

PROJECTS

HOME HYDROPONICS

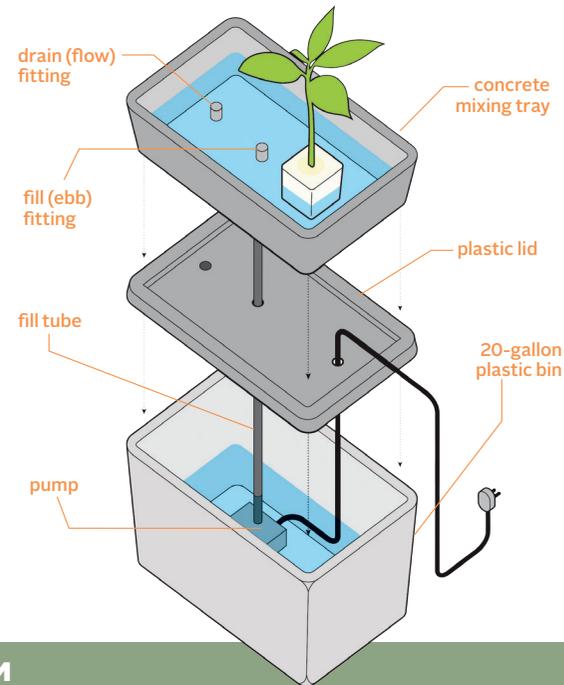
Winter doesn't have to mean the end
of growing your own produce.

BY DANIEL KLUKO



When summer ends, a lot of our gardens close for the winter. But hydroponics keep your garden going year-round. Rather than counting on the soil to provide plants with nutrients, a hydroponic setup gives them everything they need directly through the water. You don't even need natural light.

There are six basic types of systems: wick, deep-water culture (DWC), ebb-and-flow, drip method, nutrient-film technique (NFT), and aeroponics. (See page 88.) At Green Spirit Farms, an indoor vertical-farming company that I run with my father in New Buffalo, Michigan, we use a combination of NFT and ebb-and-flow. [Editors' note: Read about Dan and his dad in "In the Light Fields," June 2016.] NFT is probably the most popular system for commercial growers. It's what most greenhouses use because of the low water requirements, and it's the most conservative you can be on your water and nutrients. But it's also prone to clogging, and if you don't pay attention, little issues can lead to crop loss. For home use I recommend an ebb-and-flow system like this one. There's little maintenance and fewer opportunities to kill your crops. The system is also relatively inexpensive and easy to build. You'll be eating homegrown arugula in as little as two to four weeks.



SYSTEM

MATERIALS LIST*

- 20-plus-gallon sturdy plastic bin with lid, dark color (light promotes algae growth)
- Concrete mixing tray
- Ebb-and-flow kit (Botanicare Ebb and Flow Fitting Kit with two extensions)
- Oil-free pond pump, between 150 to 400 gallons per hour
- 2 feet 1/2-inch black vinyl tubing
- 1/4-inch spade bit or holesaw

- At two opposing sides of the concrete mixing tray, use a drill and a 1/4-inch spade bit or holesaw to create holes for the filling pipe (ebb) and drain (flow) from the ebb-and-flow kit. For a cleaner hole, put a piece of scrap wood beneath the tray to drill into.
- Place the mixing tray on top of the plastic bin lid. Mark the location of the holes in the mixing tray on the lid. Remove the mixing tray and drill holes in the lid with your spade bit or holesaw.
- Near one edge of the bin lid, drill a 1/4-inch hole. Use a box cutter to make two 1/2-inch cuts in the shape of an X over the hole. This will be where the

- Identify the flow fitting from the ebb-and-flow kit (Fig. A). It has the larger nipple on the bottom. This will be the drain for your tray. Assemble the flow fitting by screwing a riser to the side opposite the nipple, then screwing the filter on above it. (We added a riser because of the eventual height of our grow medium. You want the drain, excluding the filter, to be a quarter of the height of the medium you use. If you choose a shorter medium, don't worry about using the riser.)
- Insert both fittings in the holes in the tray (Fig. B). Do not attach them to the reservoir lid. Make sure that

- the gaskets are above the tray for a watertight seal, and that the nipples extrude beneath it. Secure the fittings by tightening the nuts beneath the tray.
- Attach the 1/2-inch adapter included with the pump to the pump's outflow and place it in the reservoir. Add the tubing to the pump and pull the power cord through the X cut in the reservoir lid.
- Pass the tubing through one of the holes in the reservoir lid and attach it to the smaller ebb nipple below the mixing tray (Fig. C).
- Place the lid on the reservoir, align the fittings, and put the tray on top of the lid.

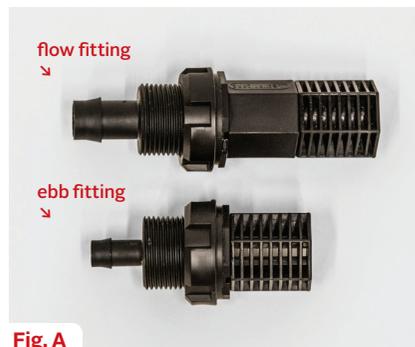


Fig. A



Fig. B



Fig. C

PLANTS AND OPERATION

MATERIALS LIST

- pH/EC meter
- Two programmable electrical timers
- Full-spectrum LED or fluorescent light
- Plant nutrient
- Arugula seeds
- Rock-wool starters and cubes

Although similar plants, like spinach and kale, could probably be grown together, for best results, you should grow only one plant in a system at a time. I recommend starting with a leafy green like arugula, which does not have a fruiting phase in which the plant makes seeds before harvest.

Before any plants go into the system, your seeds need to germinate. You'll need to choose a growing medium. This is what the plant will take hold in, and it can be a lot of things. The industry standard is rock wool, a material very similar to fiberglass that is extremely porous and holds 16 times its weight in water. It's the most widely used hydroponic medium in the world because it's completely inert. There's nothing in it, and that's exactly what you want; you can control your variables. You can also use regular soil, a foam medium called Oasis, clay pebbles, products made from the husks of coconuts, or crumpled coffee filters in plastic plant pots. As long as you have an inert material that can hold water and oxygen, you can use it as a medium. But we'll stick with rock wool.



Fig. D

- Rinse the rock-wool starter cubes (Fig. D), then soak them in water with a pH of 5.5 for about an hour. Place a seed in the hole of each starter and moisten the cubes. Keep them moist, and in a few days a sprout should appear. Put it near a window for light, and in ten to 12 days—when you see sprouts a few inches tall and roots going to the bottom of your rock-wool starters—place the cubes in their larger rock-wool blocks.
- The most important consideration in hydroponics is consistency. The basement is often a good place to put your system because of the even temperatures. (One easy way to tell if it's a good place to grow plants: Ask yourself if you're comfortable in that room. If you're not, your plants won't be either.) Place the growing medium in the mixing tray. Confirm that the risers for the drain fitting reach only a quarter of the way up the medium.

- Plug the water pump into an electrical timer. For the majority of plants, setting your pump to run two to four times per day for 15 minutes will provide adequate water and nutrients. When the pump is on, water floods through the fill fitting and drains back into the reservoir when it reaches over the drain riser (Fig. E). Once the pump shuts off, any leftover water drains back into the reservoir through the fill tube.
- Hook your lights to a timer and fix them above your hydroponic system in a way that light hits all parts of the grow tray. The amount of light your plant requires depends on the

- plant itself and the particular stage of the grow cycle. A good reference for light timing (and nearly everything else) is Howard M. Resh's *Hydroponic Food Production*. For arugula, 12 hours a day will be enough for the plant to grow but not flower.
- Fill your reservoir with 15 gallons of water and mark the water level with a Sharpie so you don't have to measure the next time. Having a consistent amount of water is important for correct nutrient concentration.
- Look up the produce you want to grow online on Cornell University's Controlled

Environment Agriculture page to find a plant-specific nutrient base. I recommend a one-part mix that can all be added at once, like J.R. Peters's 16-4-17 Hydro FeED. Follow the instructions on the nutrient mix to add an appropriate amount to the water. Change the water and nutrient solution at least every two weeks.

- Keep track of the pH and electrical conductivity (EC) of the water daily (Fig. F). The pH should remain the same for all plants. The ideal is 5.8, but anywhere between 5.5 and 6.2 is acceptable. If your levels are off, you can adjust them with a kit bought from the hot-tub section of a hardware store. The EC will vary based upon the plant you grow. As your plants feed, you want the EC to gradually rise. In order to lower the EC you will add water to the reservoir. To increase the EC, add more nutrients to the system. The target EC level for arugula is 0.8 to 1.2.

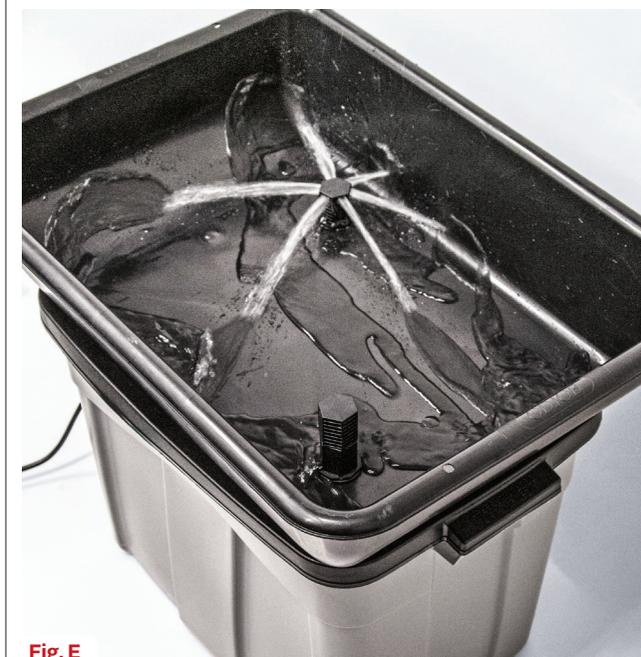


Fig. E



Fig. F

*Unless otherwise noted, all materials are available at your local hardware store or on Amazon.

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HOME HYDROPONICS

HARVEST

- 1 Watch your plants as you would in a traditional garden. If a problem gets to the point that you can see it, the plant has been dealing with it for a week. Avoid tinkering with nutrients until you get a successful first run.
- 2 Harvest your crops at the same time you would in traditional gardening. Arugula should be ready to harvest after two weeks and should provide another harvest every week for another four or five weeks.
- 3 When a harvest is finished, replace the rock wool and clean the system's reservoir, pump, and tubing with a 3 percent hydrogen-peroxide solution.

THE SIX TYPES OF HYDROPONIC SYSTEMS



WICK SYSTEMS

The simplest system. It can use soil as a grow medium with a wick line into a reservoir of plain water. Doesn't take much attention, but it's not going to have the best yield.



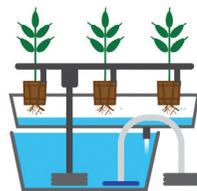
DEEP-WATER CULTURE

The medium is the water and the plants rest in it all the time. You need an air pump and an air stone to make sure that the plants get enough oxygen, though. You get great yields but it's a lot harder without experience and you are more liable to get root rot.



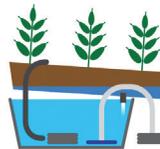
EBB-AND-FLOW

The best system for beginners, but it's used by many professionals as well. Provides good yields and uses very few mechanical parts. One drawback is that it requires large amounts of water to use.



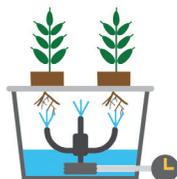
DRIP METHOD

The most sustainable approach to nutrient conservation. An emitter slowly drips nutrient water on the root system all day long. The problem comes when the small emitters clog. Which they are going to do. NASA experimented with this system on the International Space Station.



NUTRIENT-FILM TECHNIQUE

A small film of nutrient is used like a small stream that is always flowing down along the roots and recirculating. As with the drip system, expect the emitters to clog.



AEROPONICS

The highest yields—if you can do it correctly. A mister sprays water and nutrients on the roots and gives them great oxygen flow. Again, beware clogged emitters.