is the volume of water required to moisten the soil from the surface to the bottom of the root zone.

Place a measuring container under one of the irrigation drippers

Dripper control volume for root zone scheduling

Step 2. How much evaporation is required between irrigation events?

You need to know the evaporation in mm before the soil is dry between the surface and the middle of the root zone.

Position any container with vertical sides at a suitable location so that the evaporation from the container matches the evaporation near your plants. Fill the container with water and weigh it.

At sunset each day, check the moisture in the soil until the soil is dry between the surface and the middle of the root zone. If you wish to water your plants less frequently, you could wait until the soil is dry between the surface and the bottom of the root zone.

Reweigh the container to determine the volume of water that has evaporated. The number of mm that has evaporated is the volume of water divided by the surface area of the container. This is called the **root zone evaporation** and it is the evaporation required to dry out the soil from the surface to the middle of the root zone.

Reweigh the container to determine the volume of water that has evaporated

For automated measured irrigation where you can adjust the irrigation frequency, make adjustments to the irrigation frequency so that the net evaporation between irrigation events corresponds to the root zone evaporation. In the case of the DIY Smart Irrigation Controller (Chapter 5) and the SSIC (Chapter 6), adjust the irrigation frequency by changing the evaporator.

Step 3. Run the irrigation

Empty the measuring container and place it below one of the irrigation drippers.

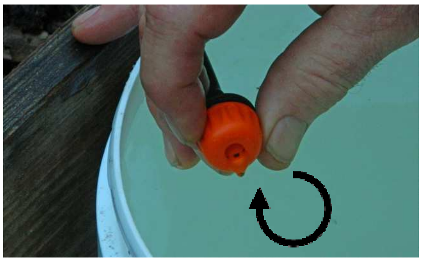
For manual measured irrigation, adjust the water level in the evaporator at sunset until it is at the low level and start irrigating. For automated measured irrigation, the irrigation starts automatically when the water level reaches the low level.

For manual measured irrigation, stop irrigating (turn off the water supply) when the water level in the evaporator reaches the high level. For automated measured irrigation, the irrigation stops automatically when the water level reaches the high level.

Step 4 Adjusting the control dripper

Check the volume of water in the measuring container at the end of the irrigation event. 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 may 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.

Repeat Steps 3 and 4 until the volume of water in the measuring container matches the dripper control volume. It is preferable that the above steps are done in a period when there is no rain.

If you have a pressurised irrigation system with pressure compensating drippers, you should replace the adjustable control dripper with a combination of pressure compensating drippers such as a precision adjustable dripper (see Section 2.2).

8.4 Root zone scheduling using an evaporator with the correct surface area

It is recommended that you watch the YouTube video DIY smart irrigation.

The video is for smallholders using manual drip irrigation. The Do-It-Yourself technology is extremely simple. All that is need is a steel pipe and a storage container.

The volume of water emitted by each dripper is controlled by the prevailing weather conditions affecting your plants.

The water level in the storage container tells you when to start irrigating and when to stop irrigating. For crops with a shallow root zone or on sandy soil, you will need to irrigate more frequently with less water. For crops with a deep root zone or on heavy soil, you will need to irrigate less frequently with more water. Root zone scheduling (also called DIY smart irrigation) takes account of evapotranspiration, the soil type and the depth of the root zone.

The following steps can be applied to any irrigation zone, regardless of the size of the zone.

Step 1. How much water is needed? (see Section 8.3)

Step 2. How much evaporation is required between irrigation events? (see Section 8.3)

Step 4. How to choose a suitable evaporator?

You need to know the correct surface area for the evaporator so that root zone evaporation occurs between irrigation events and the dripper control volume is delivered during the irrigation event. Calculate the correct surface area by dividing the dripper control volume by the root zone evaporation. Then choose an evaporator with vertical sides and with the correct surface area.

An evaporator with a surface area of 370 square cm

Step 5. How to set-up the evaporator?

Position the evaporator at a suitable location so that the evaporation matches the evaporation near your plants. Mark a high level on the inside of the evaporator about 2 cm below the overflow level. Mark a low level so that the gap between the high level and the low level is the same as the root zone evaporation.

Position an irrigation dripper so that it will drip water into the evaporator during the irrigation.

Start irrigating when the water level is at the low level

Step 6. How to use the evaporator?

At sunset, fill the evaporator with water until the water level is at the low level and start irrigating.

Stop irrigating when the water level reaches the high level.

Check the water level at sunset each day, and start irrigating again when the water level has fallen below the low level.

As your crop grows and the water requirement of the crop changes, you may wish to repeat the process of root zone scheduling.

Most weather-based irrigation controllers use data from a weather station to control the irrigation scheduling. Despite the fact that DIY smart irrigation very low cost, it performs better than weather-based irrigation controllers. DIY smart irrigation responds to the prevailing weather conditions in your garden rather than the weather at a weather station. For example, DIY smart irrigation responds to the actual ET of your plants, rather than the theoretical ET at a weather station. This is particularly important if you are using a greenhouse.