

## The Oklahoma Cooperative Extension Service WE ARE OKLAHOMA

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education

for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.

- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.



## EXTENSION

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### Vertical Hydroponics

Hydroponics is a method of growing plants without soil in a horizontal or vertical fashion, where mineral nutrients are provided through the water. Hydroponic systems that allow growing of plants in a vertical fashion are known as vertical hydroponics. Vertical hydroponics works by using conventional hydroponic techniques in a vertical, gravity fed system. The nutrient-rich water is fed from the top and collected at the bottom. Vertical hydroponics has various advantages over traditional crop production methods including:

- Allows for high density yield per unit area.
- Good for small sunny places like balconies, patios and rooftops.
- It allows year around production inside.
- It often can provide more than 90 percent efficiency in water use.
- No soil-borne diseases.

### Tower Garden

A tower garden, also called a window farm is a system of vertical hydroponics, which includes an A-Frame hydroponic system, hydroponic wall and cascades of bottles. It can be used for growing various crops like strawberry, lettuce, Swiss chard, herbs, spinach, kale, broccoli and flowering petunia. There are various online sources to get these systems, which can cost around \$500 or more, but you can build your own tower garden for much less. It can also be used for growing plants indoors if lights are provided above the tower, which is popular in urban areas with only a small space for gardening. The tower garden design described here can hold 28 plants per tower and two towers can be placed in a 5-foot x 5-foot space, producing 56 plants at one time (Figure 1). The design can be modified according to preference. For example, towers can be hung from the top and can drain to a single tank to collect the nutrient solution. Materials listed below can be found at a hardware store, except the net pots which can be purchased from hydroponic dealers or online. If tower material is modified, make sure to use food grade material.

### Material required

1. One white vinyl fence post 5 inches x 5 inches x 8 feet
2. Two white vinyl pyramid post tops
3. One 45-gallon tank

## Building a Vertical Hydroponic Tower

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Oklahoma Cooperative Extension Fact Sheets are also available on our website at: [extension.okstate.edu](http://extension.okstate.edu)



Figure 1. Vertical towers holding 56 plants.

4. A plastic sheet for preparing a lid for the tank, which provides support to the tower and should be opaque to avoid growth of algae.
5. 3-inch PVC pipe (10 feet)
6. Submersible pump (400 gallons per hour) with attachments
7. Light timer
8. 5/8-inch x 5/8-inch x 8-foot white vinyl blind stop molding - cut into 12 4-inch pieces.
9. Spray adhesive
10. PVC epoxy
11. 28 3-inch net pots
12. One silver 1-inch narrow utility hinge
13. Two brass 1 1/2-inch narrow utility hinges

14. Eight #6 32-inch x 3/8-inch machine screws with nuts
15. Clear silicone for aquariums
16. 1/2-inch nylon hose barb tee
17. 10-foot length vinyl hose inner diameter 1/2 inch - outer diameter - 3/4 inch
18. 4-inch x 24-inch aluminum pipe for dryer vents
19. Medium grit sandpaper

#### Tools needed

- Miter saw  
Tape measure  
Ruler  
Drill  
Various drill bits :
- 1/2-inch for cut out pilot hole and also for tee barb
  - 5/32-inch hole for hinges
  - 1/8-inch holes for water tray
- Jig saw with fine blade  
Soldering iron  
Two U clamps (1/4-inch x 3/4-inch x 2-1/2-inches)

#### Steps for building tower

1. Take a white vinyl fence post 5-inch x 5-inch x 8-foot and cut according to the height wanted for the tower. The recommended height for a vertical towers is 5 to 6 feet, which is easily accessible by most people.
2. Drill a hole in the plastic sheet used to prepare the lid to allow the fence post (tower) through it using the square template listed under template links on the last page.
3. Place the net pot hole template on the tower at the spacing according to the crop to be grown in the tower. Stagger the holes on each side so the pots do not touch each other inside the tower.
4. Paste the pot hole template on the fence post using adhesive.
5. Drill a hole at one end of the template so the jig saw can work.
6. Using the jig saw, cut a pot hole of the same size as the template.
7. Take a 3-inch PVC pipe and cut at a 45-degree angle with a height of 2.25-inches. This will prepare the net pot support (Figure 2). This is suitable for 3-inch net pots, but if net pot size is changed in the tower, then the pot hole size and net pot support will need to be modified.
8. Make a rectangular cut at the bottom of the tower using a template for the holes at the bottom of the tower. This will allow the water supplied from the top to exit.



**Figure 2. Net pot support.**

9. Place the net pot holder on the bottom of the net pot hole on the tower. Rub the area with sand paper where the net pot holder needs to be glued. Use the PVC epoxy on the edge of the net pot holder and place it on the bottom of net pot hole with some weight on it and let it set for two to three hours. Fix all the net pot holders throughout the length of the tower.
10. Prepare the top of the tower by using two white vinyl pyramid post tops. Drill a 1/2-inch hole through the center of the top and pass a 1/2-inch tee barb to supply nutrient solution to the tower.
11. Use the other white vinyl pyramid post top to drill the holes on all sides to distribute nutrient solution throughout the tower. Approximately 10 random holes should be drilled (Figure 3).
12. Attach both white vinyl pyramid post tops by using the hinge. On the opposite side, attach the top with holes to the tower using the other hinge and cover the screws with clear silicone for aquariums to avoid corrosion (Figure 4).
13. Take a 5/8-inch x 5/8-inch x 8-foot white vinyl blind stop molding and cut into 12 4-inch pieces. Rub the side of this piece with sand paper, which needs to be attach inside of the tower. Also, rub the inside of tower above each net

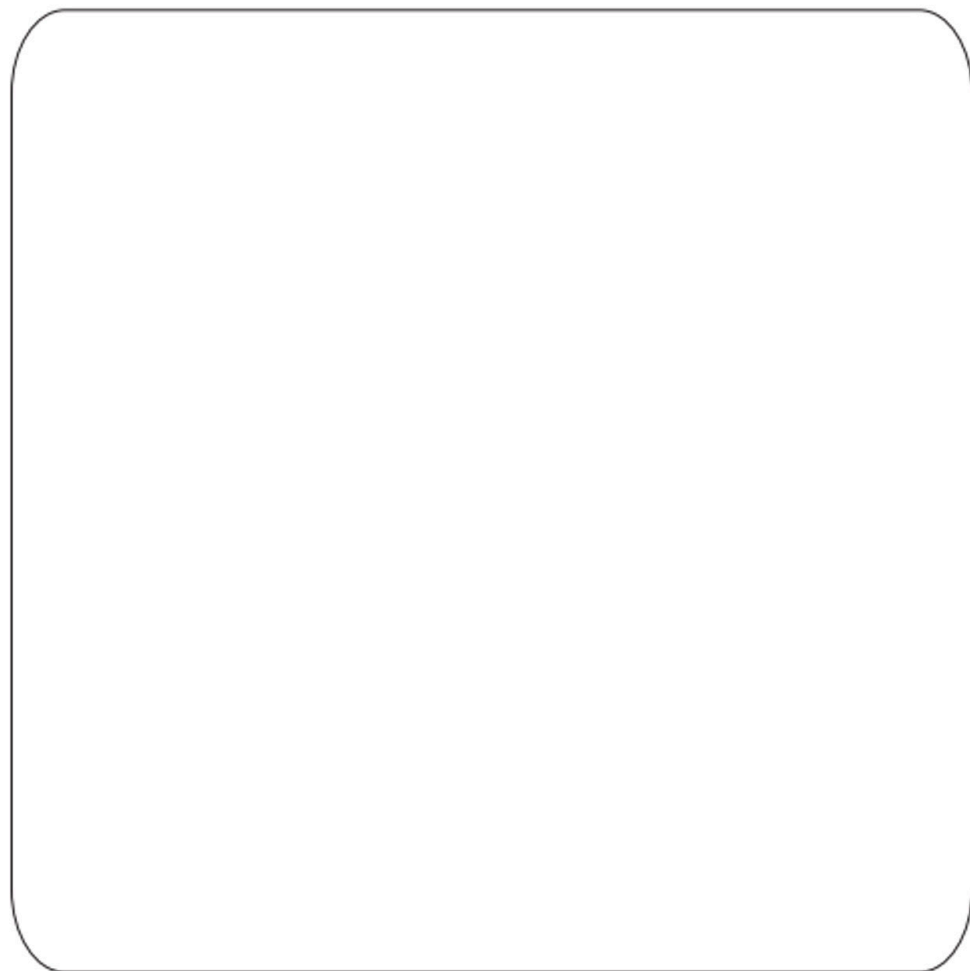


**Figure 3. Vinyl pyramid post top with holes.**

**Table 1. Spacing for different crops grown in a vertical hydroponic tower.**

<i>Crop</i>	<i>Spacing (inches)</i>
Strawberry	12
Thin leaf lettuce	6-8
Head lettuce	12
Swiss chard	12-14
Spinach	12
Kale	12
Broccoli	18





Square tower template for the reservoir cover.



Figure 4. Both white vinyl pyramid post tops attached to tower.

pot hole. Apply PVC epoxy on the rubbed edge and place it inside the tower. This will help in proper distribution of the nutrient solution through the tower.

14. Place the net pot in a net pot hole and mark the edges, which touch the top of the net pot hole. Melt this area with a soldering iron. This will prevent flow of water along the edge of pot outside of the tower and also facilitate easy placement of the pot into the hole.
15. On the covering of the reservoir, cut out a piece to make a small lid that is attached by a hinge. Apply clear silicone for aquariums to avoid the corrosion of the screws. This will facilitate adding of nutrient solution to the reservoir and pH/EC monitoring.
16. Drill another hole in the covering of reservoir to pass a nutrient supply hose in the center of both towers.
17. Place a submersible pump in the center of the reservoir and attach the nutrient supply hose to the outlet of the pump.
18. Place a T barb on the nutrient supply hose at the same height as the tower to supply nutrient solution to both towers.
19. Place a timer to turn the pump on and off. The intervals for watering may depend on type of crop grown in the tower. For example, watering for lettuce can be continuous for 24 hours, while for strawberries, the recommended watering is seven to 10 times per day for one hour.
20. Place the net pot into a net pot hole, place some expanded clay balls or other media into it, and place the plant over these balls. Also, fill clay balls around the plant (Figure 5).
21. Start the pump. If you see the water splashing out of the pot, it may wet the leaves of plants. This can lead to fungal diseases and may cause death of the plant. To avoid this, take an aluminum sheet and cut a shield of the same size as the template for the water splash shield given at the

end using the link listed under the template on the last page. Stick this shield near the pot hole opening above the clay balls (Figure 6). This keeps the plant from being splashed from the nutrient solution.

22. Provide a support to the tower from the top using some wire or a bar.

#### Post preparation care

Avoid water leakage.

Clean tower with bleach after each round of crop.

Monitoring of pH and EC for solution according to crop grown.

Water level in tank should be maintained.

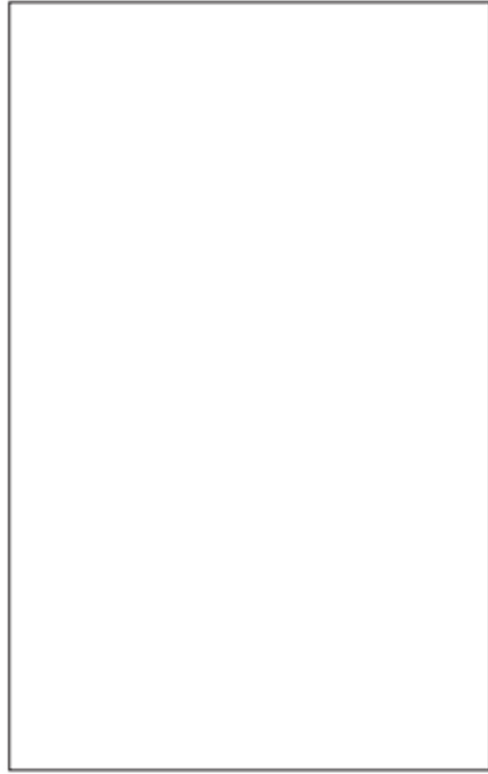
See fact sheet HLA-6722, "Electrical Conductivity and pH Guide for Hydroponics."



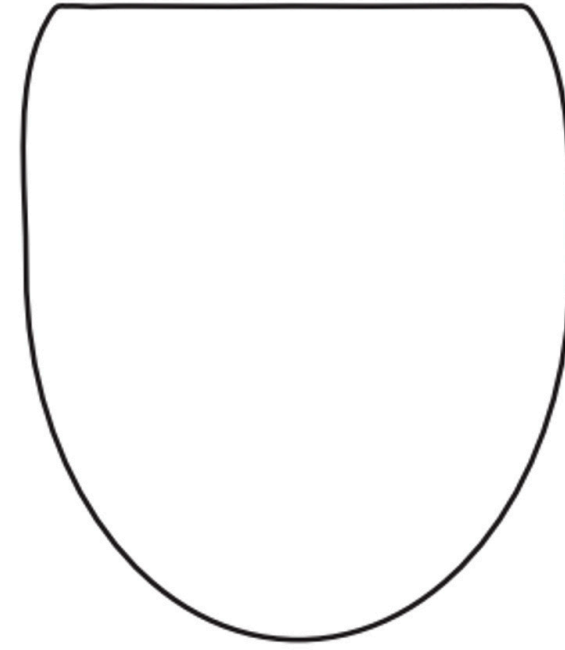
Figure 5. Lettuce plants placed in vertical tower.



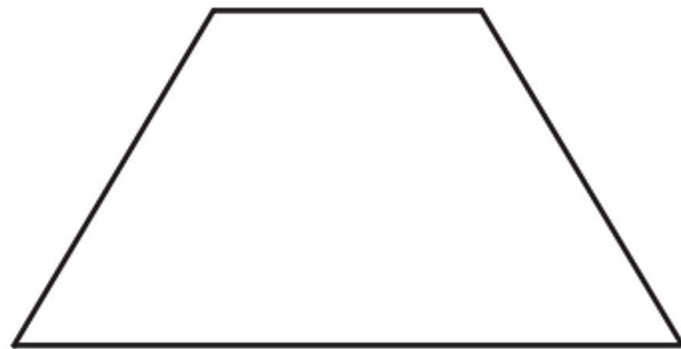
Figure 6. Strawberry plant with water splash shield on it.



Template for hole at the bottom of the tower.



Net pot hole template.



Template for the water splash shield.

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HLA-6724-5