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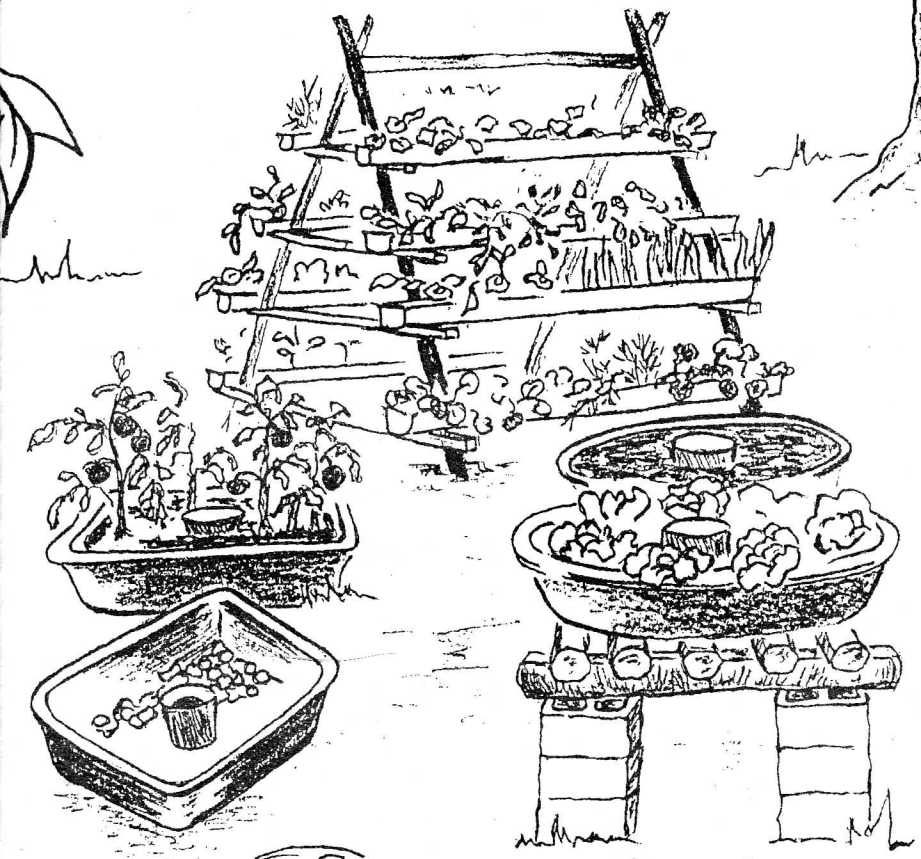
# Shallow Bed Gardening



a Gardening Hint from

ECHO

Educational Concerns for Hunger Organization

# *SHALLOW BED GARDENING*

*By Martin L. Price, Ph.D.*

*Revised May 1993*

## How Did ECHO Become Interested In Shallow Bed Gardening?

One of ECHO's purposes is to help people grow food under difficult conditions. You are not likely to encounter a worse soil for gardening than a cement slab. Neither will you find such large areas of unused growing space in full sun and near prime markets as on cement rooftops in the world's cities.

The most expensive agricultural land is always that located near large markets. If there were large areas of unused flat land right in the middle of huge population centers, the potential value for producing vegetables would be obvious. How many acres of unused flat rooftops do you suppose there are in a typical city?

For the past nine years ECHO has been working on methods for gardening on rooftops. Most of this work has been designed for Third World applications. In 1993 ECHO began assisting Russian gardeners with rooftop gardens (**RTG's**) in Moscow and St. Petersburg. It turns out that cement slabs are not nearly as difficult a challenge for gardening as one might think. In fact, they have become one of my favorite gardening spots. They offer an enormous and almost untapped opportunity for ministry to urban populations.

Applications are not limited to rooftops. To emphasize this point, we now call the rooftop gardening techniques described in the gardening hint series by the more general term "above ground gardens." Any situation where good soil is not available can use these techniques. There are many applications in certain rural settings as well.

Because we had in mind individuals and institutions with extremely limited financial resources, we established the following technical guidelines:

(1) The gardens must not be made of imported materials.
(2) They must be inexpensive; approaching no cost at all.
(3) They must have a very low-weight per square foot of growing area.

(4) They should obtain satisfactory production with minimal inputs; rather than maximum possible production with high inputs.
(5) No instruments or analyses should be needed.

## Applications To Gardeners In The United States

*An ECHO intern stands by corn grown in a 7-inch bed on a cement slab.*

We are always delighted when an innovation developed for impoverished people in the Third World has an important use in our own country. The shallow bed garden certainly falls into this category. Any flat cement slab can be easily turned into a garden, whether it be a rooftop, driveway, sidewalk, top of a cistern, or a section of a parking lot.

Uses are not limited to cement slabs. A simple platform with a shallow bed makes gardening available to people with physical handicaps, such as back or knee injuries, that prevent them from working in the soil. If placed at the right height, people in wheel chairs can garden easily.

Because the gardens are lightweight, the platform does not need to be especially designed and expensive. We have built some by placing four posts in the ground, attaching a 2x6 board across each end at the desired height, then placing 2x4's lengthwise resting on those end boards. Even sides are not usually needed but are desirable if cost is not overly important.

In another case, we used an old, steel gate. We made four pillars and rested the gate on them. Each pillar was made out of three cement

blocks placed on top of each other. Plywood was then placed on top of the gate. To lessen the rate of decay of the plywood, we covered it with a sheet of plastic. Then we built sides with 1x3 boards and added the growing medium.

A third option is to make the platform from landscaping timbers resting on four pillars of cement blocks. This requires no tools except for a shovel to prepare a base for the blocks and a saw to cut one of the eight foot timbers in two. The two, 4-foot timbers are placed on top of the blocks. The bed is made by placing the ends of the 8-foot timbers on the shorter pieces. Cover with a sheet of plastic and sides if desired.

*These are shallow beds constructed as platform gardens. They are convenient to work with and a great help to those with physical disabilities.*

I find these platform gardens to be convenient. I do not need to stoop down to garden. And the plants are at the ideal level for noticing problems of insects or disease. Many people who think they are unable to garden would be able to garden again in these beds!

If you wish to garden where tree roots fill the soil, simply cover the soil with a sheet of plastic and make a shallow bed on top. Tree roots are not

damaged by tillage; the plastic prevents the roots from interfering with the vegetables; and many plants benefit from light shade.

If you have a farm with free-range chickens or a low spot in the yard where water sometimes stands, consider one of these gardens. I just returned from a trip to the Amazon basin in Brazil. Nearly all the gardens were based on this method which was not a result of ECHO's work. Brazilians have done it that way for centuries. Plants never get too much water and chickens seldom fly up into the garden.

## How To Make A Shallow Bed Garden

If you have enough compost or bags of potting mix to make a 3 inch, deep bed, this technique is very straightforward and most of the discussion later in this bulletin will not be needed. Fill the bed and start planting. A 3 x 4 foot bed will require about 2-1/2 bushels of compost 3 inches deep. You might prefer to make your own mix with purchased materials.

If you find the following a bit complex, and wish for more precise directions for amounts, times, etc., remember two things. (1) Much of our discussion deals with how to start a garden in fresh organic material if you do not have compost. (2) The inexpensive raw materials available for making the garden differ from place to place, and the techniques used, vary depending upon what materials are used.

In the following discussion I share enough information so that you will be able to do your own trials for a season or two and do some problem solving. Once you have settled on the materials for garden construction, the available fertilizers, and the vegetables to be grown, you will be able to develop straightforward, detailed instructions for your unique system of shallow bed gardening.

## Shape Of The Shallow Bed Garden

Like most people, when I first began thinking of gardening on rooftops I envisioned gardening in rather deep containers. Container gardens, however, can be heavy and moderately expensive. If they are too small, larger vegetable plants may grow but give little produce.

Our first model garden consisted of a 3 foot deep bed of wood chips; wood chips are much lighter than soil. We got the idea from local nurseries. They sell to apartment dwellers half-bushel, bean hampers filled with wood chips. Each hamper contains a single tomato plant to be grown on a balcony. Gardeners are instructed to pour water containing a soluble fertilizer over the plant each day. The hampers work well and the taste of the tomatoes is exceptional.

Our deep garden used large amounts of fertilizer. A very important point to remember in working with organic matter that has not yet decomposed, is that the microorganisms that cause organic matter to decay use the same fertilizer elements as do plants. This becomes a special problem if, as is the case with wood chips, the material itself is low in nutrients. The decay process can use up the nutrients, leaving the plants anemic. These nutrients are not permanently lost. They will become available months later when the bed has been transformed into compost. Some plants thrived, others always showed nutrient deficiencies.

After several trials, we discovered that beds only 3 inches deep were not only lighter in weight, but also gave better results with less fertilizer. After several years of growing gardens in shallow beds, I would now describe the ideal RTG as being 4 to 5 feet wide and only a few inches deep. The ability of vegetables to grow in shallow beds should not have surprised us. Greenhouse tomatoes, lettuce and cucumbers are often grown hydroponically in long, rectangular bags 6 to 12 inches wide and a couple inches high that are filled with planting mix. Plants thrive even with such a small, root volume because just the right amount of water containing a soluble fertilizer is continually dripped into the medium.

Roots do not require much volume when there is plenty of water and nutrients. Why do roots normally cover a much larger volume? When watering is sporadic, a large volume of soil, with roots throughout, is required to hold enough water to keep the plant supplied between waterings. The primary question about shallow bed thickness comes

down to this: How often are you prepared to water?

Often people wrongly assume that only shallow-rooted plants will thrive in a shallow bed. Except for tubers where the edible part exceeds the size of the bed, we have not found this to be true. Although a shallow-rooted plant cannot take advantage of a deep bed, the roots will not reach the bottom, a deep-rooted plant can adapt to take advantage of the space in a wide but shallow container.

## The Question Of Weight

We have placed great emphasis on developing very light-weight beds. Hence we usually chose a depth of only 3 inches and use no soil.

Individual soil particles typically weigh approximately 2.75 times as much as an equal volume of water. There are spaces between the tiny soil particles, however, which can account for up to 50% of the volume of a good garden soil. It is the worst case (heaviest) that concerns us in considering any possible danger to the roof, so we will consider the weight after a drenching rain and assume that every space is filled with water. Such saturated soil weighs 1.9 times as much as an equal volume of water.

Individual particles of organic matter typically weigh slightly more than water (1.1 to 1.4 times) and the spaces between them are much more than 50% of volume. The worse case would be a totally flooded bed of fully

**Table I. Maximum Weights of Four RTG's**

| Depth | Weight | |
|---|---|---|
| | well decomposed organic matter | good garden soil |
| 3 inches (430 kg) | 598 lbs (272 kg) | 947 lbs |
| 8 inches | 1,595 lbs (725 kg) | 2,552 lbs |

decayed, compact organic matter, with the weight being at most 1.2 times that of water. In most cases, the weight will be almost the same as an equal volume of water.The weight can still be considerable. Table I compares the weight of a 3 and an 8 inch, deep bed that is 4 feet wide and 8 feet long (7.6 x 122 x 244 cm). One uses soil and the other uses well decomposed organic matter; both fully saturated with water.

If cement block sides were used, the weight would be considerably greater. Based on what I have seen in Haiti, we have been more cautious than necessary. As you can see in the picture below, the Lahrs use concrete blocks for sides (ECHO uses no sides) and depths equal to the 8 inches of the blocks. No problems have been reported although I saw perhaps half-a-dozen gardens. If there is any doubt about safety, remember to put the heaviest items, like a barrel of water, directly over walls.

*Missionary Pat Lahr is in his productive garden above his home in Port-au-Prince, Haiti.*

It might be wise to ask an engineer his/her advice if you plan many beds. In St. Petersburg, Russia, the city engineer told me, "These roofs are designed to carry the heaviest snowfall of a century." The shallow bed garden is nothing in comparison with this.

For less sturdy structures where weight is a serious consideration, the weight of the wick and shallow pool gardens can be almost insignificant. They can be placed on the outer edge of the rooftop so that people will not need to walk on the roof. Bulletins on these two techniques are available from ECHO.

## Materials For The Shallow Bed Garden

No material serves better for making a shallow bed than quality compost -- if you have it. Because compost is always in short supply, we need to consider alternatives. In the methods that follow, you are actually growing in a small compost pile while the compost is forming!

If compost is not available, I use a mix of undecayed, organic matter. The choice depends mostly on what is being thrown away in your area. We have used wood chips because they are free from the electric company after they trim along the power lines. Our favorite material is grass clippings. Contractors who mow lawns for homeowners would much rather give ECHO their load of grass clippings than pay the county landfill to take them. We have also used corn cobs and weeds. Barbara Daniels in California, who developed a similar method of RTG's independently, prefers a mixture of tree leaves. Perhaps the best results may come from a mixture of materials, which can include weeds.

Waste materials in your yard, or in the Third World, will likely be different but equally useful. Sawdust would be my last choice. It will use up fertilizer even faster than wood chips and can easily become waterlogged.

No matter what organic material you use, after one or two growing seasons it will have decomposed into a beautiful compost.

The beds do not need to contain organic matter as long as the material

is fine enough to hold sufficient water. For example, gravel has been used in various hydroponic systems for years. Non-organic media have an initial advantage in that the lack of decomposition means that only the plants, not the decaying bed, are using up your fertilizer. In the long run though, non-organic beds are more fickle. A sudden imbalance in nutrients or swing in pH, acidity or alkalinity, can more easily develop.

Organic matter, even if only partially decayed, acts as a buffer to prevent extremes. This happens because after a few weeks, nutrients begin to be released from the decaying material. If the plants need more of a particular nutrient than your solution is supplying, the bed itself provides a certain amount of it. Conversely, organic material is able to absorb, for later release, some of the excess nutrient you might add. It also resists changes in pH.

Experiment with mixtures. When possible, if compost is not available, use a mixture of materials. Mixtures are especially good because you have more flexibility to create the kind of environment that roots like. It also lets you use common garbage items. One of our more interesting beds is made of approximately 60% by volume crushed cola cans. The other 40% is grass clippings, soon to turn to compost, mixed between and placed on top of the cans. This made an exceptionally lightweight bed considering its depth.

A 2 to 5-inch layer of weeds packed closely together on the bottom and covered with perhaps a couple inches of grass clippings or, even better, compost from a previous bed works well. The 6 to 8 inch, deep bed for corn was made in this way. See photo on Page 2. A benefit to placing weeds on the bottom, rather than grass clippings, is that there are more air spaces between the weeds, which is better for the roots.

## Constructing The Shallow Bed

An important factor that makes these beds inexpensive is that no container is necessary. Depending on the material used, sides may not even be needed, especially if a mulch is placed on top of the bed. We only use sides for platform gardens or where appearance is important. We have had a lot of heavy rains and strong winds over the years. The only bed that gave us erosion problems was one in which we used a

large amount of silt from the bottom of a fish pond.

The shape of a shallow bed is determined by the same considerations that one uses in making a raised bed. They can be of any length, but a break for a path every 8 to 12 feet is helpful. They should be just wide enough ,4 to 5 feet, that a person can reach to the middle of the bed. Thought should also be given to maximum use of space. A path down the length of the rooftop with beds and aisles going off to either side is probably the most efficient.

If a sheet of plastic is available, use it for a base. Experience may later show this is unnecessary, but we believe it may minimize discoloration and slow any possible seepage into cracks that might exist. If the bed is on top of a wood base, the plastic will minimize decay of the wood. No doubt it will always be wet under the plastic, but that is less of a worry than a considerable supply of water in direct contact with the roof.

When grass clippings are used, we leave them in large piles until needed. It is best to let them decompose in a pile for at least a few weeks because the high temperatures in the piles allow much of the composting process to take place there rather than in the garden. Also, we believe (no data) that most pesticides that might have been on or in the grass clippings are destroyed during this time as well.

If the pile of grass clippings is not too old, the contents will be fluffy and moldy. Be careful breathing the dust. I have developed quite an allergy to it, though none of my staff are affected. Start with a pile high enough to allow for shrinkage during the initial preparation and continuing as the bed decays.

Thoroughly wet the pile. Often the clippings do not want to absorb water -- even after adding a lot of water, the clippings 1/2 inch deep may be dry. When this happens, add a couple tablespoons full of laundry detergent, any variety, to the watering can and pour evenly over the surface. Detergents fall under a class of compounds known scientifically as wetting agents or surfactants, surface-active-agents. They help water adhere to surfaces.

While adding water, if the clippings are fluffy, walk over the bed and

stomp down the grass as much as possible. If the bed is made of other materials that do not need to be compressed, such as wood chips, rice hulls, or dense clumps of grass clippings that have spent several months in a pile, the materials are simply placed in the bed, wet down with detergent solution, and fertilized.

Next cover the new bed with an inch or more of compost or any potting mix. Then fertilize and plant.

Remember that compost is the ideal medium. We are using these other materials only because we lack enough compost.

Finally we add an ordinary garden fertilizer and dolomitic limestone. If it is 10/10/10 fertilizer, we add 5 pounds per 100 square feet. The numbers refer to the percent of nitrogen, phosphorous and potassium, respectively. If it is 5/5/5, we add twice that amount, etc. Neither the exact numbers nor the exact amounts are that important.

There are many other fertilizer formulations on the market. You might only be able to get something like 8/6/10, for example. Don't worry about it. Just avoid extremes like 36/10/10 used for lawns or something like 10/0/10 which would be a special purpose formulation lacking in phosphorous.

We always use fertilizer with micronutrients, elements needed only in minor amounts. If you cannot find that kind of fertilizer, the micronutrients that will soon be released by the decaying organic material may be sufficient. One can often buy micronutrient formulations separately. These would be used in small amounts, following directions for a regular garden. Added micronutrients are a must with any system that is not based on organic matter. **A quick way of providing these micronutrients, if they are not contained in the fertilizer, is to apply some manure or manure tea. The tea is made by soaking a bag of manure in a barrel of water for a couple weeks.**

I like to have one of the popular soluble fertilizers available, like Miracle

Grow. Because these are more expensive than garden fertilizer, I use them only as supplements. At the first sign of any possible deficiency I pour a solution of 1 tablespoon per gallon right over the leaves. You can do this as often as needed. Soluble fertilizers have the major and micronutrients, but usually lack the calcium and magnesium that are needed in intermediate amounts. They leave them out because they tend to make the other nutrients less soluble.

If you cannot find dolomitic limestone, dolomite, I doubt if it will matter too much as long as some of the organic matter has begun to decay. Add regular limestone instead. The main function of the dolomite is not to control acidity which has never been a problem for us, but as a source of the two minor nutrients: calcium and magnesium. Ordinary limestone adds calcium. Dolomite adds both calcium and magnesium. A commonly available, alternative source for concentrated magnesium is epsom salts.

Whether you use fertilizer, manure or manure tea depends on your location and philosophy. In many urban situations it is easier to obtain fertilizer than manure. The response of plants to manure depends upon the age of the manure, the animals' diet, and on the kind of animal. Goat manure is reportedly one of the best manures for hydroponic systems. This may be because goats are browsers, eating a little from many kinds of plants each day. Consequently their manure has a composite of nutrients found in a wide variety of plants.

## Planting In The New Bed

Planting seeds or transplants into shallow bed gardens is done as in any other garden if you made the bed of compost or potting mix, or if you covered a bed of fresh organic material with an inch or two of the mix.

Planting directly into beds of organic material that has not yet decomposed requires some special techniques. Larger seeds like peas or beans can usually be planted directly. This can be done only if the medium is made of a material that packs closely enough together to remain moist most of the day and make close contact with the seed to keep it wet. Seeds must be deep enough into the medium to remain moist but shallow enough to be able to grow to the surface after

germination. The top inch or so of many materials, such as nearly fresh grass clippings, tend to dry out. In such situations you may need to water a few times each day until they germinate. We have also had the opposite problem with older, matted grass clippings which stayed too wet.

Smaller seeds, like carrots, require compost, soil or something of very similar texture to get started.

If you cannot cover the entire bed, just form a 1 to 2 inch, deep trench in the packed down grass clippings, fill it with compost or soil, and plant in this trench. Even this small amount of compost will provide an environment for the seed and initial roots that is just like they would experience in any garden.

Transplanting likewise can demand special care if the medium is not similar in texture to soil. We often make a small hole, insert the transplant, and fill in around it with several handfuls of compost or soil.

Keep a close watch on the appearance of the vegetables. At the first sign of nutrient deficiency, add a bit more fertilizer. With high nitrogen materials like grass clippings, this may only need to be done once or twice, or not at all. With low nitrogen materials like wood chips it will be necessary to add fertilizer frequently.

A small amount of solid fertilizer can be sprinkled around the plants, taking care not to get it in direct contact with leaves or stems. Our best wood chip gardens were grown by watering every other day with a solution of soluble fertilizer or manure tea. Most soluble fertilizers are made to pour directly on the leaves because some nutrients can be absorbed through the leaves of some plants. This is especially helpful if a deficiency has already appeared.

## Refurbishing The Shallow Bed -- Subsequent Seasons

If you had to use fresh organic material, you may be surprised at two

things: (1) how quickly the depth of the bed drops as the material turns to compost and (2) how quickly a beautiful compost is formed.

Because there is no soil in the beds, the material turns deep black and may eventually look like peat. The bed must be refurbished after harvest whenever it has shrunk to less than the desired depth or has become so dense that it holds too much water. Alternatively, the bed can be recycled; the compost can be used as the top layer in constructing new beds.

If the bed is still deep enough for another growing season, all that may be necessary is to apply fertilizer. The bed should not need as much as when it was new. Much of the bed, depending on its original composition, has now been converted to compost. This is not a delicate system, like hydroponics, with exacting fertilizer requirements. I trust that any frustration at not finding rigorous details on the amount of fertilizer, will be more than compensated by having a bed that allows some flexibility. More fertilizer will be needed if you have heavy rains that leach away nutrients.

Watch your plants for clues as to what they may need.

A bed of compost contains a lot of nutrients, but they are released slowly day-by-day. Several days of heavy rain can leach away those nutrients which have been released. The plants may begin to show nutrient deficiencies until more decay and release of nutrients can replenish the supply. In such cases it is good to supplement with fertilizer.

The task of refurbishing is much easier than making the original bed, because we are now starting with a considerable amount of compost. Rather than layering new organic material, such as grass clippings, on top of the bed, it is best to remove the composted material, layer the desired material onto the empty bed, and then place the remains of the old bed back on top of the new material. We add some fertilizer, perhaps a bit less than with a totally new bed, and water.

There are two reasons for placing the newer, not-yet-composted organic material on the bottom. First, the older, composted material is ideal for planting seeds or making transplants, while the roots will grow just fine into the newer material. Second, sometimes the old material becomes very dense and holds too much water. By placing it on top of the more coarse new material, there will always be air spaces for the roots.

## What Plants Will Grow In A Shallow Bed?

We have had success with a wide variety of vegetables: amaranth, broccoli, cabbage, cow peas, corn, eggplant, cucumber, green beans, herbs (rosemary, tarragon, basil, sage, mints, chives), kale, kohlrabi, lettuce, okra, onions, quail grass, radishes, sugar snap peas, tomatoes, winged beans and a variety of flowers.

It is easier to say what crops may give problems. We stay away from very **large vines**, such as pumpkins, jicama or sweet potatoes, that have such a large leaf area that they would quickly deplete the reserve of water in the shallow bed. However, with sufficient volume, either a deeper bed or fewer plants in a bed, or more frequent watering, there should be no problem growing vines such as pumpkin or watermelon, letting them flow over the side of the building.

Root crops require deeper beds. We have grown acceptable carrots in grass clippings, but had to make the bed about 8 inches deep. It shrank so much during the growing season that the carrots stuck out of the top by at least an inch. One time we got L-shaped carrots because we planted them in a bed that was too shallow. Carrots grown in wood chip beds were distorted because of the twists and turns the tap root had to make to avoid wood chips.

## Conclusion

If you keep a constant supply of water and nutrients, most vegetables will grow in a 3 inch deep bed. If weight and cost of materials is not a problem, you can make two or three times as deep a bed. The advantage is that you will not need to water it as often. The main disadvantage of the very shallow bed is that you cannot go away and leave it for some days without watering. If you will give it daily care, or make it deeper

for less frequent care, I am almost sure you will succeed.

Think creatively about how the shallow bed technique might enhance your own gardening options, whether it be on a rooftop or other applications. But also consider whether there might be some opportunities to reach out with your newfound skill. Perhaps there is a one-time gardener that could garden again if you made a platform garden for him/her. Drop us a note, maybe even send a picture, about your success or problems with your shallow bed gardens, and any special uses or ministries you found for them.

**Happy gardening!**

# The ECHO Garden Hint Series

A collection of publications designed to share some of ECHO's innovative gardening techniques.

*Shallow Bed Gardening

*Hill Culture

*Using Cola Cans in Your Soil Mix

*Growing Wick Gardens

*The Wading Pool Garden

*The Eave Trough Garden

*The No-Till Garden




**ECHO is a non- profit interdenominational, Christian organization dedicated to the fight against world hunger. We accomplish this by providing consultation, agricultural information, and seeds to those working in the Third World with peasant farmers or urban gardeners. ECHO receives no government help and depends upon public donations to carry on its work.**

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