

Hydroponics & Aquaponics Basics

Growing without soil at all, in a nutrient solution (hydroponics) or in a closed loop with fish supplying the nutrients (aquaponics). Neither is covered anywhere else on this site: the real system types and how to build one, aquaponics' nitrogen cycle and tank setup, nutrient mixing and pH/EC management, grow-light requirements, what crops genuinely do well, and the honest tradeoff this method carries that row crops, a food forest, and a walipini mostly don't: most of these systems depend on continuous electricity to keep the water moving, oxygenated, and lit.

Four real system types, and which one actually fits a beginner

System	How it works	Real tradeoff
Wick	A wick draws nutrient solution up from a reservoir to the roots by capillary action, no pump at all	The simplest and only genuinely no-electricity option; can't support larger or heavier-feeding plants as well as the pumped systems below
Deep water culture (DWC)	Roots hang directly in an aerated nutrient reservoir; an air pump and air stone keep it oxygenated	The most forgiving pumped system for a first build, a basic version can be built for well under \$50, but needs weekly nutrient changes and steady water temperature
Nutrient film technique (NFT)	A thin, continuously flowing film of nutrient solution runs through channels past the roots	Scales well for leafy greens and is standard in commercial lettuce production; a pump failure dries roots out fast since there's no reservoir of standing water at the roots themselves
Ebb and flow	A grow bed is periodically flooded with nutrient solution, then drained back to a reservoir	The most versatile of the four, handles everything from herbs to peppers and small tomatoes, at the cost of more moving parts (a pump and a timer) than DWC

For a household new to this and thinking about resilience, not just yield, wick systems deserve more attention than they usually get: they're the one option here with nothing to fail during a power outage. The three pumped systems all trade that resilience for higher yield and a wider range of what they can grow.

Building a DWC bucket: the actual materials and steps

This is the system worth building first: it's the cheapest, the most forgiving of mistakes, and everything below scales up conceptually to the other three once it's understood.

Material	Spec	Approximate cost
Bucket	One food-grade 5-gallon bucket per plant, look for the fork-and-knife symbol stamped on the bottom, opaque or painted so light can't reach the roots and grow algae	\$5–8
Net pot	One 6-inch net pot with lid, sized to a hole cut in the bucket lid	\$3–5
Air pump and air stone	A pump rated for 1–2 liters per minute per gallon of water in the bucket, so a 4-gallon fill needs at least a 4–8 L/min pump, plus one 4-inch air stone and a length of airline tubing	\$12–20
Growing medium	Expanded clay pebbles (also sold as hydroton or LECA), enough to fill the net pot and hold the plant upright	\$8–12

Assembly: cut a hole in the bucket lid sized to the net pot so it sits with about an inch of the bottom submerged once the bucket is filled. Drill a second, smaller hole in the lid for the airline tubing. Fill the bucket with nutrient solution (mixed per the section below) to just below the net pot's base, drop the air stone to the bottom of the bucket, and run the tubing out through its hole to the pump, which sits outside the bucket and above the waterline so water can't siphon back into it. Line the net pot with a thin layer of growing medium, set the seedling or rockwool cube inside, then fill around it with more medium to hold it upright.

WARNING

Run the air pump continuously, never on a timer

One plant per bucket is the rule; two compete for dissolved oxygen and root space and both suffer. A few hours without the air stone running in warm water is enough to start root rot, so this is not a component to economize on or leave switched off overnight.

The other three systems scale the same logic up: an NFT system replaces the bucket with a slightly sloped channel (food-grade 3–4 inch PVC pipe works well for a small build, holes drilled 6–8 inches apart for net pots, roughly 1 inch of drop for every 4 feet of channel length) fed by a submersible pump in a reservoir at a flow rate of 3–5 gallons per hour per channel, with the far end draining back to that same reservoir. A wick system needs no pump at all: a reservoir sits below a growing container, and a few strips of absorbent

wicking material (cotton rope or felt strips work) run from the solution up into the growing medium, carrying water and nutrients up by capillary action alone. Ebb-and-flow adds a grow bed above the reservoir, a submersible pump on a timer that floods the bed on a schedule (typically a few times a day for 15–30 minutes) and lets it drain back down between cycles.

Starting seeds for a soilless system

Regular seed-starting mix doesn't drain the way these systems need. Rockwool cubes or foam starter plugs are the standard approach: soak the cube in pH-adjusted water (5.5–6.5) for a few minutes until fully saturated, then push one or two seeds into the hole in the top with a toothpick, about a quarter-inch deep. Keep the cubes moist and, if using a humidity dome, remove it daily to let fresh air in and check for mold. Once the seedling is 2–3 inches tall with a couple of true leaves, move the whole cube, root disturbance and all, directly into the net pot's growing medium; there's no need to remove it first.

Aquaponics: the nitrogen cycle is the whole system

Aquaponics closes the loop: fish waste supplies the plants' nutrients, and the plants clean the water the fish live in. The mechanism that makes this actually work is bacterial, not a design trick: *Nitrosomonas* bacteria convert the ammonia fish produce into nitrite, and *Nitrobacter* bacteria convert that nitrite into nitrate, the actual form of nitrogen plants can use. None of that bacteria exists in a brand-new system on day one.

WARNING

A new system has to be cycled before fish or plants can safely go in it

Building a working bacterial colony from scratch takes 30–45 days of running the system with an ammonia source and no fish yet, seeded with bacterial supplements or media from an already-established system, that timeline can drop to 10–20 days. Adding fish before this cycle is established is the single most common way a new aquaponics system fails: ammonia builds up with no bacteria to convert it, and it's directly toxic to the fish.

Tilapia is the standard beginner fish: hardy, fast-growing, and tolerant of the water-quality swings a new system inevitably has, but it needs water in the 75–85°F range and growth slows sharply below 60°F, a real heating cost in Utah's climate for anything but an indoor or actively heated setup. Start with a low stocking density, roughly 20–30% of the system's eventual fish capacity, and fast-growing leafy greens (lettuce, herbs, Asian greens) rather than heavier feeders, both to protect a colony of bacteria that's still establishing itself.

What the tank itself actually needs

Component	Spec for a beginner setup	Why it's there
Fish tank	20–40 gallons for a first system; food-grade totes or barrels work as well as an aquarium tank	Bigger volume dilutes ammonia spikes and swings temperature more slowly, both of which buy a new grower time to react
Biofilter	A separate container (a 5-gallon bucket or small barrel) packed with a high-surface-area media, clay pebbles, lava rock, or plastic bio-balls all work, that water flows through before reaching the plants	This is where most of the nitrifying bacteria colony actually lives; the grow bed's growing medium helps too, but a dedicated biofilter gives the colony far more surface area to establish on
Heater	Sized to 3–5 watts per gallon of tank volume, thermostat set in the mid-70s°F for tilapia	Without one, water temperature tracks room or outdoor temperature, and tilapia growth and appetite drop sharply below 60°F
Dechlorinator	A capful of aquarium dechlorinator treatment per the bottle's directions, or let tap water sit uncovered for 24–48 hours before adding it to the tank	Chlorine and chloramine in tap water kill fish directly and also kill the nitrifying bacteria the whole system depends on

Cycle the tank for 4–6 weeks with an ammonia source and no fish before stocking it, matching the cycling timeline described in the warning above; adding fish to an uncycled tank is the single most common way a first aquaponics build fails.

Nutrient solution and pH: hydroponics' equivalent of soil fertility

In hydroponics without fish, the nutrient solution is mixed directly rather than produced by a biological cycle, which makes pH and concentration something to actively monitor rather than something soil buffers for you.

Buy a 3-part concentrate line (General Hydroponics' Flora Series, sold as Grow/Micro/Bloom, is the standard beginner choice) rather than trying to formulate a solution from raw salts. Start from dechlorinated water: fill the reservoir with tap water and let it sit uncovered for 24 hours, or use a treatment drop, since chlorine harms roots the same way it harms fish. Mixing order matters because the three parts can react with each other directly in concentrate form: add Micro first and stir it in completely, then Grow, then Bloom, one at a time, never combining two concentrates before they've hit water. Let the mixed solution sit and aerate for 30 minutes to an hour, then test pH and adjust into the 5.8–6.3 window with a pH-up or pH-down product made for hydroponics, waiting another 30 minutes after each adjustment before rechecking.

Measure	Typical range	Why it matters
pH	5.5–6.5 for most crops; 5.8–6.3 for fruiting crops like tomatoes	Outside this range, nutrients that are actually present in the solution become chemically unavailable to the plant, a deficiency the plant shows even though the fertilizer is right there
EC (electrical conductivity)	0.8–1.2 mS/cm for seedlings, 1.2–2.0 for herbs and leafy greens, 2.0–3.5 for fruiting crops	A direct measure of how concentrated the dissolved nutrients are; too low starves the plant, too high can burn roots

EC drifts on its own as the system runs: it falls as plants actively take up nutrients, and rises as plain water evaporates or transpires away and leaves the dissolved salts behind. Correct a low reading with concentrated nutrient stock, and a high reading by adding plain water, checked regularly rather than assumed stable once mixed.

None of this is guessable by eye. A combination pH/EC/temperature meter (pen-style meters that read all three run roughly \$15–20) is a real, non-optional tool for this method, not an accessory; if buying only one instrument to start, get the pH meter first, since a pH swing causes visible plant damage faster than an EC swing does. Whatever meter is bought, keep the calibration solution that comes with it and recalibrate against it every few weeks; an uncalibrated meter that reads confidently wrong is worse than no meter at all.

Grow lights: the requirement every one of these systems has if it isn't outdoors

A hydroponic or aquaponic system run indoors, in a garage, or in a basement needs a dedicated grow light; a sunny windowsill does not deliver enough usable light intensity for anything beyond a few weak, leggy seedlings. Two numbers matter here: the light's actual output at plant height, and how long it runs each day.

Crop stage	Target intensity	Hours of light per day
Seedlings	Roughly 20–30W of LED draw per square foot of growing area	16–18 hours
Leafy greens and herbs	Roughly 25–35W per square foot, aiming for a PPFD (a direct measure of light intensity at the leaf) of 200–400 micromoles per square meter per second	14–16 hours
Fruiting crops (tomatoes, peppers)	Roughly 35–50W per square foot, PPFD of 400–700 micromoles per square meter per second	12–16 hours

A full-spectrum LED grow light fixture is the standard choice; it runs cooler and cheaper to operate than the older high-intensity discharge lights this hobby used to rely on. Wattage is a starting point, not a guarantee: two fixtures rated at the same wattage can put out very different actual light at the leaf, so check a fixture's specifications for its PPFD rating at the mounting height being used, and mount it low enough to hit the target range at canopy height rather than trusting the package wattage alone.

What actually grows well, and what doesn't

Leafy greens and herbs are the reliable performers across every system type here, fast-growing, tolerant of the nutrient swings a home system inevitably has, and forgiving of a beginner's mistakes. Fruiting crops (tomatoes, peppers, strawberries) are realistic in ebb-and-flow or DWC once the grower has a season of experience, but need more support (trellising, hand-pollination since there's no wind or bees indoors) and are less forgiving of an inconsistent nutrient solution. Root crops and large vining plants are a poor fit for hydroponics generally; the space and support they need work against nearly every system type described above.

WARNING

An honest gap: none of the five staples this site recommends is a real hydroponic crop

What to Grow names potatoes, dry beans, corn, and winter squash for calories, and cabbage for vitamin C, precisely because they store. Hydroponics doesn't serve that goal well:

- **Potatoes** are technically possible, dedicated hydroponic potato setups exist, but they need a larger grow bed than any other crop here and most home systems simply aren't built for a tuber crop; this is a specialty project, not a beginner one.
- **Corn and winter squash** are, in the words of growers who've tried, "space hogs" that take over a whole home unit for one or two plants, a poor use of a system that's expensive per square foot to begin with.

- **Dry beans** grow genuinely well hydroponically, but for fresh green beans harvested young, not the mature, dried, shelf-stable beans What to Grow actually wants; letting pods mature and dry on the vine the way a dry-bean crop requires works against everything that makes a hydroponic system worth the cost and effort.
- **Cabbage and other leafy brassicas** are the one real fit, squarely in the leafy-greens category these systems are actually good at.

The honest read: hydroponics is a genuinely good tool for fresh vitamin-completeness crops and herbs, exactly the category What to Grow treats as secondary to calorie staples, not a substitute for growing the calorie crops that guide actually prioritizes. Row crops, a food forest, or a walipini are where those staples belong; see Row Crop & Raised Bed Gardening for all five.

WARNING

The real vulnerability: most of these systems need continuous electricity

This is the honest tradeoff against row crops, a food forest, or a walipini, none of which stop working the moment the power does. In DWC and aquaponics, dissolved oxygen in standing water can drop dangerously within 30–60 minutes without the air pump running, and by up to 50% within about 3 hours; root rot and, in aquaponics, fish death follow if power isn't restored in that window. An aquaponics system's bacterial colony itself needs oxygen too, an outage past roughly 12 hours risks a real bacterial die-off that crashes the nitrogen cycle and lets toxic ammonia build back up. An indoor system run under grow lights loses that light the same moment it loses the pumps, and a multi-day outage during an indoor grow costs real growth even if the roots themselves survive. A battery-powered backup air pump or a small power station bridges a short outage; for anything longer, this is a real, structural weak point of these systems that a wick setup, with no pump or light to fail in the first place, doesn't carry at all.

Secondary crops: this is where hydroponics actually earns its place

Unlike the five staples above, several of What to Grow's six secondary crops are genuinely strong hydroponic performers, not a compromise.

- **Culinary herbs, basil especially, are one of the best crops for any of the four system types.** Basil is a standard commercial hydroponic crop for a reason: it reaches harvest in about 4 weeks under good conditions, roughly twice the speed of soil-grown basil, and does well in a simple floating raft DWC setup specifically. Grow it on its own nutrient solution rather than mixed in with other crops; basil tuned for another plant's needs doesn't perform as well.

- **Tomatoes and peppers** are the same realistic ebb-and-flow or DWC crop already covered above, now tied to What to Grow's own recommendation for fresh vitamin C and variety, not just a generic "fruiting crop" example.
- **Carrots, onions, garlic, and sunflowers don't fit**, for the same root-crop and space reasons potatoes, corn, and squash don't: carrots and onions want real soil depth or a root-crop-specific system most home growers don't have, garlic needs months in the ground doing very little, and sunflowers grown for pressing oil need field-scale space no home hydroponic system offers.

Between this and the calorie-staple gap above, the honest shape of the tradeoff is consistent: hydroponics is a real, worthwhile method for exactly the leafy-green, herb, and fruiting-vegetable categories, and a poor one for calorie-dense storage crops, root crops, and anything grown at field scale, regardless of which of the six secondary or five staple crops is in question.

Sources

- Basil as a strong hydroponic crop, floating raft system suitability, and growth-rate advantage: National Library of Medicine; Upstart University
- Hydroponic system types, comparison, and beginner suitability: Gardyn; The Growcer; NoSoilSolutions
- Aquaponics nitrogen cycle, cycling timeline, and stocking guidance: Aquaponics Revolution; Soil Free Harvest
- Tilapia temperature requirements and beginner fish selection: Lakeway Tilapia; Urban Goes Green
- Nutrient solution pH and EC ranges by crop stage, Cornell CEA program: Cornell CEA; Cornell Greenhouse Horticulture; Gardyn
- Power-outage risk, dissolved oxygen depletion timelines, and bacterial die-off: Go Green Aquaponics; DiscountHydro; AquiFarm
- Hydroponic potato feasibility and real space requirements: Why Farm It; Bigger Garden
- Corn and winter squash as impractical, space-consuming hydroponic crops; dry beans as a strong hydroponic crop for fresh pods specifically: Backyard Garden Lover; Agri Farming
- DIY DWC bucket build materials, sizing, and one-plant-per-bucket rule: NoSoilSolutions; Hydroponic Horizons
- DIY NFT channel slope, pump flow rate, and assembly: Atlas Scientific; Growlode
- Rockwool and starter-plug seed-starting method: Bright Lane Gardens; Greener Hydroponics
- General Hydroponics Flora Series mixing order and pH adjustment: NoSoilSolutions; Aqualogi
- pH/EC/TDS meter selection and calibration for beginners: NoSoilSolutions; Urban Hydro Space
- Grow-light PPF, wattage-per-square-foot, and daily light hours by crop stage: Soil Free Harvest; Trimleaf
- Beginner aquaponics tank size, biofilter, heater, and dechlorination setup: Soil Free Harvest; Go Green Aquaponics