The Self-Sufficient Polytunnel

Ludwig Appeltans describes how to design a permaculture polytunnel to grow food all year round in a cool temperate climate.

At Earth Ways in north Scotland, we have designed and built a versatile polytunnel. To get maximum use from it, we have made one section of it completely frost-free, we harvest rainwater for irrigation, and we have equipped it to provide plants with enough light for year-round growing.

Watering
Rainwater is often the best and easiest source of water for polytunnels in the UK. At Earth Ways we do sometimes run out of it because we also use it to make and dilute liquid fertilisers, so it is good to have mains water as back up.

We fill barrels with it as it is better than using tap water directly because it allows some of the chlorine to evaporate and the water to warm up.

We looked into self-watering systems like drip feeds, but I have been told by experts that they only really work well with mains water at mains pressure, so we didn’t try them. Self-watering beds are handy, so an alternative that we tried was the traditional African ollas,1 a porous terracotta pot, kindly provided by Thys Berkens. This gradually releases water into the surrounding soil and the roots from plants nearby grow towards the pot. We loved it but found it too pricey for a whole tunnel. We did an experiment creating a self-watering bed, using a pond liner (more about this later). In the end we chose to use water tanks. The main argument in favour of this choice is that it forced us to visit our plants daily. We spotted pests, diseases and nutrient issues much quicker than we would have otherwise.

Harvesting Rainwater
The logical place to harvest rainwater is from a convenient clean surface area high up the roof of the polytunnel. Plastic tile trims work really well as flexible gutters that can be taped to the outside of the tunnel. Use the ones that go on top of a row of tiles in the bathroom. They are shaped like a little gutter if you turn them upside down and are much cheaper than commercial polytunnel gutter kits.

Clean the plastic well and use transparent tunnel repair tape. Coloured tape blocks light and heats up in the sun, shortening the life of your plastic. Tape the gutters in a...
**Moving the Water**

It is simple to move water between barrels by siphonage. When taking water out of one barrel, most of it will be replaced by gravity and air pressure. There is a need for a bit of extra pressure as the narrow diameter of the hoses creates friction which needs to be overcome by creating a hydraulic head. To achieve this we have a height difference of 180mm (7in) between each barrel.

Barrel 0, where we take water out, is dug 180mm into the soil, barrel 1 is at ground level, barrel 2 is raised 180mm and barrel 3 is raised 360mm (14in).

To connect the barrels, submerge the ends of a short hose in each barrel with a piece of metal wire at the ends to weigh it down. Make sure there is no air in the hose or the syphon won’t work. We use a water hose to “blow” the air out.

Having a couple of barrels in the tunnel makes the water easy to access and it warms up a little, which is better for the plants as cold water can be a shock, especially to seedlings.

**Pond Powered Self-watering Bed**

One of the barrels from outside the tunnel leads into a small pond inside. When it rains, it slowly refreshes the water in the pond and when full it overflows into a self-watering bed.

**Storing Water**

We placed five blue 225 litre (50 gallon) barrels on both sides of our tunnel and two more inside. We used second-hand blue barrels because they are cheap and sturdy. We found them for £10 each. Sometimes they are used to transport toxic material, so check what they were used for previously.

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**Above:**
One end of the self-sufficient polytunnel showing rainwater collection system, outside pond and wind turbine.

V-shape above a barrel, with the ends sticking out a little. Make a slit in the hose and slide it on to the gutter and fasten with wire. The hose will guide the water nearly into a barrel.

**Right:**
Part of the rainwater collection system, showing taped on guttering, collection hoses, water storage barrels and interconnecting syphons.

**Above:**
Rainwater harvesting system diagram with syphon detail (left).
Above:
Irrigation system flow diagram.

Above right:
Inside pond and self-watering bed.

Right:
Air sump in the Jean Pain heating system acts as a pressure relief valve.

**Stage One Costs**

**Irrigation System**
- Gutters: 20 x £5 = £100
- Barrels: £10 each, 10 outside, 2 inside = £120
- Polytunnel repair tape: 50m = £12
- Hoses and metal wire are reclaimed.
- Pond liners: 2 x £15 = £30
- Total = £262.

**Heating System**
- Pump: £17.99
- Power Module: £34.99
- Pipes: £282.40
- Fittings: £86.12
- Woodchip: £20 donation to tree surgeon
- Total: £410.

Above:
The polytunnel.

Right:
Heating system.

Below right:
The heating coils.

Below left:
Inside the tunnel.

Air sump and pump (see above)

Radiator coil under beds

Change over valve

Pick-up coils in woodchip filled pits (see below).
This bed is made from a pond liner and has sand and stones on the bottom until just above the water line. On top of the sand layer is a few inches of soil. The water at the bottom wicks upwards and plant roots grow down. When this bed reaches the maximum level, the excess water runs into a pond outside, where any escaping nutrients are soaked up by the water plants and marginals. The pond is on the south side, to reflect light into the polytunnel.

Our experience with this setup is really positive. We’ve never had to water the self-watering bed. It works so well, that it tends to be forgotten and pond plants are slowly colonizing it. Two growing seasons of experimenting is not quite long enough to be conclusive, but so far, all good.

**KEEPING THE TUNNEL FROST FREE**

**Capture and store energy**

When making beds, you can use materials that have multiple functions. Stones can keep the soil in the beds, but also function as stepping stones and as thermal mass, capturing warmth during the day and releasing it at night. We also use black roof slates and dark coloured bottles filled with water when there is a danger of frost. The bottles do crack if it gets really cold, so watch the weather forecast. The water barrels and the pond system stores warmth too.

**Jean Pain heating system**

Steve Hanson explained the workings of a Jean Pain system really well in PA87. The same idea is used to keep part of our polytunnel frost free.

We created a 200m (650ft) long, closed water pipe loop using 32mm (1.26in) MDPE water pipes. One half was placed in a spiral under the raised beds in the middle of the tunnel to act like under floor heating. The other half is in pits outside the tunnel, filled with wet woodchip.

**The hot woodchip pits**

The pits are 2x2m (6.5x6.5ft) wide and 1.5m (4.9ft) deep.

It is hard to determine what woodchip is the best to use. It depends on the hardness off the wood, the surface area of the chips or shreds, the sugar content of the sap, the amount of leaf litter that is mixed in with it and so forth. They are a waste product from tree surgeons so you can’t pick and choose easily. Our last load was the best: sycamore shreadings harvested in autumn, which included leaves. This mix heated up to reach 43°C (109°F) and held consistently for 14 weeks, warming the water to an average of 23°C (73°F). This was enough to keep the soil inside above 10°C (50°F). The temperature in the pit itself was still 30°C (86°F) after four months. The coldest night we had this winter was -5°C (23°F) which is not as cold as it can be here. Any colder and I would cover the plants with a frost fleece at night to keep the warmth in.

The frost season is longer than the woodchip can provide heat for, so when the woodchip cooled down in pit one, we filled the second pit with a new load. After 10 days or so, this was hot enough to switch to the new pit using valves in the loop. We left the woodchip in the first pit to decompose further and added urine to speed up the decomposition. A year later, we used it as mulch amongst the perennial plants.

**Air sump**

Warm water expands so you can’t keep the cycle sealed. The pipes can deal with pressure, but the pump connections cannot. You therefore need an air sump in the circuit. I made one out of a 5 litre bottle. Both hoses are submerged in the water inside. The water enters through the shortest one and exits through the bottom one. This prevents air bubbles from being sucked into the pump, which can break it.

**Pump**

We used a 12V DC brushless water circulation pump to cycle the water around the circuit. We decided to use a step down power module to limit the voltage. There is no need for the water to cycle fast and it helps to reduce the power usage. We installed the water pump close to the air sump, so that it sucks water out of the bottle. This reduces the chance of air passing to the pump. We work with the forces of nature, so we pump the warmest water through the spiral in the woodchip upwards, and the colder water downwards.

**Off grid power**

We have a 12V system powered by solar voltaic panels and a wind turbine. The system can generate up to 1,785 Watts per hour if it is really sunny and windy at the same time. Via a battery bank, this powers the water pump in the Jean Pain composting heater, a pond air pump, a ventilation system, a theft prevention system and 5,000 LED lights – used to provide extra growing light during the darker months.

Earth Ways is working on a detailed design manual which you can pre-order by going to their crowdfunding page. The campaign will be used to implement an aquaponics system and make further improvements. Your support and donations are gratefully accepted: http://tiny.cc/earth-ways-polytunnel

The Earth Ways Team consists of Ludwig Appeltans, Suzanne de Waard and Jack Lennon. Earth Ways grows food and teaches permaculture in the north of Scotland: www.earth-ways.co.uk

Illustrations by Suzanne de Waard
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1 http://tiny.cc/clay-pot-irrigation
2 ‘Shower for Free’ by Steven Hanson, in PA87