DIY solar drip irrigation

This document is for smallholders using gravity feed drip irrigation on a small plot of land. Before reading this document I recommend that you watch the YouTube video with the title “DIY solar drip irrigation”.

I will assume that water needs to be pumped from a farm pond up to a raised header tank. I also assume the depth of the farm pond is no more than 4 metres.

By reading these guidelines, a farmer is taking the first step towards automating their drip irrigation system so that he or she can leave their plot unattended for weeks. At sunset each evening, water will be automatically pumped from the farm pond to the header tank, and all the plants will be automatically irrigated by measured irrigation. This will allow the farmer to spend more time generating income from other activities away from the farm; for example, travelling to the market to sell their produce.

Do It Yourself solar drip irrigation requires the farmer to solve any problems that may arise and to break the cycle of dependency upon the so-called experts. By following these guidelines the farmer will learn new skills. When the automation of the drip irrigation system is complete, the farmer will then become the expert, and their knowledge and expertise can be shared with other farmers. I am assuming that the farmer has access to the Internet and to Google. Google will help you find solutions to problems and low cost components from anywhere in the world, especially China.

The total cost of automating the drip irrigation system will be less than $200. However, the cost may be much less if the farmer is able to develop low cost solutions to various challenges that may arise during the Do It Yourself implementation.

Because I am encouraging the farmer to solve their own problems, the guidelines presented below are not complete instructions.

Farm pond in Kenya for gravity feed drip irrigation

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Solar Panel

Provided the number of drippers in the irrigation system is less than 500, a 12 volt 20 watt solar panel should provide all the power required.

The farmer needs to find a low cost method of mounting the solar panel. In the southern hemisphere the solar panel should face the sun when the sun is in the north. In the northern hemisphere the solar panel should face the sun when the sun is in the south. The ideal angle of the solar panel changes throughout the year. It is easy to adjust the orientation of the solar panel if it is mounted on a pole as shown.

20 watt solar panel mounted on a pole

Battery

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

Solar Charge Controller

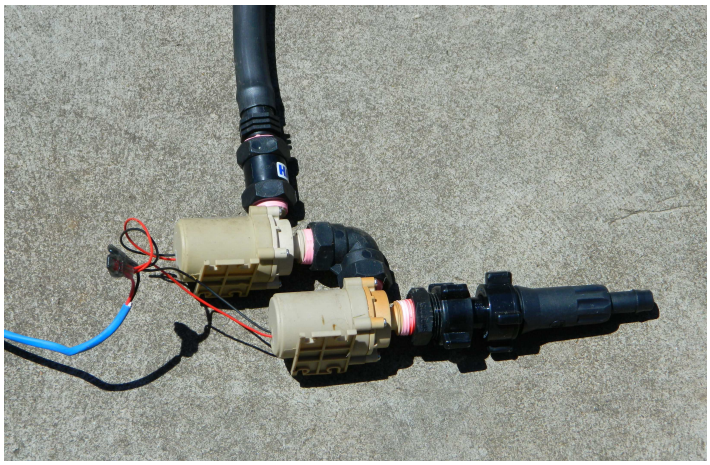
A solar charge controller is needed to protect the battery. A suitable low cost weatherproof solar charge controller may be purchased online https://www.aliexpress.com/item/5A-12V-solar-waterproof-charge-controller-IP67-for-small-solar-home-use-mini-size-solar-cells/32234529757.html?spm=2114.40010308.4.11.qR2JQ7

Waterproof solar charge controller

Pump

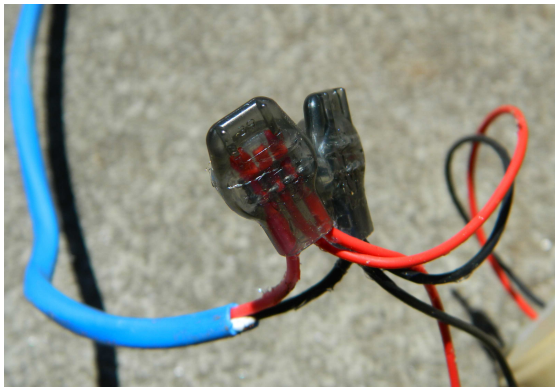
A 12 volt submersible pump is needed to pump the water from the farm pond up to the header tank. I strongly recommend that you use a double pump consisting of two 12 volt 14 watt pumps connected in series as shown in the photo. The pumps can be purchased online form Solarproject in the UK. These pumps are reliable and extremely efficient.
http://www.solarproject.co.uk/page2.html

The double pump will deliver at least 240 litres per hour at a head of 5 metres.



The two pumps are connected in series as shown. A low cost filter should be connected to the inlet of the first pump.

A length of polypipe (LDPE) is connected to the second pump so that the double pump can be easily submerged at the bottom of the farm pond.



A waterproof electrical cable is connected to the pumps using waterproof electrical connectors.

Float switch for the pump

A 12 volt horizontal float switch is mounted on the side of the header tank near the top of the tank. When the water level in the header tank reaches the flow switch the pump will stop automatically. A suitable low cost float switch may be purchased online.

https://www.aliexpress.com/item/KSOL-Float-Switch-Liquid-Water-Level-Sensor/32744925495.html?spm=2114.40010408.3.70.4KHkGg

https://www.aliexpress.com/item/Fish-Tank-Black-Water-Level-Sensor-Horizontal-Liquid-Floating-Switch-3-8-PT/32666409938.html?spm=2114.40010408.3.10.frpnZv

The inlet to the header tank should be higher than the float switch.

The inlet to the header tank is higher than the float switch.

Power relay for the pump

A power relay is needed to protect the float switch for the pump. The relay should have a rating of at least 5 amps. A suitable low cost relay may be purchased online.
https://www.aliexpress.com/item/Free-shipping-10PCS-LOT-relay-12V-10A-T73-SRD-12VDC-SL-C-5-feet-T73-3FF/32308779497.html?spm=2114.40010208.4.36.Kq4R8y

How to connect the components for automatic pumping

Connect the COM pin on the relay and one of the COIL pins on the relay to the Load negative lead from the charge controller.

Connect the other COIL pin on the relay to one of the leads from the float switch.

Connect the NO (normally open) pin on the relay to the negative lead from the pump.

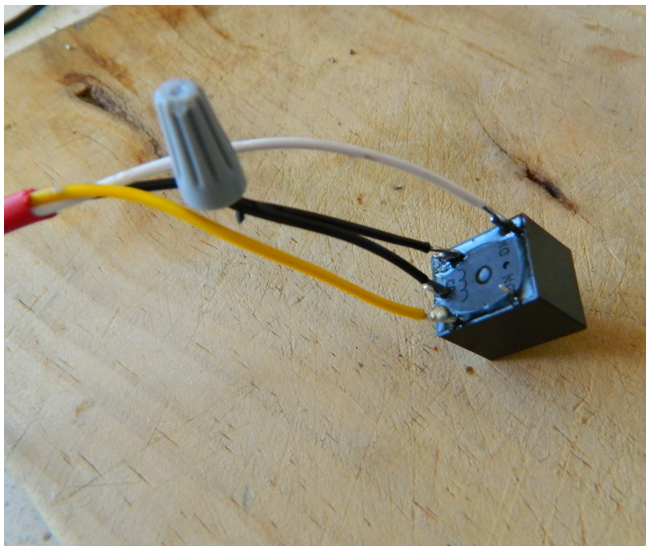
Connect the positive lead from the pump and the other lead from the float switch to the Load positive lead from the charge controller.

Connect the positive lead from the solar panel to the corresponding lead from the charge controller.

Connect the negative lead from the solar panel to the corresponding lead from the charge controller.

Connect the positive lead from the battery to the corresponding lead from the charge controller.

Connect the negative lead from the battery to the corresponding lead from the charge controller.



If you are using a relay with pins (for a printed circuit board), you can use solder to connect a length of insulated wire to a pin.

One way of protecting the relay from the weather is to house the relay in a short length of vertical polypipe with a plug at the top.

How does the automatic pump work

At sunset each evening the pump will start automatically and fill the header tank. The pump stops when the water level in the header tank has reached the float switch.

If you wish to start the pump during the day you will need to temporarily disconnect the solar panel. Remember to reconnect the solar panel after you have finished pumping, otherwise you may flatten the battery. The pump will not operate if the battery charge has fallen below a critical level.

Evaporator for measured irrigation

An evaporator is used so that the weather controls the irrigation. The application rate for each dripper in the irrigation system is directly proportional to the net evaporation rate (evaporation minus rainfall).

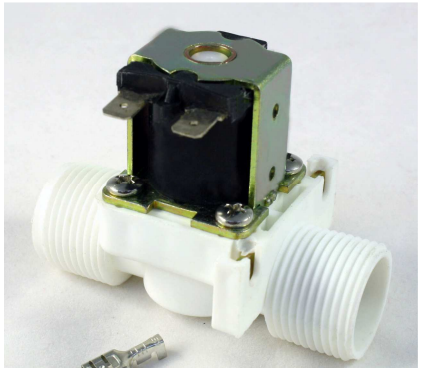
The evaporator may be any container with vertical sides. I recommend that the surface area of evaporation be at least 0.08 square metres. The application rate for each dripper in the irrigation system is directly proportional to the surface area of evaporation from the evaporator.

The evaporator is placed in the farmer's plot so that one of the drippers drips water into the evaporator during the irrigation event. This dripper is called the control dripper. All of the drippers in the plot (including the control dripper) should be at approximately the same level. This ensures that each dripper in the plot emits the same volume of water as the control dripper. Between irrigation events the water level in the evaporator falls due to evaporation.

Evaporator with control dripper positioned so that it drips water into the evaporator during the irrigation event. The dripline used is in this application is Netafim Landline 8.

Solenoid valve

A 12 volt gravity-feed solenoid valve is connected to the outlet from the header tank. A suitable low cost solenoid valve may be purchased online. http://www.ebay.com.au/itm/3-4-inch-NPSM-Thread-12V-DC-GRAVITY-FEED-Plastic-Nylon-Solenoid-Valve-/121083402337?hash=item1c31221861:g:t1gAAOxy14VRR4DE



12 volt gravity-feed solenoid valve

Float switch for the solenoid valve

A horizontal float switch is mounted on the side of the evaporator. When the water level in the evaporator reaches the float switch, the solenoid valve will close automatically and stop the irrigation. I recommend that the float switch be mounted so that the irrigation stops when the water level is about 3 cm below the overflow level for the evaporator.

Horizontal float switch mounted on the side of the evaporator.

Power relay for the solenoid valve

A power relay is needed to protect the float switch for the solenoid valve. The relay should have a rating of at least 5 amps. A suitable low cost relay may be purchased online (see above)

How to connect the components for automatic measured irrigation

Connect the COM pin on the relay and one of the COIL pins on the relay to the Load negative lead from the charge controller.

Connect the other COIL pin on the relay to one of the leads from the float switch.

Connect the NO (normally open) pin on the relay to one of the leads from the solenoid valve.

Connect the other lead from the pump and the other lead from the float switch to the Load positive lead from the charge controller.

How does automatic measured irrigation work

During the day the water level in the evaporator falls due to evaporation. At sunset each evening the irrigation starts provided that the water level is lower than the float switch so that the float switch is closed. The irrigation stops when the water level reaches float switch and the float switch is opened. When it rains the water level in the evaporator rises and delays the start of the next irrigation.

If you wish to start the irrigation during the day you will need to temporarily disconnect the solar panel. Remember to reconnect the solar panel after you have finished irrigating, otherwise you may flatten the battery.

How to adjust the surface area of the evaporation

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

To take account of all these additional factors, I recommend that you use a length of steel pipe to check the moisture level in the soil. I suggest that the diameter of the pipe be between 40 and 50 mm. An angle grinder can be used to cut some slots in the steel pipe to that you can inspect the soil inside the pipe. I suggest that the width of the slots be about 13 mm.

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

Early in the morning after irrigation the night before, push (or hammer) the steel pipe into the soil near a dripper.

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

By checking the moisture level in the soil through the slots in the steel pipe, you can decide whether the plants have been irrigated the night before with too much or too little water. If the plants have been given too much water then you can reduce the water usage by reducing the surface area of evaporation. For example, the surface area of evaporation can be reduced by placing full bottles of water in the evaporator. On the other hand, if the plants have not been given enough water then you will need to increase the surface area of evaporation. After irrigation and adjustments over several days, the surface area of evaporation should stabilise at an appropriate level for the plants at their current stage of growth.

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

In this case 2 large drinking bottles have been used to adjust the surface area of evaporation.

Measured irrigation uses much less water

By implementing measured irrigation scheduling as described in these guidelines, you may use half as much water compared with programmed irrigation scheduling. I am currently running a research project in Adelaide to quantify the improvement in the crop yield per litre using measured irrigation.

Additional irrigation zones

In some locations you may wish to use more than one irrigation zone. For example, on sloping ground it is preferable to have a number of irrigation zones where each zone is at a different level. For each additional zone you will need an evaporator, a solenoid valve, a float switch and a relay. Repeat the process described above for setting up each additional zone.

Unpowered measured irrigation

I you don't need an automated drip irrigation system, you can upgrade your drip irrigation system to measured irrigation at almost no cost. All that is needed is an evaporator and a length of steel pipe. Instead if using a float switch, mark a level line on the inside of the evaporator about 3 cm below the overflow level. Simply irrigate the plants each evening until the water level in the evaporator reaches the level line.


Stop irrigating when the water level reaches the level line.