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HYDROPONICS

- No weeds
- Freedom from soil borne diseases
- Waist high plant culture vs. stooping and kneeling in muddy soil
- Reduced animal and insect pest problems
- Ideal plant moisture and nutrient conditions
- Location choice: grow where soil gardens are not possible e.g. driveways, patios
- Highly educational: horticulture and plant science; chemistry; circuits, batteries, solar cells and electricity; plumbing, and more. Great for schools.
- No. 1 advantage: much more FUN! Much more LEARNING!

START UP and OPERATING INSTRUCTIONS
Outdoor Solar Garden

Critically Important Information

- Even a 12-volt system will burn you and/or start a fire if short circuited. Be very careful not short circuit (touch the positive and negative wires together at any time when connected to either the battery or solar panels.
- Don't trust wire colors. Normally positive is red but it is brown on the Rule pump and black on the solar panels (the panels reverse the red and black color). Note: the solar panels simply plug one way only inside the Electrical Box so mistakes are not likely unless the wires are cut.

- Use ONLY genuine Qplugs and nutrients with MyGarden! Reorder at www.koolsci.com Any soil, dirt, organic matter - any small particles - in the Reservoir will block the irrigation manifold and spaghetti tubes. Needle nose pliers rescue newly seeded plugs that fall into GroPipes

- In its final location MyGarden must be sloped from back to front and level from side to side. Back to front is built in. Achieve level side-to-side positioning if necessary using small shims (tiles, thin boards, or similar) under legs. This is usually no problem on driveways or patios but takes some patience when setting up on sod or bare ground where you may need a level.

- Never allow Qplugs to dry after the seeds have been hydrated and germination begun. Small seedlings die quickly if the Qplug dries out. On some occasions in the first few days you may have to dip a cup into the Reservoir and hand wet the Qplugs.

- Location Location Location
    - Solar means sun, lots of sunshine, a basic requirement for both solar panels and almost all food crops. Success with MyGarden™ is predicated on receiving direct sun for half a day minimum. Morning sun is especially important

    - The position of the sun changes throughout the seasons. Full sun on a backyard patio at 8a on June 1 might change to no sun till late afternoon in the same spot October 1 as the sun drops and becomes shaded by the house

    - MyGarden includes solar panel supports on 3 sides but these might not be the ideal panel locations. Panel have built in stands and long wires enabling you to reposition them as needed

- Plants are tolerant of varying nutrient concentrations. However for best results follow good practices. Don't let Reservoir water levels drop too low because that concentrates nutrients which damages roots. In between nutrient solution change outs maintain the correct level in the Reservoir by adding **water only**. Appendix B

- You can't overwater plants in the Garden, and the Garden is quite tolerant of flow rate. The pump doesn't have to run after dark when plants need little to no water. Do not program the timer to run at night.

- Empty the Reservoir and replace the nutrient solution on a regular schedule. The solution will last 2 – 4 weeks when plants are small but with large plants, which remove nutrients faster, its recommend to change out the solution at least twice/month. However when necessary the solution will last for 3 and even 4 weeks if water level is maintained (manually or via Autofill).

- Periodic cleaning is required for all hydroponic systems. Older plant roots decompose after newer roots replace them. Without soil bacteria to break it down this organic matter coats GroPipes, spaghetti tubes and other surfaces. See Annual Clean Out below.

- When placing plants in the Garden try to keep them from shading each other. Plant larger growing plants like tomato on the north end and smaller ones like lettuce to the south end. If you have shade in later afternoons keep larger plants to the west side where they'll see sun above the smaller plants to their east.

- You will love Autofill if/when growing large crops. However the hose bib/splitter/timer connections must not leak! Autofill information below.

- Needle nose pliers gently rescue newly seeded Qplugs that may fall into the GroPipe

The most recent instructions for assembly, operation, and more are always available at:

KoolSci.org

Address questions, comments, requests to: info@koolsci.com

MyGarden's inventor and KoolSci president Henry Robitaille (Hank) was director of The Land at Epcot in the Walt Disney Vacation Resort a major showcase for hydroponic agriculture. His goal is to design, build, and perfect home and school (educational) hydroponic growing systems.

My Garden (Garden) is a quality, outdoor, solar powered, autonomous, modular, and expandable

hydroponic growing system designed for maximum flexibility. The approximately 3' x 3' x 3' Basic Unit is accommodated on most patios and balconies. Same size Add On Units (AOU) mate with the Basic Unit doubling and tripling production space. An Overhead Rack provides support for tall and/or vining plants and, most importantly, a framework for cold and animal and insect protection covers.

Components

The structure is fabricated from strong, lightweight PVC pipe and fittings. PVC is permanent and easy to clean and sterilize if necessary between crops. To avoid negatively impacting the environment KoolSci, Inc. accepts back and refurbishes orphaned Gardens.

Drain Manifold (Manifold)

GroPipes screw securely into the five ports on the Manifold (photos below). Nutrient solution flows downhill from the south end of the Garden through the GroPipes and Manifold and back into the Reservoir. Most of the fittings are sealed with Teflon tape not glue to permit easy adjustments.

Manifold with five GroPipe attachment ports and the drain assembly. Each port accepts one GroPipe. The drain assembly connects with the Reservoir via the short, straight, screw-on pipe in bottom of picture. The short, angled, screw-on pipe replaces the straight one to drain the nutrient solution into a bucket during solution change out (details below)

Direct GroPipes

The Garden is a "plug and play" system. Crops are seeded in QPlugs where they remain dry and viable for long periods of time germinating only when "plugged" into the Garden and imbibed with nutrient solution. This "perfect start" is hugely advantageous over veggie seedlings otherwise purchased stressed and past their prime on garden center shelves.

Seeded QPlugs are inserted directly into the GroPipe holes (GroHoles). Nutrient solution is pumped to the top of the sloping GroPipes (there is a 1" drop from the south to the north end on the Basic Unit and on each additional Add On Unit) where it runs downhill hydrating the QPlugs. In full sun continued flow is essential so that plant roots do not dry. Fortunately in full sun the solar panels are powering the nutrient solution circulation pump. However plants transpire some water even on cloudy days when the solar panels are inactive. As a security backup to solar power an Electrical Box uses battery power to run the irrigation pump for 2 minutes every other daylight hour (recommend programming is for 2 minutes at 10a, noon, 2p, 4p, 6p, and 8p (military time 9, 12, 14, 16, 18, and 29) hours each day. More information below under Electrical Box.

Check for Leaks

Fill the Reservoir to the 4-gallon mark with water and run the pump to check for leaks. You can use the solar panels if you're in the sun or push the "on" timer button to operate on battery. The interior of the Electrical Box cannot get wet, always make certain that its covered. Check the entire Garden carefully for leaks. Leaks cannot be tolerated because they result in loss of nutrient solution (Appendix A) which will cause plants to display nutritional deficiencies and grow poorly. The Garden was carefully designed and tested but leaks can occur in shipping. Appendix B is a short explanation of why avoiding leaks is critically important. Leaks are rare but damage can occur in shipping. Especially check the manifold (if there's a leak push it firmly together and, if necessary, add additional tape (included) to the leaking joint and the Autofill Level Control Valve stem underneath the reservoir. If the latter drips tighten the large white nut

you'll find at the top of its stem. If it still drips remove the valve and reseat it with additional rope putty (included).

Plant and start Growing

Garden crops are seeded in QPlugs which sit down in the GroPipe GroHoles. Insert one QPlug per hole making certain Plugs touch the bottom of the Pipe. If you purchase seeded QPlugs there will usually be several seeds in each Plug. If you're seeding your own Plugs find the tiny hole in the plug (you may need to open it a bit with a toothpick) and insert 2-3 seeds about ½" deep. After germination keep the strongest seedling and pinch off the others (although in some cases e.g. lettuce you'll get a nice plant either way). You can grow small plants to harvest in just a few weeks depending on temperature and amount of daily sunlight. To harvest plants, pull the entire plant out of its hole roots and all. You can immediately replant by dropping a new seeded QPlug into the hole.

Watch the Qplugs carefully during the first week or two of germination. Once seeds imbibe water they quickly die if they dry. If Qplugs appear dry pour a little water over them. This is not usually a problem with a properly operating Garden but the first few days are critical in the plants life and attention is required. Once the seedling's roots penetrate the Qplugs you should be home free. As soon as you see green, set up the nutrient solution and plan to change it out at least monthly when plants are small and twice monthly once they're large.

Roots

Lettuce, spinach, basil, mint, cilantro, rosemary, cherry tomato and many more plants grow happily directly in GroPipes. Those harvested after four or five weeks easily pull out intact: tops, plugs, and roots. They stay fresh longer in the refrigerator if roots are retained as long as possible. Plants in hydroponics grow way more roots than they need. Plants staying in the GroPipes longer than 5 weeks require root checks about twice monthly to prevent them from outgrowing their GroHole becoming impossible to pull out. Use sharp scissors to trim 25 – 35% of the roots including a little shaving on the QPlug. Interestingly even large plants can be pulled, trimmed, and replaced without interruption of growth and development. Always retain as much of the root system as possible, never pruning roots unless necessary. The pruning sounds complicated but it's quick, easy, and routine with a little experience. After two root pruning's most plants stop producing superfluous roots.

If you forget to root prune and you can't remove a plant from its GroHole let it go unless roots begin to block the GroPipe or even the Manifold causing a potential back up and loss of solution. When you finally harvest the entire row unscrew and remove the GroPipe and clean it out with a broom handle and garden hose.

If you desire to grow large plants long term we recommend growing in "Bottles", and an using an Overhead Rack (see options below) to tie plants and vines. When growing directly in GroPipes you'll do better with smaller varieties like Red Robin (tomato).

Highly productive Red Robin cherry tomato and Butter Crunch lettuce growing side by side in My Garden™

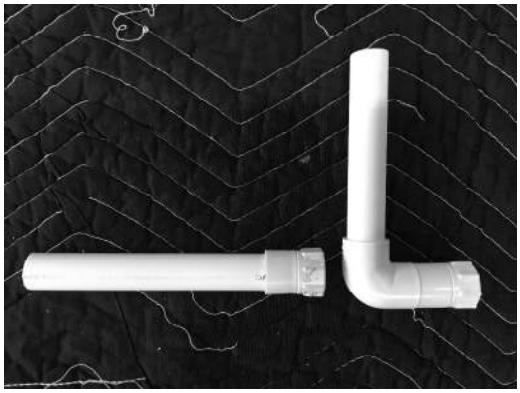
Nutrient Solution Distribution

The Reservoir holds and recirculates nutrient solution through a drip irrigation system. A small 12v pump (Rule 360 GPH) supplies solution to the GroPipes via standard drip equipment. A small combination filter and valve sits just above the pump. The filter should be checked and cleaned each time the nutrient solution is changed and especially with the first few change outs. The valve allows for flow adjustment. Normally the valve is left wide open when growing with Direct GroPipes but there may be times in direct strong summer sun when the irrigation system can't handle full flow and the valve should be turned down a bit.

The Reservoir is constructed and positioned to make flow adjustment and nutrient solution change out convenient and simple. Solution change out takes 10 minutes only and is recommended minimally each two month for seedlings and twice monthly for large plants. When the operator is not available plants can go longer between change outs without damage. My Garden is as independent and care free as possible. Take that vacation, the Garden will take care of itself (with larger plants your vacation will require Autofill installation (see options below).

Changing the Nutrient Solution - Drain and Fill the Reservoir

Empty the Reservoir while the sun can pump out the old solution. Cover the solar panels to stop the pump, unscrew the Reservoir Return Pipe, and replace it with the Reservoir Drain Pipe to Bucket (below).



Left - Reservoir Return Pipe; Right - Reservoir Drain to Bucket

Position a bucket under the Pipe and uncover the panels to restart the pump. Tilt the back of the Garden up slightly to get all the solution out of the GroPipes and Manifold. The pump won't remove the last ½" from the Reservoir. Remove the Drain Pipe and pull the Reservoir forward just enough to be able to scoop out the last of the solution. You can make a good scoop out of a plastic milk bottle. If the Reservoir isn't clean rinse it with and pump out additional water. Remaining small particles can block the spaghetti irrigation tubes. It's always a good idea to check the filter. Pull the pump and filter assembly apart and check the screen in the filter. If necessary, clean it under running water. If you keep the Reservoir covered and use only Qplugs you'll have few problems with nutrient solutions.

Alternatively, especially if the Reservoir really needs cleaning, it's easy to disconnect the pump and filter assembly and place it outside the Reservoir on top of a closed Electrical Box. Now you can remove the reservoir return pipe and pull out, dump, rinse out with a garden hose, and replace the Reservoir all in just 5 minutes. Again, if you keep things clean you'll seldom have to take this last step.

Now re-cover the panels to stop the pump and reverse the operation pushing the Reservoir back into position and replacing the Reservoir Return Pipe. Add water to either the 4 or 8-gallon mark in the Reservoir, dump a 4 or 8-gallon nutrient packet into the water, and stir vigorously. Rinse the bag out in the Reservoir to dissolve any remaining nutrients. Nutrients won't dissolve 100% immediately but over time they will all eventually go into solution. Nutrients are very hygroscopic i.e. absorb water. If they clump in the bag crush the clumps to really fine particles (hammer the bag!) before dissolving them in the Reservoir.

Uncover the panels to restart the pump and ensure that everything operates correctly.

Since plant nutrients remain in the old solution you just removed it's a good idea to use the bucket water to fertilize your potted plants and garden. With just a little practice changing out the nutrient solution becomes a simple 10-minute task. Develop a routine and it becomes a negligible chore.

When the seedlings are small, and even when plants are large but the operator is unavailable, the Garden can easily go a month without a nutrient solution change out. But the solution level cannot be allowed to drop more than 25%. Maintain the reservoir level at 4 or 8 gallons **with water only.** Add nutrients only when you do the full weekly solution change outs.

The Reservoir is calibrated for 4 and 8 gallons and nutrient packets are available for making 4 and 8 gallons of solution. Four gallons is adequate for seedlings and small plants. When the plant canopy is larger and you find yourself adding water too often switch to 8 gallons. There is no downside to working with the larger volume and a larger volume may even be desirable because you'll be adding make up water less often. The larger volume provides more leeway with both water and nutrients. Autofill only operates on 8 gallons of solution.

Electrical Box – a solar back-up system

Solar power is ideally suited for hydroponic gardening. Ninety five percent of the water plants absorb they use in transpiration, cooling themselves by evaporating water from tiny pores called stomates in their leaves. The brighter and hotter the sun the more water plants transpire but, fortunately, at the same time the more solar power the panels produce to speed the pump.

Plants can wilt however during extensive periods of cloudy and even rainy weather when solar radiation is insufficient to power the pump. Their roots need some water under those conditions and an Electrical Box provides a battery back-up to guard against wilting.

The solar panels plug into the Electrical Box (Box) simultaneously powering the pump and charging a 12-volt battery. The large PVC elbows on the Box serve two purposes, providing a waterproof entry place for solar panel and pump wires, and ventilation for the battery. Charging batteries emit hydrogen gas, which rises and dissipates through the elbow vents. A programmable timer operates the pump via the battery. The timer is very forgiving and easy to program. Its natural to be hesitant but don't be. An easy to follow instruction sheet is included in the Box and the timer instruction sheet is included in the packet with these operating instructions. Experience suggests programming 2 minutes on and off about every daylight hour each day. It may come from the factory programmed to energize the pump for 2 minutes at 10, 12, 14, 16, 18, and 20 hours but you can easily do or adjust the programming.

On bright days battery operation, while superfluous because the pump is running directly from the solar panels, is harmless because the panels are also continuously charging the battery. On cloudy or rainy days, when the pump isn't running on solar, the 2-minute battery operation is more than sufficient to keep plant roots wet. The battery should be checked at least at each nutrient solution change out. A battery tester is included in the Box and a test takes 10 seconds. If / when necessary the battery can be brought indoors and charged overnight indoors using the 110v charger included in the Box.

Timer

The back side of the Timer has an AA battery that we recommend changing between crops or at least each 6 months. The battery can be accessed without removing wires. Lift the Timer carefully until you can reach and open the battery compartment. Pop out the old battery and pop

in a fresh one. It's OK if you can't successfully replace the battery compartment door. The battery's tight and won't fall out. Its a good idea to keep battery change out dates on a small paper near the Timer.

Put an AA battery in the back of the Timer. Programming the Timer is very easy. Start by holding down the CLOCK button while entering the correct day of week, hour, and minute. Timer uses military time so 1p is 13 hours. Hold down the keys to run the minute numbers faster.

Next set the daily on and off times that you want to operate the pump during daylight hours. We set it to turn "on" on each hour and "off" 2 minutes after each hour on the following hours: 9, 10, noon, 14, 16, 18, and 20. The hours you select depend on season, longer in summer and shorter in winter's shorter daylight periods. You might include 22 hours (8p) in mid-summer.

Press and quickly release the TIMER button and note the "1on" in the bottom left display. Press WEEK and note lots of selections in the display including one that includes all seven days in the display. This is the choice you want to select. Once you select it here it will hold it throughout the programming. Next press the HOUR button until you reach 9.
Press TIMER button a second time and you'll see "1off" in bottom left of display. Press HOUR until you reach 9, press MINUTE until you reach 02. The Timer will turn on at 9a and off at 9:02a.
Press TIMER button a third time and you'll see "2on" bottom left of display. Press HOUR button and go to 10; press TIMER button a forth time, see "2off", press HOUR to 10 and MINUTE to 02.

Continue the process. If you're too slow the Timer reverts to the time of day but press TIMER to continue. If you stop at "4off" for example you'll have to press TIMER 8 times to get back to "4off". It never forgets what you've already programmed at 1, 2, 3, and 4on. To start everything over again press the RESET button.

To operate the pump e.g. - emergency watering or to pump out the Reservoir - at any time press the MANU button.

On sunny days the timer will power the pump per the program but it won't matter since the pump should be already running on direct solar power. No harm.

Reflective Covers
Strong summer sun destroys plastic. Cut the solar shade (included) in half and place half each on the Reservoir and Electrical Box. Leave adequate overlap to protect the sides of the Box. Additionally, covering the Reservoir in summer effectively reduces solar overheating the nutrient solution."

Safety
Always remember that short circuiting (touching positive and negative wires together) can cause a serious burn and/or fire. Use great awareness even when working with 12 volts.

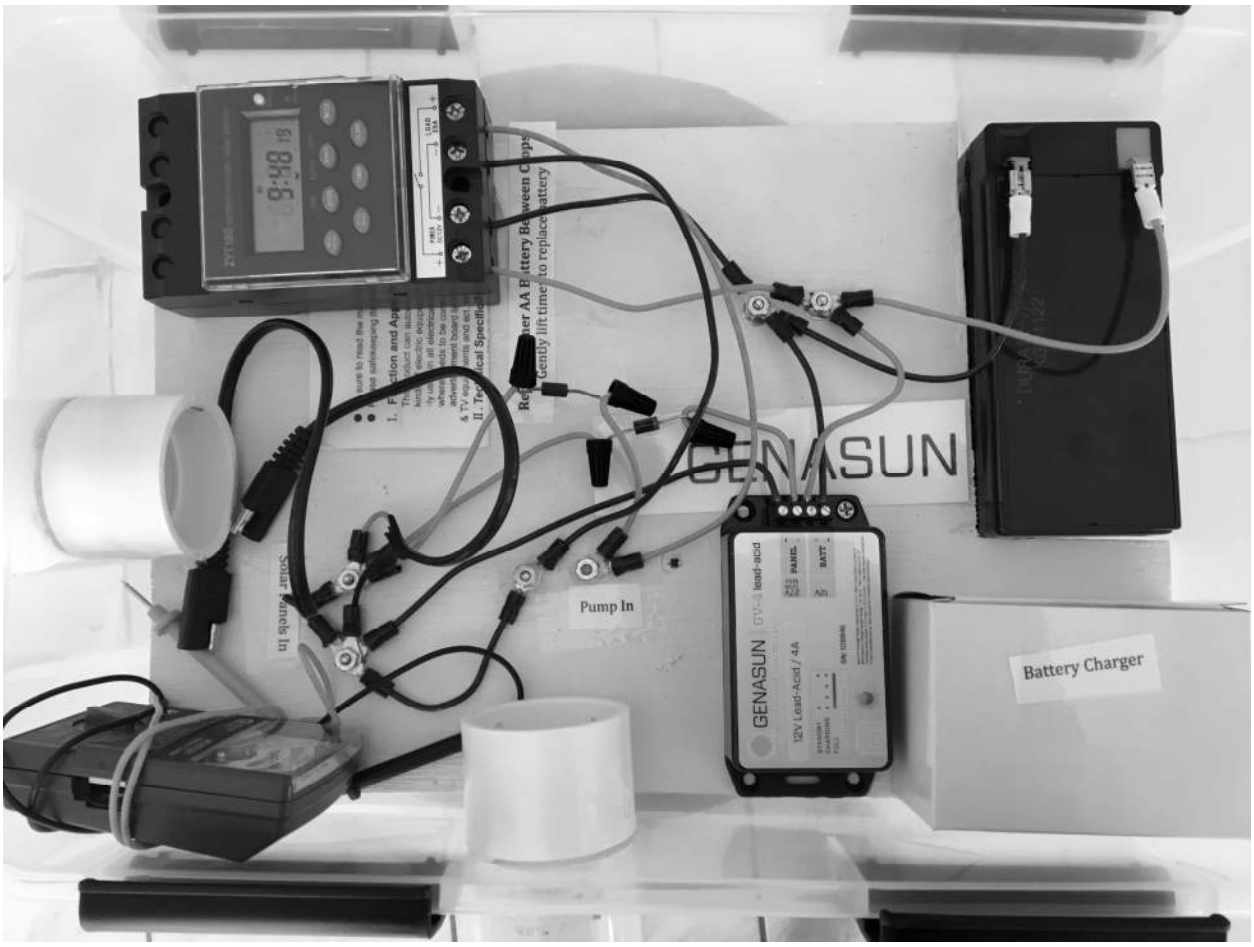


Figure 24 Electrical box. Contents include battery (12v, 7ahr); Genasun solar charge controller; programmable timer (instructions beneath); battery charger; and battery tester (green). Solar panel inputs enter through the elbow on the left and mate with the connectors at "solar panels in". Pump wires enter through the elbow at bottom of picture and attach to the terminals labeled "pump in". Pump brown (+) and black (-) wires connect with circuit red (+) and blue (-) wires respectively. Everything is easy to reach especially the timer for programming. Lift the timer to access the single AA battery that we recommend changing between crops. The battery charger is for emergency charging only as in operation the battery stays continually charged by the solar panels. The battery tester is useful for measuring solar panel input as well as battery current.

Water Acidity (pH)

Water acidity, which varies greatly from region to region, influences gardening success by affecting the uptake of individual nutrients. See Appendix C for a more detailed explanation and for a discussion of pH (the measure of acidity) and the Garden™. Crops differ in their preferred pH; a medium solution pH around 5.5 is closest to ideal to accommodate most food crops. If your water pH is high, 7 or above, adding a cup of white vinegar to the Reservoir will lower it quickly and improve nutrient uptake. Usually, however, the solution pH will quickly drift back higher. If you're having problems or are simply curious ask your water supplier for your water's pH or have a sample tested at your County Agricultural Extension Office or at almost any laboratory including high school chemistry labs.

Other hydroponic systems companies sell additives to improve nutrient solution quality for growing. Our tests don't prove their benefits and our results are excellent with pH 7 on many crops.

Clogged Spaghetti Tubes

This is not a common problem in a properly operating Garden. It's imperative to keep the Reservoir and the nutrient solution clean to prevent small particles from clogging the irrigation system spaghetti tubes. Note the filter inside the Reservoir in the Pump and Filter Assembly. If spaghetti tubes block first check that filter. It's a good idea to check that filter periodically during nutrient solution change outs. Pull the Assembly apart (fittings are not glued) and clean the small copper screen under running water.

If you encounter a clogged spaghetti tube you can try sucking hard on it and spitting out the solution, or running a fine wire through it. If that doesn't work simply replace the tube. Replacement tubes are included in the Spares and Starters package.

Slow nutrient solution flow is adequate but if flow gets too slow there may be a problem. Check the pump by pulling the Pump and Filter Assembly apart inside the Reservoir. Particles may be clogging the pump intake. Next check the spaghetti tubes. Particles of any kind in the nutrient solution can clog the tubes. In that case follow the advice in the paragraph above.

Pest Management

Diseases

Early on you won't experience disease problems but they can build up over time due to accumulation of dead and decaying plant material. Hydroponic systems are great environments for water loving organisms like Pythium fungus, which feeds on both dead and living plant material. The good news is that it's easy to control using good sanitation practices. When a GroPipe is empty remove it from the Garden and clean the inside with a garden hose and rag ball on the end of a broomstick. Finish by pouring a thin layer of dilute bleach solution through it covering all the inside wall. It's also easy to clean the Reservoir with rubber gloves and a rag with dilute bleach solution. Only if you have a persistent disease problem do you have to clean and bleach all the system including the manifold at one time. A quick rinse following bleach and you're ready to plant once again.

Insects

MyGarden™ have less problems with insects because its off the ground and out of the weeds. And if you frost protect depending on location much of your growing will be fall, winter, and spring before the height of the garden insect explosion season. And since plants are eye level larger insects like caterpillar are easier to find and remove. But you will probably eventually experience some reduced insect challenges. Check with your local horticulture extension office for advice on organic and biological controls.

Animals

Rabbits, groundhogs, and other small animals can't reach MyGarden™ crops. Bird and deer problems are controlled with chicken wire covers on the Overhead Rack. In one upper New York location deer were so prevalent that MyGarden™ was the only gardening possible!

Harvest

Plants grown directly in Direct GroPipes must be harvested "on time" by gently pulling their root mass from the hole. When done timely and correctly all roots are removed. A little experience

is required. It is undesirable to delay harvesting leafy vegetables and herbs like lettuce and spinach because they become bitter and tough. It is best to harvest and replant on time. Some plants like basil or mint can be cut and left to regrow. Others like rosemary are slow growing and may stay in place for months. In those cases its best to prune their roots every 2 weeks. As stated above they can lose 25% of their roots with no adverse affects. You'll learn lots during your first year growing.

Annual Clean Out

Older plant roots die and slough off replaced by new roots. In soil this organic matter is quickly broken down by natural bacteria but in hydroponics it can build up and encourage root disease causing bacteria like Pythium. Once a year or more frequently under intensive growing conditions its good practice to thoroughly clean the Garden. Remove the GroPipes, take them outside, and flush them out with a garden hose. Run water through the manifold and use a rag to wipe out the Reservoir. Replace the spaghetti tubes or run a wire through them cleaning them out. Use a razor blade to cut them off the manifold (they don't easily pull off). Wipe down all exterior surfaces.

If you encounter root disease problems, you'll have to run a dilute bleach solution through your system once you complete the above clean-up. Bleach is not toxic to plants and is easily rinsed away after treatment. All this sounds like lots of work but its only a fun hour on a pleasant sunny afternoon. Your plants will thank you!

Fun!

The Garden is freestanding, independent and easy to operate but it does require a bit of practice, attention, and effort to maximize success. You'll enjoy it most if you like plants, technology, and growing and are willing to dedicate at least some minimal time. The Garden is an excellent platform for creating, designing, and testing for fun, or for competing in science fairs. Environmental, nutritional, and technical factors can all be altered to determine the effect of alteration on plant growth, development and/or productivity. The platform is composed of easy to alter off the shelf parts making it perfect for experimentation.

Options

Autofill

You won't need this at first since small seedlings transpire very little water. Check Reservoir water levels daily and add water as needed. If you can't check daily add plenty of water to hold the plants till you return. Seeds have their own built-in food to sustain seedlings for the early post-germination days.

Larger plants are a different story and plants growing in bright light transpire lots of water to keep cool. A large tomato plant will transpire ½ gallon of water daily. The Reservoir holds only 8 gallons. Worse, only water is transpired leaving the nutrient salts behind resulting in a damaging increasing salt concentration in a lowered nutrient solution. The grower of large plants has two choices: manual addition of water at least twice daily or Autofill.

Autofill automatically maintains the nutrient solution level in the Reservoir by opening flow from a hose bib and adding the necessary quantity of water twice daily. Components are:

- Existing hose bib **that does not leak and will make a watertight seal with the splitter** and timer (customer responsibility). Autofill components:
- 2-way hose splitter adapter (optional: allows continued use of hose bibb for other purposes)
- Rainbird pro 2x/day timer
- ½"dia garden hose (customer responsibility)
- High performance level control valve (factory preinstalled)
- Connector – Level control valve to garden hose connector

Keep the hose as small and short as possible to minimize the slug of hot (summer) or cold (spring and fall) residual water going into the Reservoir. The water temperature problem is obviously exacerbated by longer and fatter diameter hoses. In ideal situations hoses are buried or otherwise covered with reflective material to minimize extreme water temperature problems. If the garden hose is distant from the Garden set the timer to be open longer to ensure adequate Reservoir fill. Fine tuning Autofill takes a little trial and error but the final product is well worth the initial effort.

During operation the bib remains open ¼ turn allowing the timer to control water flow. The bib/timer connection is the only weak line in the system and **cannot leak** at all or water loss will be continuous. Have a plumber replace old, leaky bibs before installing AutoFill (something you should probably do anyway!).

The Rainbird timer can be programmed to open twice daily; one suggested program is to open for 2 minutes at both 1pm (prior to afternoon plant water demand) and 4 or 5pm (preparing to begin following day with a full Reservoir). The length of the open period must be long enough to refill the Reservoir but is not otherwise critical because the Reservoir solution level is controlled by the fill valve.

Autofill. Left: Reservoir showing installed level control valve (A) and valve to garden hose connector (B).
Right: Upside down Reservoir showing all Autofill connections. The hose bib is shown here without the 2-way splitter, but the splitter is included for those needing to share the bib with another garden hose.

Grow Bottles

Young tomato plant germinating in a perlite-filled GroBottle. Note the drip spaghetti tube entering the bottle, bottom center of photo

Bottles provide plants with 2 liters of media for their roots. They use special GroPipes that have only two GroHoles only per length since they are designed for spacing big plants. All Manifold ports accept Bottle GroPipes, which are easily interchanged with Direct GroPipes. Bottles tie to the Plant Support Bars which are shipped with each Garden and AOU. The GroBottle option is usually purchased together with the Overhead Rack option, which is designed to tie up large plants (see below).

Bottle GroPipes are totally interchangeable with Direct GroPipes. Bottles are tied to the Plant Support Bars and plants to an Overhead Rack

Bottles are easy to use. Invert the Bottle and place its neck in the GroHole, tie it to the support pipe using the strap provided, insert a spaghetti irrigation tube into the small hole above the inside Qplug, and seed the Qplug. Once hydrated the seed will germinate and grow inside the bottle. Bottles are covered to inhibit algae growth but covers are easy to remove temporarily to

watch root growth. It may be necessary to install a longer spaghetti tube (included) to reach the more distant Bottle. Use a razor blade to cut the old spaghetti off the manifold and firmly insert the new tube.

Highly productive young tomato canopy growing in Bottles (visible bottom left) and tied to an Overhead Rack

Overhead Rack (OHR) and Various Covers

An OHR plugs into the top fitting on each leg of Basic and Add On Units. Leg top plugs are removed and the 4 OHR vertical members inserted in their place. OHR vertical are 40 inches long putting the top of the OHR about 6' above the ground. Vertical members can be easily shortened or lengthened (with a short trip to Lowes) as desired by the grower.

The OHR serves a number of practical functions providing a place to tie up large and vining plants and a supporting structure for various covers. A frost protection cover, especially with a small heat source beneath, effectively extends the growing season in temperate climates in both

fall and spring by a month and permits growing throughout the winter in Florida. A different cover that results in a tolerable 15% shading may provide protection from large Lepidoptera insects a big problem with tomato, and most other crops. Chicken wire covers result in minimal shading and provide excellent protection from deer, rabbits, and other animals.

A covered Overhead Rack and 60W incandescent light bulb protects MyGarden™ on a frosty Florida night

Overhead Racks supporting major tomato production

Add On Units (AOU)

MyGarden™ provides fresh vegetables and great fun on small balconies and patios but it is also expandable to almost any length where space permits. Three units (Basic Unit plus 2 AOU's) will grow the equivalent of 75 heads of lettuce in a 3' X 9' space (plus necessary space to work around). And though a Basic Unit with its relatively pricy solar panels, solar charge controller, and options like Autofill can seem expensive, AOU's require only additional piping to double and triple production at very little additional cost. All AOU's and OHR's plug together quickly and easily.

Lettuce production in a MyGarden Add On Unit

Inexpensive AOU's (one above, two below) attach quickly and easily to the basic MyGarden instantly doubling or tripling production capacity

Appendices

Appendix A: Checking for, and dealing with, leaks

The nutrient solution is composed of water and 13 essential elements that plants require for growth and development. Plants use lots of water to cool themselves through transpiration under the hot sun, water that must be replaced. In full sunshine, a large tomato plant can transpire a gallon of water a day. Plants take up the dissolved nutrients in that water, however, much more slowly than they do the water. A closed system like the My Garden™ may need make up water daily while a batch of nutrients may last for 2 weeks.

This is true however only in a truly closed system. If there's a leak, even a very small one, the nutrients are being lost right along with the leaking water. Instead of the nutrients lasting for 1 - 2 weeks the plants will begin to show nutrient deficiencies and grow poorly.

If you have a leak it may be where a GroPipe attaches to the manifold. Tighten the connection. If leaking continues wrap Teflon tape (included with Starters and Spares) around the Manifold Port threads. Leaking can also occur inside the Reservoir which does no harm except reducing

flow pressures. The Pump and Filter assembly is not glued so simply push the components firmly together.

Appendix B: Transpiration and plant nutrition
Seeds require only water for germination because they carry their own stored food. After germination, the nutrient packets provide the precise concentration of the 13 plant essential nutrients in the same proportion that field-grown plants take them from the soil solution (nutrients from rocks and minerals dissolved in rainwater). Plants are tolerant of nutrient solution concentration to a point but growth and development will suffer if the solution becomes too concentrated or too dilute.

Under good growing conditions plants take up the water in large quantities and pass it out through pores in their leaves for cooling a process called transpiration. But they take up the 13 nutrients individually and at much slower rates than they do the water. This is insignificant with small seedlings but a large crop canopy in the Garden on a hot sunny day will transpire up to 2 gallons of water for cooling themselves while removing relatively few nutrients. That water must be replaced regularly or the nutrient solution becomes too salt concentrated and will damage the plants (not to mention that the plants will wilt and die once they've used up all the water). The plants do take up the nutrients too of course, albeit at a much smaller rate than water which is why the nutrient solution should be changed out bimonthly for small seedlings and weekly for larger plants.

Appendix B: pH – a measure of soil acidity
Nutrient solution (or in the field, soil) acidity (measured in pH units) influences the uptake of nutrients by plants. When the pH is too high or too low plants have difficulty taking up nutrients and exhibit stunted growth, yellowing and other nutrient deficiency symptoms. You may have noticed in your landscape that acid loving plants like pin oaks, blueberries, and azaleas turn yellow in alkaline soils. That's because they can't take up iron at a high soil pH. Fortunately, plants are quite tolerant and likely OK if deficiency symptoms aren't visible. And most food crops are relatively pH tolerant. Water chemistry varies tremendously from region to region so some experimentation required.

In Central Florida, MyGarden™'s home base, city water is pumped from a calcium carbonate aquifer making it an alkaline pH 7. Adding ½-1 cup of white vinegar to 4 gallons of nutrient solution drops the pH to a much better (for many plants) 5.5. When plants are small we keep them at 5.5 with vinegar additions but once they're large and transpiring lots of water maintaining a lower pH is an impossible proposition. Despite that we have successfully grown many vegetables and herbs in the Garden. If you're lucky you'll learn that your water's pH is ideal for growing!

Measuring pH requires a pH meter or indicator paper. A pH range close to 5.5 on the meter or paper color chart will be ideal for most crops. Adding vinegar lowers higher pH readings. If your pH is higher than 7 (the indicator paper turns green) ½ cup of white vinegar for every 4 gallons of nutrient solution should drop the pH to 5.5. Add vinegar again each time the pH drifts high. Good luck!

Appendix C: Hydroponics Primer

In hydroponics, the objective is to maintain the plant tissue concentration of each of 13 root-absorbed essential elements between their critical and toxic limits. This "adequate" concentration zone can be wide for the macronutrients (those required in "large" amounts) and quite narrow for many of the micronutrients (those required in "tiny" amounts). However, even with macronutrients, it's important to avoid "luxury consumption" or the upper end of the adequate zone, to reduce both fertilizer costs and environmental pollution.

Plants get their oxygen(O), hydrogen(H), and carbon(C) from the air (elements in the middle of the table below). Interestingly, even though air is 80% nitrogen, they can't get their nitrogen, a macronutrient, from air except in rare cases in the pea family including soybeans where bacteria growing in the plants roots can fix aerial nitrogen. Plants take up nitrogen and all other nutrients except O, H, and C from the soil solution which is dissolved rocks and minerals in rainwater. Rocks and minerals have very complex chemical structures that include all the elements listed in the table below.

Essential elements for higher plants

Element	Chemical Symbol	Form Available to Plants[a*]
Sulfur	S	$SO_4^=$
Phosphorus	P	$H_2PO_4^-$, $HP0_4^=$
Magnesium	Mg	Mg^{2+}
Calcium	Ca	Ca^{2+}
Potassium	K	K^+
Nitrogen	N	NO_3^-, NH_4^+
Oxygen	O	O_2,H_2O
Hydrogen	H	H_20
Carbon	C	CO_2
Molybdenum	Mo	$MoO_4^=$
Copper	Cu	Cu^+, Cu^{2+}
Zinc	Zn	Zn^{2+}
Manganese	Mn	Mn^{2+}
Iron	Fe	Fe^{3+}, Fe^{2+}
Boron	B	H_3BO_3
Chlorine	Cl	Cl^-

In hydroponics rocks and minerals are simply broken down into simpler components (what we call nutrients), which dissolve in water more easily than their original complex structures. We are exactly mirroring what occurs in the natural environment.