Get started with more efficient irrigation systems *for PermacultureAust*

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1. Introduction

The world water crisis is undisputable, yet surprisingly little work is being done to promote, develop and understand more efficient, low cost irrigation systems. Drip is considered the 'choice' but is ill suited for remote areas with low technology and unpressurized, unfiltered water systems. The systems described here will work well and use less water than drip. Capturing and utilizing any rain that falls is also desirable. First, make use of catchments and hard surfaces to collect rainwater in cisterns. Then save as much water on the land as possible with microcatchments, pitting, swales and imprinting. Check dams in the gullies of course. mulch, compost or brush bits if you have them

2. Alternative irrigation systems

I have worked with and tested many alternative systems from traditional cultures and worked on new methods that work well and use much less water. These generally also reduce weed growth, minimize disease problems and improve yield. These systems include many you may never have heard of, including:

a. Deep pipe irrigation

Deep pipe irrigation uses an open vertical or near vertical pipe to concentrate irrigation water in the deep root zone. Experiments in Africa showed that grape vine weight on a deep pipe drip system was more than double the weight found with surface drip and more than six times the vine weight of conventional surface irrigation. Deep pipe has been the most effective system for many of my restoration projects. I usually will use 4-5 cm diameter plastic pipe placed vertically in the soil 30-60 cm deep near the seedling or tree with a screen cover (6 mm screen) to keep out lizards and animals. These can be glued on with silicone caulk or polyurethane glue. A series of small holes should be spaced down the side of the pipe nearest the plant. Mark it near the top with paint to get the alignment right. Bamboo with the nodes punched out works also, but wrap the bamboo with a few turns of twine or wire to prevent splitting.

Deep pipe irrigation can be used with low quality water. It is possible to set up with simple materials and unskilled labor without extensive support systems (pressurized filtered water is not needed). The deep pipes provide better water use efficiency (due to reduced evaporation) and weed control. They also enable water to be applied quickly and efficiently with no runoff waste even on steep slopes. Deep pipe irrigation with drip emitters installed in 13 mm pipe was also very effective. This provides for deep irrigation but makes it easy to check and repair emitters. A commercial system is now sold in the USA as DeepDrip.

b. Watering into tree shelter

Treeshelters like Tubex can be inserted into the ground around (over) a seedling and used for watering by simply pouring water into the mini-dam. The amount of water can be calibrated by marking a fill line on the shelter. Irrigating into treeshelters has worked well for species that tolerate getting wet or on sites with fast draining soil. The tree shelters also improve survival by limiting wind exposure, increasing humidity around the plant, eliminating sand blast, and minimizing herbivory. Combining treeshelters with catchment basins is a good minimal cost irrigation system. Double wall tree shelters have worked better in the hottest desert climates.

c. Wick irrigation

Wicks look very promising, either in capillary wicking (slow), gravity fed (moderate), or pressurized (fast) wick mode. Nylon wicks made with woven (not braided), washed and weathered nylon or polyester rope have been best. You can test them by hanging them down into a bucket of water with some food coloring in it and watching the capillary rise. The flow rate will depend on the type of system and wick. Gulf Rope makes a wick rope for herbicide spreaders that works. A Palo Verde seedling in a bucket of 16 grit silica sand in a very hot and dry greenhouse used only 20-30 ml/day. I have been working with wicks since 1989 and have found that 11 mm wick works well. A gravity flow rate using 11 mm new washed solid braid nylon and the hose clamp tightened one turn past snug released about 1 liter/hour. I will usually tighten further, for a release rate of 20 l in 3-5 days. These require some attention to adjust as plant demand and flow rate varies over time.

Gravity flow moved moisture down a vertical wick from an open reservoir 1.8 m in 8 minutes and 4.5 m in about 15 minutes. This suggests they will work well for deep watering to get roots to groundwater at 2-5 m. Capillary rise in polyester rope was 46 cm up in 6 hours. Do your own tests to make sure your wicks will work. Use a food coloring in the water to help see water flow in the wick.

With 20 l reservoirs and 11 mm solid braid nylon rope wicks washed once starting in a short length of ~12mm inside diameter vinyl tubing with a hose clamp the survival was 100% at 5 years after minimal watering for just two years. In 2013 the same wick material performed well in a large garden test. Dr. Preslav Trenchev in Australia has used wicks to irrigate nut tree orchards. About 6,000 nut trees were irrigated for 2 years by this method on 27 farms around Sydney. Seedlings got a 5 liter plastic bucket with a gravity wick with rain collected by an aluminum tray glued to the cover of the bucket. The Groasis Waterbox, a commercial product, also combines a wick with reservoir and rainwater collection. A low cost wick irrigation system might be made by inserting a wick in the bottom corner of a sturdy plastic garbage bag. This partly filled bag with 80-120 l could provide a couple of months of water for seedlings or young shrubs or trees.

d. Buried clay pot irrigation

Buried clay pot (olla, pitcher) irrigation uses a buried, unglazed terra cotta clay pot filled with water to provide a steady supply of water to plants growing nearby. The water seeps out through the walls of the buried clay pot at a rate that is in part determined by the water used by the plant. This auto regulation leads to very high irrigation efficiency. I found out about this system in an ag extension book by Fan Sheng-chi from ancient China (~50 BCE). Fan Sheng-chi was tasked with improving yields for farmers who had too little land and little water.

By selecting covers that collect rainfall any precipitation that does fall can be conserved and utilized. Ollas designed for irrigation are increasingly being sold in the USA, but they are still rare. Most standard red clay garden pots are suitable for irrigation if the bottom hole is plugged. Silicone caulk or epoxy works better than rubber stoppers or corks. Buried clay pot irrigation is also very effective for irrigating cuttings, in the nursery or in the field. In the nursery a sealed pot is placed within a larger pot with the drain left open, with sand or potting mix between them. The interior pot is filled with water and maintains moisture in the soil.

e. Porous capsule irrigation

Porous capsule irrigation is an efficient modern adaptation of buried clay pot irrigation. WetPots are now available in Australia. A great system! Porous capsules can be more easily tied into a piped network than buried clay pots. If you can't buy them you can make them by gluing clay pots or pots and pot bases together. They have been effective, but are more costly to make and install than buried clay pots or deep pipes.

Buried porous clay pipes are similar to porous capsules. Finding porous pipe is a challenge, but is sold in Japan. Old drain tiles may also be suitable. In a study of buried porous clay pipe in France water use was cut 80%, chemical fertilizer use was reduced 50% and corn yield increased 83%, melons 48% and potatoes 34%.

f. Porous hose irrigation (leaky hose, sweaty hose, soaker hose, leaky pipe)

Porous hose irrigation parts are readily available and reduce water use. But placing sections of porous hose vertically like a deep pipe is much more efficient. A hose designed for low pressure is needed. This can be connected to a water bottle or a tank and distributing system. Trials of vertically placed 30 cm long 1 cm diameter porous hose were very encouraging. A series of porous hoses in a triangle arrangement can be used to develop wind firmness in very windy areas.

g. Perforated pipe

Buried slotted drainage pipe run beneath the soil can work much like a horizontal deep pipe. This 10 cm slotted drain pipe has been very successful in installing windbreaks in the Mojave Desert. One run is almost a km. Vertical standpipes with screen covers at about 100 foot intervals are filled from a water truck to water the plants. Filling risers are tied to posts at intervals based on slope and flow direction.

h. Microcatchments

Microcatchments are specially contoured with slopes and berms to increase rain runoff and concentrate it. Rain drains into a planting basin where it infiltrates and is effectively 'stored' in the soil profile. Microcatchments are simple and inexpensive to construct and can be built rapidly using local materials and manpower. The runoff water has a low salt content and, because it does not have to be transported or pumped, is relatively inexpensive. Microcatchments enhance leaching and often reduce soil salinity. The primary drawback of microcatchments is that they work only if it rains. Microcatchments improved survival and growth of our transplants in the Mojave Desert. Microcatchments with irrigation can be even better – deep pipes or porous capsules might be best.

i. Waffle gardens

Planting in depressions with compacted walkways between small sections provides some microclimate improvement for the plant and captures added rainfall. The walkways can be rock lined. These waffle gardens were used by the Hopi people in the American Southwest.

j. Drip -- the problem is

Drip systems require too much water, typically two-four liters per emitter per hour, and they demand regulated water pressure and careful filtration. In addition we have found that many animals will chew tubing (often called spaghetti tubing) and pipes even when open water is available nearby (including coyotes, rabbits, and dogs). In one study we did using repellants to protect seedlings all the spaghetti tubing was chewed up before the plants were attacked. We have also tried repellents on the tubing to little avail. The emitters are also easily blocked with sediment and salt, and several insect species plug the emitters. Drip systems are also easily vandalized and repairs can be costly. Supply interruptions can cause plant damage fairly quickly.

3. Try alternative irrigation – help advance the knowledge

The cost of all of these systems is modest and they work. Try them! Plants should also receive a tree shelter if possible or a fence to reduce windblast and chewing by animals and insects. These alternative and little known irrigation systems can dramatically increase survival and improve plant growth even in severe desert conditions. Supplemental irrigation for seedling shrubs and trees should be provided for as long as possible, perhaps once every two weeks the first three months and then once a month for two summers. Water demands for the garden will be higher but may still require refills just once a week. These effective and efficient irrigation systems should be considered for gardens, farms, restoration, landscaping and interior greenscapes because they save water and time.

Suppliers:

Deep Drip® Watering Stakes www.deepdrip.com

Ollas for buried clay pot irrigation drippingspringsollas.com/

Wick rope www.gulfrope.com/agriculturehorticulture.html

Porous hose (leaky pipe, sweaty hose, soaker hose) Leaky Pipe's LP12UH will work down to 1metre head (0.1bar, 50 & 100 metre rolls. www.leakypipe.co.uk

Porous capsules – Wetpot Industries, Paddington QLD http://wateringsystems.net/

More information

My papers and presentations free on line at http://works.bepress.com/david_a_bainbridge.

Slide show on alternative irrigation http://works.bepress.com/david_a_bainbridge/9/

Coming soon Bainbridge, D. A. **Super-efficient Irrigation**. Storey Press. TBA.

Bainbridge, D. A. **A Guide for Desert and Dryland Restoration: New Hope for Arid Lands**. Island Press. 2007.

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