Super efficient irrigation with buried clay pots

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A little known opportunity
Although the majority of the World's dry lands are still farmed by small scale, subsistence farmers, efficient traditional methods of irrigation that could be of great use on these small and medium sized farms and gardens have not been well studied or publicized.

The buried clay pot or pitcher method of irrigation is one of the most efficient systems known and is ideal for gardeners and small farmers. Buried clay pot irrigation uses a buried, unglazed clay pot filled with water to provide controlled irrigation to plants as the water seeps out through the clay wall at a rate that is influenced by the plant's water use.

This leads to very high efficiency—considerably better than drip irrigation and many times better than conventional surface irrigation.

In India, for example, the yield of buried clay pot irrigated melon was 25 tons/hectare using only 2 centimeters of water/ha, this compares with yields of 33 tons/ha using 26 cm of water with flood irrigation.
A detailed study of cucumber production showed that 1.9 cm/ha with buried clay pots provided yields comparable to 7.3 cm/ha by hand irrigation. And trials in Zimbabwe found the yield of beans was 17 kg/cm water used with buried clay pots, compared to only 13 kg/cm for drip, 12 kg/cm for subsurface, and only 10 kg/cm for conventional basin irrigation.

**Irrigation system efficiency**

<table>
<thead>
<tr>
<th>Method</th>
<th>Productivity in kg plant per cubic meter of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>closed furrow (basin)</td>
<td>0.7</td>
</tr>
<tr>
<td>sprinkler</td>
<td>0.9</td>
</tr>
<tr>
<td>drip</td>
<td>1.4</td>
</tr>
<tr>
<td>buried clay pot</td>
<td>up to 7</td>
</tr>
</tbody>
</table>

**Other benefits**

In addition to being more efficient than drip systems, buried clay pots can be used without pressurized, filtered water supplies. The clay pots can be made with locally available materials and skills and are less likely to be damaged by animals or clogged by insects than drip systems. And finally, while even a brief interruption of water supply to a drip irrigation system due to a pump or filter failure can lead to serious problems and costly crop failure, the buried clay pot systems may require water only once every few days or once a week.

This makes buried clay pots ideal for farmers and gardeners who are busy with other crops, children, household duties, or who must work away from home much of the week. It also makes using remote areas with better soil more feasible for specialty crops, as they do not have to be visited every day.

Snails and slugs are easier to manage with clay pot irrigation as well. They collect at the pot/soil seam and can be easily removed.

Buried clay pot irrigation allows soil amendments to be placed only where they will benefit the crops not the weeds. This is very important as studies of traditional farming systems have found that as much as 30% of the labor is for weeding -- labor that could be put to more productive use.

The precise water application minimizes weed growth and reduces both the labor requirement for weeding and weed competition with crops for water and nutrients. A study in India found that the dry weight of weeds was only 62 kg/ha using buried clay pots compared to 465 kg/ha with basin irrigation.

**When should you use clay pots?**
Buried clay pot irrigation should be considered wherever water conservation is important. It will probably continue to prove most valuable for producing high value crops in dry lands. Buried clay pot irrigation is also valuable for food production and revegetating areas affected by salinity or where only saline water is available for irrigation.

Buried clay pot irrigation is also valuable for gardening, landscaping, and growing plants in containers. It can be very effective for plants that are prone to diseases from over watering or wetting leaves by sprinkling. It could also be of commercial value for many situations encountered in landscaping, gardening, and plant propagation.

Small ceramic watering tubes for potted plants and liter bottles are now also sold, see Gardener’s Supply and Texas Hill Country Ceramics.

How do you do it?

The Fan Sheng-chih Shu (the first agricultural extension book) describes the use of buried clay pot irrigation in China more than 2,000 years ago. It is likely buried clay pot irrigation had been used for many decades or centuries before this description was published. Current practices remain much the same.

Make 530 pits per hectare (210 pits per acre), each pit 70 cm (24 inches) across and 12 cm (5 inches) deep. To each pit add 18 kilograms (38 lbs.) of manure. Mix the manure well with an equal amount of earth.

Bury an earthen jar of 6 liters (1.5 gallons) capacity in the center of the pit. Let its mouth be level with the ground. Fill the jar with water. Plant 4 melon seeds around the jar. Cover the jar with a tile. Fill the jar to the brink when the water level falls.

Buried clay pot irrigation is simple and straightforward

1. Finding porous clay pots

The first step is obtaining or making suitable clay pots. The size of buried clay pot will depend on the type of crop, the density of planting, and the time desired between refills. Two to five liter (2-5 qt) sizes are convenient. Larger pots may be more suitable for trees or for long refill intervals. A few sources are now selling clay pots (ollas) specifically for irrigation.

In the developed countries most standard red clay pots used by nurseries will also work if the drain hole is plugged. The hole can be sealed with silicone caulk, a rubber cork, or a wood plug. It is easiest to use caulk, simply put some masking tape over the outside bottom of the pot. Then turn the pot over and use a caulking gun to fill the hole. Let dry for two days, then use.

Ollas and low fired clay water pots and pitchers are easier to obtain in many areas of the world. Most of these are low fired and will work well, but if they are not heated enough they may breakdown in the soil.

Pots can be tested by spraying them with water and making sure that the surface becomes damp immediately. If time and vendors allow, filling the pots with water and making sure moisture reaches the outer surface is even better.

Lids that will fully cover the top should be used. The ceramic pot holders sold with pots often make good covers. A small hole should be drilled in the top to let rainwater in. Ceramic tiles, flat stones, plastic, or metal dishes can also be used. The cover should fit tightly, slope inward, and have a hole to let rainwater into the buried clay pot. Animals may knock lightweight lids off to drink the water. For narrow necked buried clay pots a clay cup, will work. Aluminum pie tins are readily available to fit commercial red clay 20 cm (8”) pots, a rock can be glued on top to hold these light lids in place. Poorly fitted covers may enable undesirable insects to use the buried clay pot as a home.
Mint grown on red clay pot with red clay lid.

Painting the rims of the buried clay pots or pots with white paint makes them easier to see and will reduce water evaporation. The body of the buried clay pot can also be partially painted to reduce water use. Paints should not include potentially harmful materials such as lead or cadmium.

If pots are made the clay should not be fired much above 1000°C or the porosity will be limited. Adding more grog (ground old ceramic) to the mix will also increase porosity.

2. Prepare the planting hole

Dig a planting hole about three times as wide and two times as deep as the clay pot. Use a fork to break up soil at the bottom of the hole. Break up clods in the soil that has been removed and mix in 1/3 compost or aged manure and fertilizers as needed. In very heavy soil mix you may wish to add some sand, in saline or alkaline soil gypsum may improve soil characteristics.

3. Place the buried clay pot

Place and firm sufficient soil mix in the hole so that the top of the buried clay pot will be 2 cm [1 inch] above the surface of the surrounding soil. Then set the buried clay pot in place and fill the
space around it with the soil mix and gently firm it. Fill the buried clay pot with water and put on the cover.

4. Planting seeds, cuttings or plants

The seeds, cuttings or plants can then be planted. A small amount of water should be added to the seed spot or transplant to help wet the soil and establish capillary action from the buried clay pot. The seeds or plants should be placed within 1-2 cm [1/2-3/4 inch] of the edge of the buried clay pot in most soils. It is helpful to leave a space between plants on one side of the buried clay pot to make it easier to lift the lid and refill the pot as the plants grow larger.

The spacing of the clay pots depends on the crop and size of the pot. In general they will be 6-3 m [9 feet] apart for vine crops and 1-1.5 m [3-5 feet] apart for corn and other plants that grow up more than out.

A double clay pot can be set up specifically for propagating cuttings. A sealed pot is set inside a larger pot with open drain. The space between is filled with sandy potting mix. The cuttings are kept moist – but still get oxygen. Ideal for many species, this works very well with willows and cottonwood.

5. Watering

Fill the buried clay pot regularly and try to keep it from becoming completely dry. This may require refilling every 2-3 days for small pots or perhaps only once every week for larger ones. This may vary over the growing season.

It is also possible to hook buried clay pots up to a drip system or float fill valve to keep them full automatically.
What crops are suitable?

Buried clay pot irrigation has been successfully used for a wide range of annual and perennial plants including: melons, tomatoes, corn, and many other annual crops in China, Pakistan, India, Mexico, and Brazil; pistachio trees in Iran, mesquite, acacia, and eucalyptus in Pakistan, fruit trees in Mexico, India, and Brazil, and palo verde in the California desert.

In our test gardens in California, Arizona, and New Mexico and research we have found that the following plants are very compatible with clay pot irrigation. The more we try, the more we find like buried clay pot irrigation.

- Basil
- Beans
- Cilantro
- Corn
- Chiles
- Chiltepines
- Cucumbers
- Garlic
- Marigolds
- Melons
- Mints
- Onions
- Peas
- Poppies
- Potatoes
- Rosemary
- Squash (Bush type)
- Sunflowers
- Tomatoes
- Tomatillos

Few plants have not done well, but fast growing spreading squash and melon vines with big leaves have not been able to get enough water in some situations. The constant soil moisture has also led to disease problems with sensitive species in some gardens when rains added too much extra moisture to the garden.

Why not intercrop?

The Fan Sheng-chih Shu describes intercropping with buried clay pots. This ancient text recommends planting 10 scallions around the buried clay pot with four melon seeds. The scallions should be harvested at the 5th month as the melons begin to ripen. Lesser beans can also be planted in with the melons and scallions with bean leaves sold as greens.

Many other intercrops, including the traditional corn, bean, squash intercrop should work well with buried clay pots.

What about saline soils?

The stable soil moisture maintained by buried clay pot irrigation enables crops to be grown in saline soil or with saline water where conventional irrigation would not work. Crops have been grown in soil with pH of 10.5. High tomato yields, 27 tons/ha, were obtained in India using saline irrigation water, EC 10.2 mmhos/cm, while typical yields in this area with fresh water, EC 0.4, are only 15-25 tons. Buried clay pot irrigation moved salt out of the plant root zone better than drip irrigation in one scientific test.

Clay pots fired at very low temperature may break up in very saline soil as a result of chemical reactions with the salts.

Why not trees?

Buried clay pot irrigation is recommended for dry orcharding in India and has proved to be very useful in tree establishment and revegetation. In Pakistan the survival of tree seedlings irrigated with buried clay pots was 96.5% compared to 62% for hand watering and the buried clay pot irrigated seedlings were 20% taller.

Our trials of buried clay pot irrigation in the Colorado Desert near the Salton Sea suggest they have great potential for revegetation and orchards in the desert. After eight months all tree
seedlings on buried clay pots in one trial were alive and growing well, while all of the trees irrigated with the same amount of water using basin irrigation had died.

Eight inch clay pots were used for this study in an area that receives less than 1.5 cm [3 in.] of rain a year. The pots were refilled every two to four weeks. After 8 months one of the plants was dug up to examine root distribution. Although several roots were wrapped around the pot two dominant tap roots went straight down to considerable depth.

After the pots were removed survival has remained good, suggesting that buried clay pot irrigation develops a sufficient root system for long term survival of desert trees. The clay pot only needs to be filled regularly for the first year and can then be removed. For fruit trees a permanent installation is recommended.

![A palo verde tree seedling on a buried clay pot. Rim painted wide to reduce evaporation losses.](image)

**Are there any drawbacks?**

The drawbacks of buried clay pots include the cost of the clay pots, the energy required to make them, the time to install them, and limited flexibility once they are installed. However, a study in India found that 800 buried clay pots per hectare provided a substantial net profit even after paying for the clay pots. Where water costs are high (due to labor or pumping cost) or where water supplies are limited the returns are even better. The pots may clog over time and require scrubbing and soaking or re-firing to clean out the pores.

**Acknowledgments**

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Thomas-Manuel Stein has done some recent work with clay pot irrigation and it is worth reviewing his irrigation resource center, www.sakia.org. An excellent thesis was recently done in Africa on the use of clay pot irrigation and interest is growing in better understanding and using buried clay pot irrigation.

A special debt of gratitude is acknowledged to the Indian and Pakistani scientists who have contributed so much to our understanding of buried clay pot irrigation. Dr. R.C. Mondal deserves
special credit for his pioneering work in studying and publicizing this excellent traditional method of irrigation.

*The goal -- To grow four ears of corn where one grew before (with only ½ as much water)*

The Canelo Project was established in 1989 to develop, study, and publicize strategies for sustainable development in the Southwest. The Canelo Project is a 501C3 non-profit organization and tax deductible contributions are welcomed to support this type of research. Research and education for people and the environment.

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Further reading


