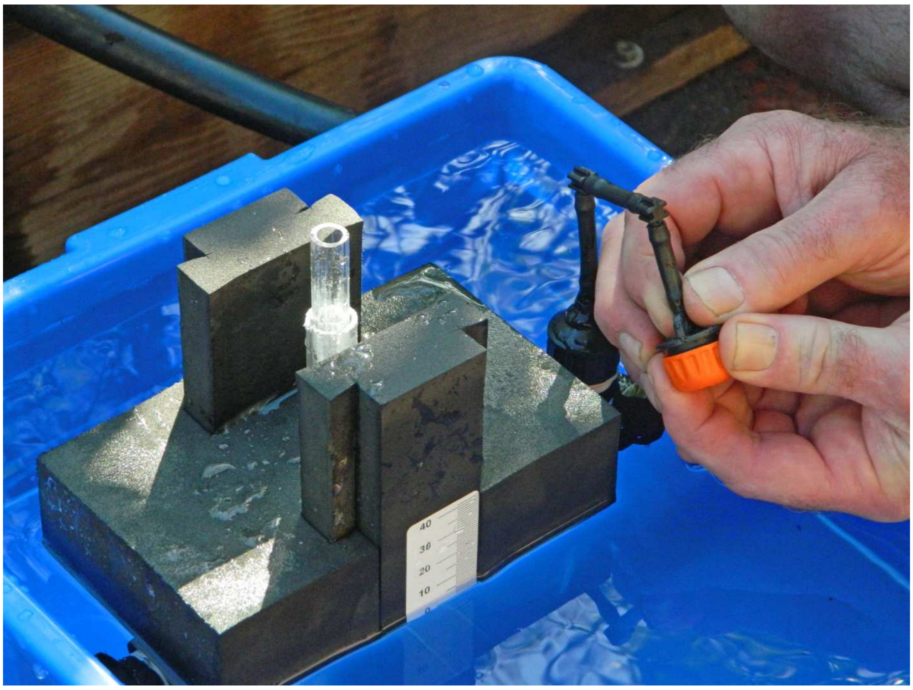
Unpowered Measured Irrigation Training Manual for Smallholders

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

CONTENTS

Introduction to Unpowered Measured Irrigation (MI)

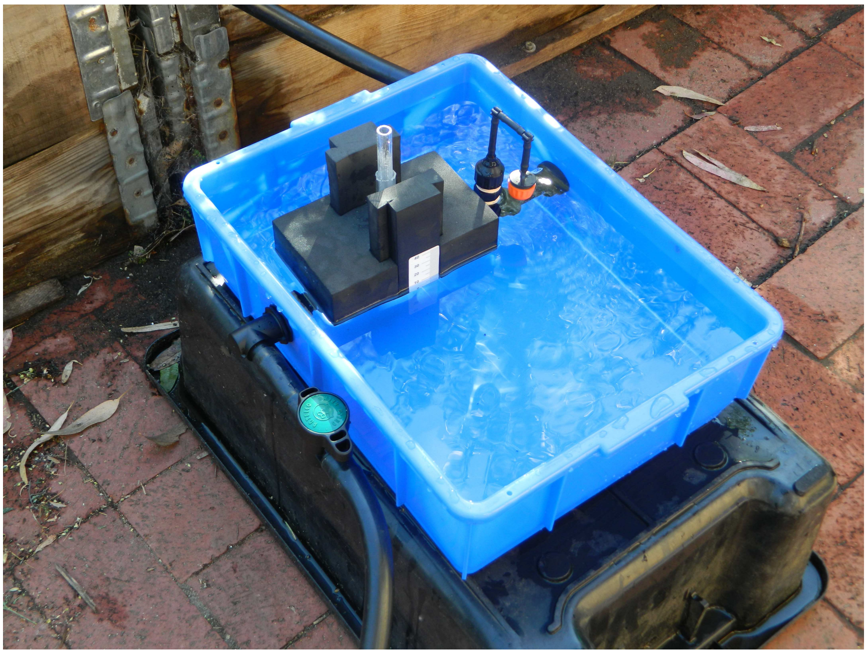
Definition of measured irrigation

Measured irrigation is a drip 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 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.*

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 use one or more UMIC's to automate the irrigation system for any size plot.

Using the Unpowered Measured Irrigation Controller (UMIC), you can upgrade your drip irrigation system so that all your plants are irrigated automatically. Provided you have a continuous water supply to UMIC, you can leave your garden unattended for weeks. This will allow you to become involved in other activities away from the garden; for example, travelling to the market to sell your produce.



Unpowered Measured Irrigation Controller (UMIC)

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

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.

How large can the plot be?

For large scale irrigation applications that require a large flow rate, it is recommended that you construct your own DIY Smart Irrigation Controller by following the instructions in Chapter 3.

DIY Smart Irrigation Controller with ferrite ring magnet assembly

Chapter 1. Manual Measured Irrigation

To install manual 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 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.

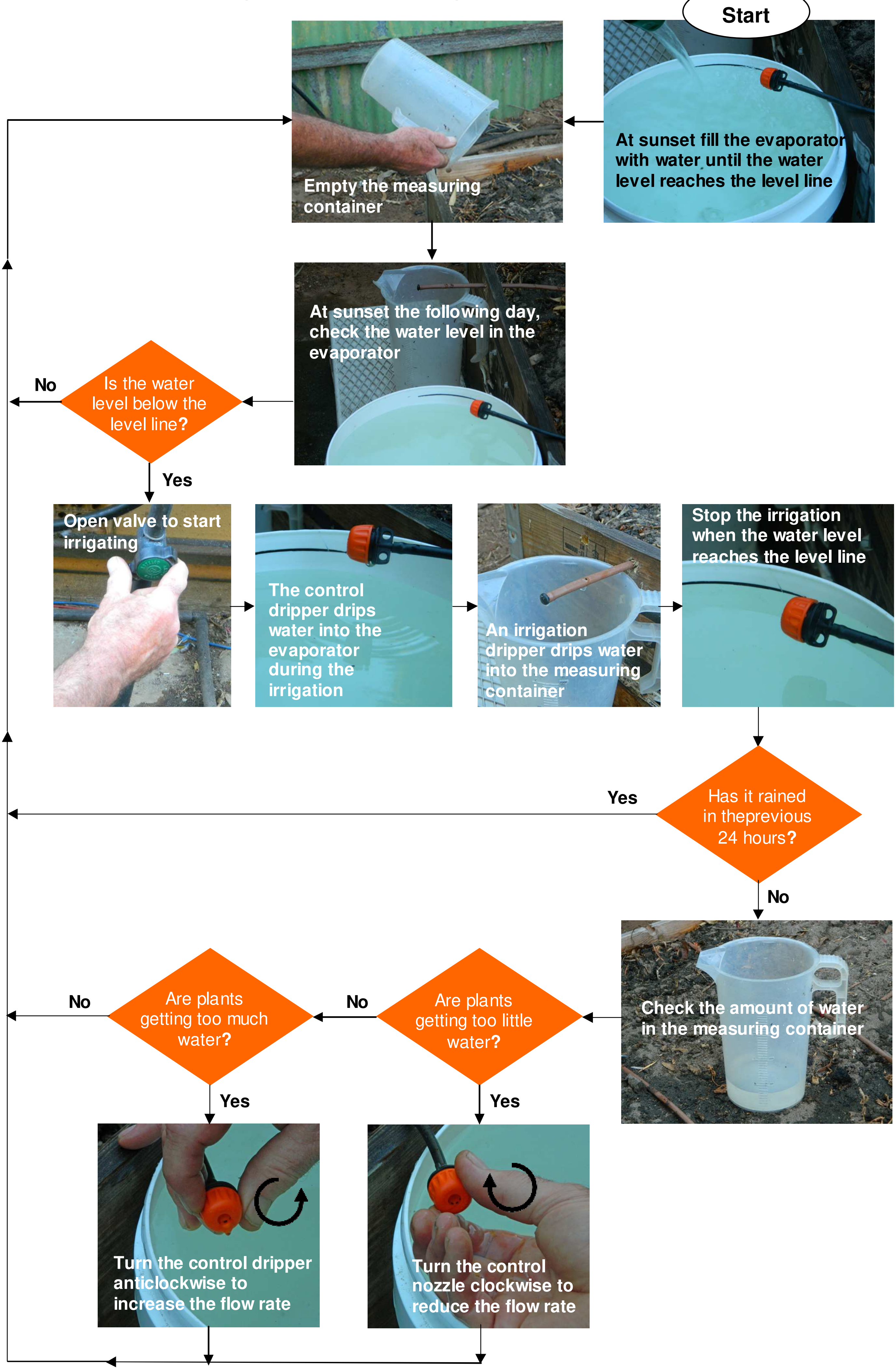
Place a measuring container under one of the irrigation drippers

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).

1.2 Flowchart for using manual measured irrigation



If you have a pressurised irrigation system with pressure compensating drippers and the water supply pressure is variable, replace the adjustable control dripper with a pressure compensating dripper. You can alter the water usage by using a different combination of pressure compensating drippers for the control dripper, or by changing the surface area of the 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).

Garden beds being irrigated by manual MI

Chapter 2. Unpowered Measured Irrigation Controller (UMIC)

2.1 Instructions for installing the 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.

Start with any drip irrigation application

Step 1. Remove the UMIC from the shipping carton and screw the elbow onto the threaded outlet from the UMIC.

Step 2. Position the evaporator in a suitable location so that the evaporation matches the evaporation in your garden.

Step 3. Connect the water supply to the green back valve on the inlet side of the UMIC.

Connect UMIC inlet

Step 4. Connect the UMIC outlet (next to the adjustable control dripper) to the irrigation zone.

Connect UMIC outlet

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

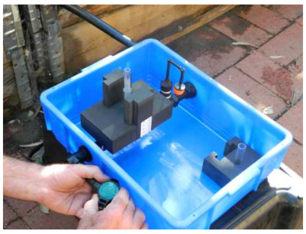
Step 6. For gravity feed application you may need to adjust the height of the evaporator so that the control dripper is at the same level as the irrigation drippers. Use a spirit level to ensure that the evaporator is horizontal. Then use the spirit level to ensure that the float shaft is vertical. The float shaft must be vertical so that there is minimal friction between the float and the float shaft.

Use a spirit level to ensure that the float shaft is vertical

Step 7. 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 8. Open the green back valve and the irrigation should start. The adjustable control dripper drips water into the evaporator. If the irrigation does not start there may be air trapped in the inlet pipe. To remove any trapped air, open the small flush valve on the left side of the green back valve. If you have a pressurised irrigation system you will need to use hose clamps for all pipe to barb connections.



Open the green back valve and the irrigation starts

Step 9. Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers. If you have a pressurised irrigation system with pressure compensating drippers and the water supply pressure is variable, then you should either replace the adjustable control dripper with a pressure compensating dripper or install a pressure regulator on the water supply.

Adjust the control dripper

Step 10. Fill the evaporator with water until the float jumps up as the magnetic valve closes. (Replace the water and clean the UMIC regularly to remove algae and other contaminants).

Fill the evaporator

Step 11. 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

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).

The 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. The 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.

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

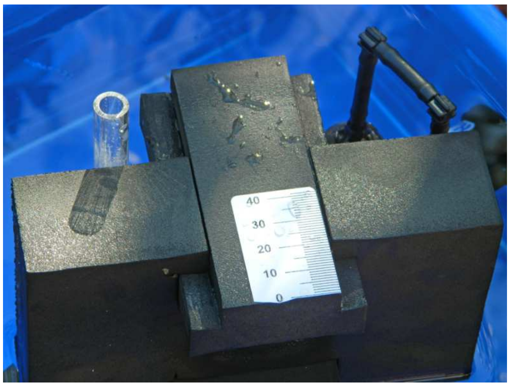
Adjust the control dripper to suit the water requirements of your plants

2.2 How to the adjust irrigation frequency

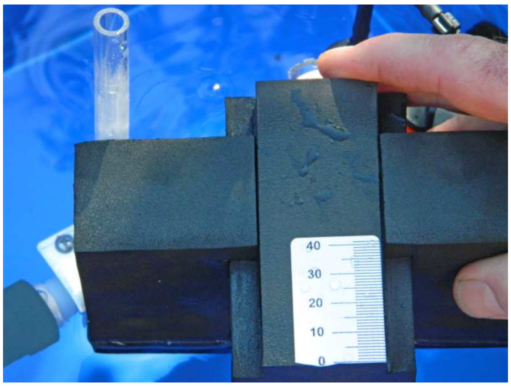
To increase the options for the irrigation frequency, the UMIC is provided with two floats, a large float and a small float.

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

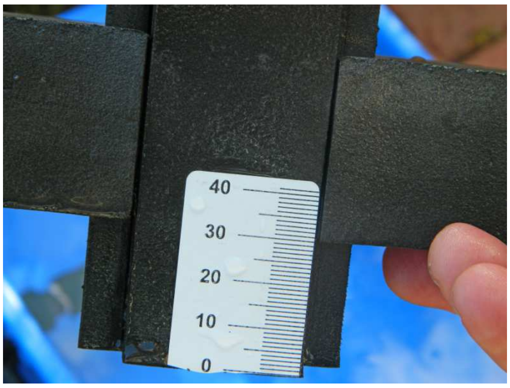


40 mm gap between the bottom of the float and the bottom of the slides

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.

2.3 How to adjust water usage

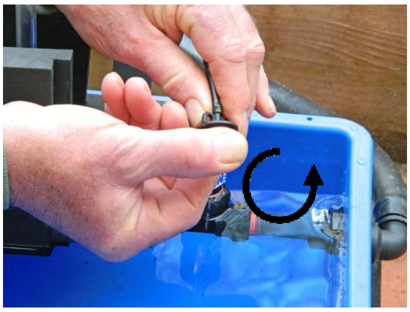
Adjusting water usage by adjusting the control dripper

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

If you are using pressure compensating dripper for pressurised irrigation and the water supply pressure is variable, then the adjustable control dripper is replaced by one of the pressure compensating drippers. To adjust the water usage you need to change the surface area of evaporation.

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 for evaporation is increased.

2.4 UMIC flow rate

The UMIC can be used for pressures ranging from 5 kPa to 800 kPa.

The maximum UMIC flow rate when the input pressure is 100 kPa is 980 L/h.

The following table shows the maximum UMIC flow rate for gravity feed input pressures ranging from 5 kPa (0.5 metres head) to 20 kPa (2 metres head).

UMIC Table 2. Flow rate

Input pressure in kPa	Maximum UMIC flow rate in L/h
5	116
6	136
7	155
8	173
9	190
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 2.5.

For irrigation systems that require a large flow rate, the magnetic valve in UMIC can be replaced by a magnetic valve with a higher flow rate. The float may need to be redesigned to ensure that it is compatible with the high flow magnetic valve. For example, a stronger magnet may be required.

2.5 Key features of UMIC

1. UMIC is completely automatic
2. No electricity is needed (no batteries, no solar panels, no solenoids valves, 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. If there is an unexpected heat wave, UMIC will respond appropriately
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. 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)

Chapter 3. DIY Smart Irrigation Controller

3.1 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 solenoid valve used for irrigation can be converted into an unpowered smart irrigation controller. 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

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 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

3.2 How to assemble the DIY Smart Irrigation Controller

I will now give you step by step instructions for assembling the 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.

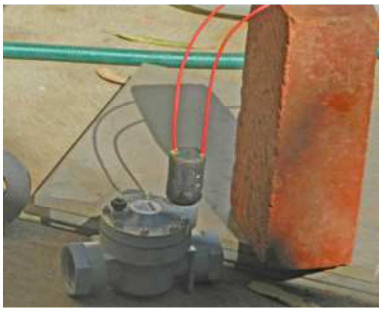
Step 7 (rare earth disc magnet assembly)

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 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 fill it with water until the water level is about 20mm below the overflow level.

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. Then progressively remove counter weights until the magnet assembly rises from the low position to the high position thus closing the valve.

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

Then progressively remove counter weights until the magnet assembly rises from the low position to the high position thus closing the valve

Step 13 (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 13 (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.

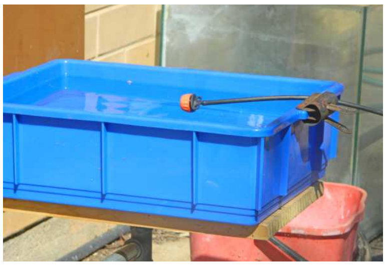
When the rare earth disc magnet assembly is in the high position, the top of the solenoid should be 20mm below the magnet

Step 14 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.


Connect the inlet of the solenoid valve to the water supply


Connect the outlet of the solenoid valve to the irrigation application

Step 15 Position the adjustable dripper so that it will drips water into the evaporator during the irrigation.



Step 16 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 17 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 18 The irrigation controller should be protected from birds and other animals.

Yes, it really is that simple.

Buying the components for the DIY Smart Irrigation Controller

The 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

3.3 How to adjust the irrigation frequency of the DIY Smart Irrigation Controller

An irrigation controller needs to be able to adjust both the irrigation frequency and the water usage (litres per week for example)

Irrigation frequency

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

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 a rare earth magnet assembly is significantly less than the irrigation frequency for a ferrite 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.

3.4 How to adjust the water usage of 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 and the water supply pressure is variable, then you should either install a pressure regulator on the water supply.

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.

3.5 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. Adjust the water usage by adjusting the control dripper
4. 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 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 4. Soil Moisture

4.1 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 end of the soil moisture probe to make it easier to hammer into the ground.

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 not enough water.

After the irrigation event 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.

After the irrigation event 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.

4.2 Irrigation scheduling for manual measured irrigation

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

When you use manual MI, 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 and you stop irrigating when the water level reaches the high level. This method of irrigation scheduling is called **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 **root zone scheduling** is recommended.

Step by step instructions for root zone scheduling for manual MI:

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. 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. Record the dripper control volume for future reference.

Place a measuring container under one of the irrigation drippers

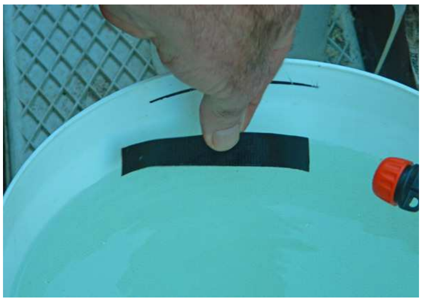
Dripper control volume in the measuring container

Step 3. Fill the evaporator with water until the water level reaches the high level. (Replace the water and clean the evaporator regularly to remove algae and other contaminants).

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

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. As soon as the soil is dry between the surface and the bottom of the root zone, mark a line on the inside of the evaporator corresponding to the water level. This line indicates the **low level**. The gap between the high level and the low level is the evaporation required to 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 with a line

High level and low level

Step 5. Empty the measuring container and place it below one of the irrigation drippers.
Start irrigating by turning on the main valve. Stop irrigating when the water level in the evaporator reaches the high level.

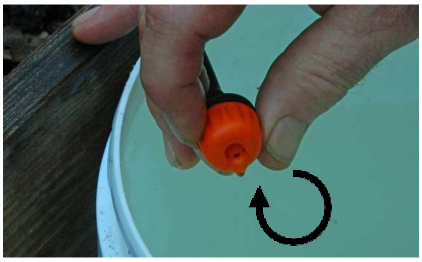
Empty the measuring container

Start irrigating

Stop irrigating when the water level reaches the high level

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.

If you have a pressurised irrigation system with pressure compensating drippers and the water supply pressure is variable, then you should either replace the adjustable control dripper with a pressure compensating dripper or install a pressure regulator on the water supply. If you replace the adjustable dripper with a pressure compensating dripper, you can alter the water usage by changing the surface area of evaporation. You can increase the water usage by increasing the surface area of evaporation by using a larger container for the evaporator. 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).

Step 7. Check the water level in the evaporator daily. When the water level is below the low level, 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 root zone scheduling to adjust water usage.

4.3 Irrigation scheduling for the UMIC

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.

Step by step instructions for root zone scheduling for UMIC:

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).

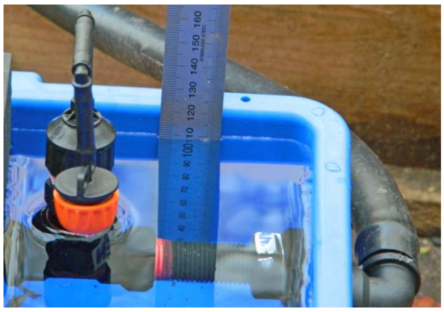
Step 2. Place a measuring container under one of the irrigation drippers to collect the water. Empty the evaporator to start irrigating. During the course of the irrigation, regularly check the depth of the moisture below various drippers (use a soil moisture probe). Stop the irrigation as soon as the 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 the measuring container

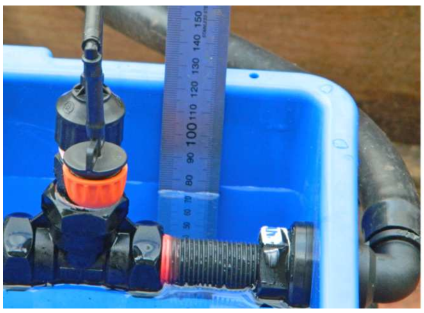
Step3. Fill the evaporator with water until the magnetic valve closes and the control dripper stops dripping. Measure the depth of water in the evaporator at the high level.

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



Measure the depth of water in the evaporator at the high level

Step 4. Remove the float and 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. As soon as the soil is dry between the surface and the bottom of the root zone, measure the depth of water in the evaporator at the low level. The difference between the high level and the low level is the number of mm's of water that needs to evaporate to dry out the soil from the surface to the bottom of the root zone. This is referred to as the **root zone scheduling evaporation.**



Measure the depth of water in the evaporator at the low level

Step 5. The float on the UMIC has two slides that can be moved up or down in order to adjust the irrigation frequency (see Section 2.6). Use UMIC Table 1 to adjust the position of the slid so that interval between irrigation events corresponds to the root zone scheduling evaporation in Step 4.

Step 6. Turn on the green back valve and add water to the evaporator until the irrigation stops. Empty the measuring container and place it below one of the irrigation drippers. Carefully remove water from the evaporator until the irrigation starts when the water level reaches the low level. The irrigation stops automatically when the water level reaches the high level.

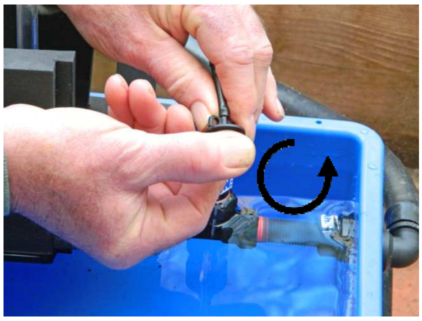
Empty the measuring container

Remove water from the evaporator until the irrigation starts

The irrigation stops automatically when the water level reaches the high level

Step 7. 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.

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.

If you have a pressurised irrigation system with pressure compensating drippers and the water supply pressure is variable, then you should either replace the adjustable control dripper with a pressure compensating dripper or install a pressure regulator on the water supply. If you replace the adjustable dripper with a pressure compensating dripper, you can alter the water usage by changing the surface area of evaporation. You can increase the water usage by increasing the surface area of evaporation by connecting a second container to the evaporator via a connecting tube at the bottom of the containers. You can decrease the water usage by decreasing the surface area of evaporation (for example, by placing full bottles of water in the evaporator).

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 root zone scheduling to adjust water usage.

4.4 Irrigation scheduling for the DIY Smart Irrigation Controller

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.

Step by step instructions for root zone scheduling for the DIY Smart Irrigation Controller:

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).

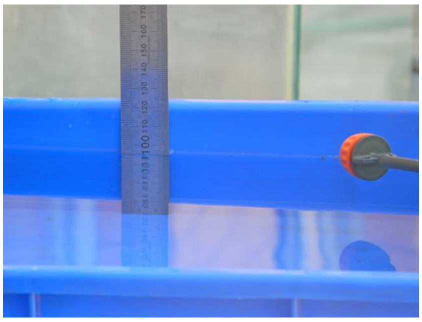
Step 2. Place a measuring container under one of the irrigation drippers to collect the water. Empty the evaporator to start irrigating. During the course of the irrigation, regularly check the depth of the moisture below various drippers (use a soil moisture probe). Stop the irrigation as soon as the 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 the measuring container

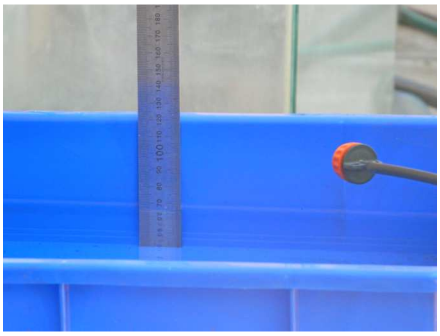
Step3. Fill the evaporator with water until the magnet assembly rises and the control dripper stops dripping. Measure the depth of water in the evaporator at the high level.

Fill the evaporator with water until the magnet assembly rises



Measure the depth of water in the evaporator at the high level

Step 4. Turn off the water supply and 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. As soon as the soil is dry between the surface and the bottom of the root zone, measure the depth of water in the evaporator at the low level. The difference between the high level and the low level is the number of mm's of water that needs to evaporate to dry out the soil from the surface to the bottom of the root zone. This is referred to as the **root zone scheduling evaporation.**



Measure the depth of water in the evaporator at the low level

Step 5. Choose a suitable evaporator so that the difference between the high level (when the magnet assembly rises) and the low level (when the magnet assembly falls) corresponds to the root zone scheduling evaporation in Step 4. Changing the evaporator changes the irrigation frequency (see Section 3.3).

Step 6. Turn on the water supply and add water to the evaporator until the magnet assembly rises and the irrigation stops. Empty the measuring container and place it below one of the irrigation drippers. Carefully remove water from the evaporator until the magnet assembly falls and the irrigation starts. The irrigation stops automatically when the water level reaches the high level.


Empty the measuring container


Remove water from the evaporator until the ring magnet component falls and the irrigation starts


The irrigation stops automatically when the water level reaches the high level

Step 7. 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.

If you have a pressurised irrigation system with pressure compensating drippers and the water supply pressure is variable, then you should install a pressure regulator on the water supply.

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 root zone scheduling to adjust water usage.

Chapter 5. Measured Irrigation using Pressure 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

This option is appropriate for unpowered manual measured irrigation and UMIC. This option should not be used for DIY Smart Irrigation Controller. Each irrigation zone will require its own evaporator.

After you have replaced the control dripper by a pressure compensating dripper, you can adjust the water usage by changing the surface area of evaporation. 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 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).

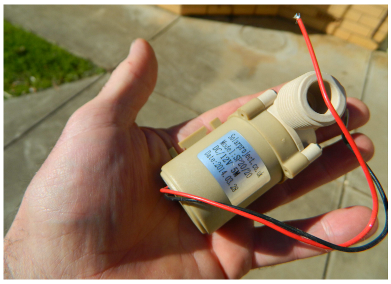
Option 2. Connect a pressure regulator to the water supply

This option is appropriate for unpowered manual measured irrigation, UMIC and DIY Smart Irrigation Controller.

Pressure compensating drippers require a minimum pressure of 100 kPa. After you have installed the pressure regulator, adjust the pressure regulator so 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. If the flow rate is less that the specified flow of the pressure compensating dripper, increase the pressure at the pressure regulator.

Chapter 6. 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 L/h

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.**