Bato Bucket Hydroponic Systems

Guide 3 · System Build & Operation

Outdoor Hydroponics for the Dragoons

Version 2026.05 · Revised 2026-05-16

Contents

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1 · Why Bato Buckets — for the Dragoons

Dutch buckets · Cochise County conditions · what this system solves

The Bato bucket — also called the Dutch bucket — is a recirculating drip system originally developed for Dutch greenhouse tomato production in the 1970s. Each bucket holds a single plant in a soilless medium, fed by a low-volume drip line from a central nutrient reservoir. A built-in siphon elbow holds a shallow reservoir of solution at the bucket bottom between irrigation cycles; excess drains into a shared channel and returns to the reservoir. The system is simple, durable, modular, and forgiving — which makes it almost ideal for the conditions on the east side of the Dragoons.

Why this system, for this place

The Dragoon Mountains go dry in May and dry again in October, and well water in Cochise County is stubbornly hard year-round. A bato bucket on a 2×4 bench and a 15-gallon reservoir solves both problems at once: every drop of water is pre-treated for bicarbonates, fed precisely at the right EC, and captured again on the drain side of the channel. The bench frame stands free of the ground, so jackrabbits and packrats cannot easily reach the root zone. The Cropking bucket's enclosed siphon elbow keeps the small standing reservoir dark, cool, and inaccessible to mosquitoes. A small solar pump and timer covers irrigation without a wall outlet — useful on a property where outbuildings are wired loosely or not at all.

Dragoon challenge	How the bato system addresses it
Hard well water (200–500 ppm — *parts per million*, a measure of total dissolved solids in water; pH 7.5–8.5)	All water is pre-treated for bicarbonates before nutrients are added (see §4).
Intense UV and heat	Enclosed drain channel keeps solution dark; reservoir lid blocks algae and slows evaporation.
Wide diurnal swings (30–40°F)	Solution mass in reservoir buffers root-zone temperature compared to bare ground.
Rocky, alkaline native soil	Eliminates the soil entirely — coco/perlite mix gives you full control of the root environment.
Variable power infrastructure	Solar pump with built-in timer runs off-grid; no extension cord required.
Native pests (packrats, rabbits, javelina)	Plants are elevated on a bench frame above ground browse height.
Monsoon nutrient leaching	Recirculating drain captures runoff — nothing leaches into the desert.

What this guide covers

This is the systems guide. It covers building the bench, plumbing the buckets, treating the water, programming the pump, and keeping the whole rig running across the Dragoon season. It does **not** cover what to plant — for the pepper-specific cultivation track see Guide 2; for the nutrient program that drives the system see Guide 4.

> This guide is the canonical home for the **5-step Cochise bicarbonate water-treatment protocol** (§4). Every other guide in this library that mentions water treatment refers back to this section.

2 · Equipment & Components

Parts list · sourcing · what to buy and where

The component list below is for a 20-bucket, 2-row build — enough for a serious household pepper operation plus a row of tomatoes or cucumbers. Scale up or down by changing the number of buckets and reservoir capacity proportionally. All sourcing is verified for Cochise County (Sierra Vista, Benson, Willcox) availability as of 2025.

Core components

Component	Specification
Cropking Bato Buckets	12“×10”×9” UV-resistant plastic with built-in drain port and two siphon elbows. Maintains a 2” nutrient reservoir at the bucket bottom between irrigation cycles. Sold in cases of 10 with free UPS shipping.
Drain channel	2×3 inch vinyl downspout with 2” holes drilled in the top face at each bucket position. Enclosed channel keeps drain solution dark, cool, and debris-free.
Reservoir	15-gal ACE Hardware black/yellow utility tub — fill to ~12 gal working volume. Keep lid on to block light and reduce evaporation.
Pump & timer	RAINPOINT solar automatic watering pump (B0DQ4DQL33) — solar-powered with built-in programmable timer. No wall outlet required. Minimum supported cycle interval is 8 hours.
Supply line	1/4” spaghetti tubing from RAINPOINT outlet to drip stakes at the base of each plant.
Growing medium	Coco coir / perlite blend (preferred). Coco provides moisture retention and cation exchange buffering; perlite ensures drainage and aeration. Both available at ACE Hardware or bulk from Amazon.
Nutrients	Masterblend 4-18-38 + bulk calcium nitrate (50 lb bags) + Epsom salt. 3-part system mixed directly into pre-treated reservoir water. **Full recipe lives in Guide 4.**

Tools & additional hardware

Tool	Purpose
Drill + 2” hole saw	Drain holes in downspout top face
Level	Verify bench slope
Small wedge / shim	~1/4” elevation on uphill bench end
Digital scale (0.1 g)	Accurate nutrient weighing
pH meter	Check daily — target 5.8–6.2
EC/TDS meter	Monitor concentration daily. **EC** is *electrical conductivity*, reported in mS/cm (millisiemens per centimeter); **TDS** is *total dissolved solids*, reported in ppm. Same underlying measurement, two units. A typical fruiting reservoir runs EC 2.0–2.8 mS/cm (≈1000–1400 ppm).
1/4” barbed tee fittings	Branch supply at each bucket
2×3 elbow + end cap	High end of drain channel — enclosed
45° / 90° elbow	Low end — drain return into reservoir
Mesh screen	Cover reservoir return — catches debris
Zip ties	Secure supply line to bench frame
White vinegar	Monthly descale of pump & emitters

LOCAL TIP

Sourcing note for Cochise County: ACE Hardware in Sierra Vista, Benson, and Willcox all stock the 15-gallon utility tub, 2×3 vinyl downspout sections, concrete blocks, and most lumber items. Order the Cropking buckets and RAINPOINT pump online — they are not stocked locally. Plan a single Amazon order plus one trip to ACE Hardware to gather most of the build.

3 · Bench Construction & Assembly

Dimensions · slope · drilling · medium fill

Bench frame

Item	Specification
Bench surface	Four 2×4×8 boards laid flat side by side. Provides a solid platform for the bato buckets and downspout channel with minimal flex.
Supports	Three 8×8×16 concrete building blocks at each end. Inexpensive, stable, no anchoring required on a patio surface.
Slope method	Place a ~1/4” wedge under the uphill end of the bench — almost any thin scrap works: wood shim, flat stone, plywood offcut. This minimal elevation creates sufficient gravity slope along the full 8-foot run.
Checking slope	Lay a level along the bench after shimming. The bubble should lean consistently toward the reservoir end. Adjust wedge before fixing the downspout.

Downspout installation

1. **Mark hole positions.** With downspout flat on a work surface, mark hole centers on the top face at your chosen bucket spacing — 12” for peppers/herbs, 18–24” for tomatoes.
2. **Drill 2” holes — reverse technique.** Start in forward direction with just the pilot bit to lock center. Once hole saw teeth contact vinyl, switch drill to reverse. Reverse rotation scrapes rather than bites, producing a clean hole without cracking or binding. Back with a scrap 2×4 underneath.
3. **Deburr all holes.** Run a utility knife around each hole interior. Smooth edges prevent root debris from catching over the season.
4. **High end — elbow and cover.** At the uphill (high) end, install a 2×3 downspout elbow and cap it fully. This closes off the terminus so solution cannot back up or overflow out the high end, and keeps the channel completely enclosed — no light, insects, or debris.
5. **Low end — elbow to reservoir.** At the downhill end, fit a 45° or 90° elbow directing flow down into the 15-gal ACE tub. Keep the outlet below the waterline to reduce splashing.

6. **Mount and place buckets.** Fix downspout on bench at confirmed slope. Set each Cropking bucket so the built-in drain port drops through its 2” hole. No fittings or sealant needed.
7. **Fill with coco/perlite.** Pre-wet coco and break up compressed blocks. Mix coco/perlite — 70/30 is a solid starting ratio. Fill each bucket to within 1–1.5” of the rim.

LOCAL TIP

Tip: Drill all holes before mounting. Working flat on sawhorses is far easier than drilling in place on a sloped, fixed channel.

WARNING

Never use potting soil in bato buckets. It will clog the Cropking drain port within days. Coco/perlite or perlite-only media only.

Figure 1: A finished dual-row bato build on a stone patio. Two 8-ft benches, downspout channels sloped to a reservoir at the far end, hanging LED rail overhead — the canonical layout this chapter is describing.

4 · Water Treatment — The Cochise Bicarbonate Protocol

The canonical 5-step procedure for SE Arizona well water

Water quality is the single most important variable in Cochise County hydroponic growing. Well water in the valleys below the Dragoons — Sulphur Springs, San Pedro, Whetstone — is consistently hard, alkaline, and high in bicarbonates. Skipping this section will cost you a crop. **Always treat your source water before adding any nutrients.**

This section is the authoritative home for the 5-step bicarbonate protocol. Other guides in this library that touch on hydroponic water — Guide 2 §6 (hydroponic peppers), Guide 4 (nutrient mixing), Guide 1 (the primer) — all cross-reference back here.

The bicarbonate problem

Bicarbonates (HCO_3^-) are the main culprit in hard-water pH instability. They are not removed by ordinary pH adjustment — they act as a chemical **buffer**, neutralizing acid as it is added and pushing pH back up within hours. The fix is to neutralize them first, before any nutrients enter the reservoir. This is what the 5-step protocol does.

> **Why peppers care:** Bicarbonates do not just push pH around — they directly inhibit iron and manganese uptake at the root surface, even when pH is technically in range. Untreated bicarbonates show up as new-growth chlorosis (interveinal yellowing on the youngest leaves) that does not respond to pH correction alone. You have to remove the bicarbonates.

Step 1 — Test your source water

Before anything else, characterize what you are starting with. Take one good reading and keep it in your notebook — it does not change much across the year.

Instrument	Purpose
EC/TDS meter	Measures dissolved minerals already in your water. SE AZ well water commonly reads 200–500 ppm before any nutrients are added.
pH meter	Target 5.8–6.2 for peppers. Local well water often reads 7.5–8.5.
Alkalinity test strip (optional)	Reports total bicarbonate/carbonate in ppm $CaCO_3$. Above ~120 ppm $CaCO_3$ requires the full protocol below. SE AZ well water typically reads 150–300+ ppm.

Instrument	Purpose
Starting EC adjustment	If your source water EC is already 0.3 or higher, reduce your Masterblend dose proportionally (see Guide 4). Plants cannot distinguish source minerals from added nutrients — excess causes toxicity.

Step 2 — Pre-treat for bicarbonates (the 5-step protocol)

This is the procedure. Run it every time you make up a fresh reservoir.

Step	Action	What happens
1. Fill	Fill reservoir with source water to working volume (~12 gal in a 15-gal tub). Let stand 15 min if water is cold — warmer water reacts faster.	Starting pH likely 7.5–8.5; EC 0.3–0.8.
2. Acid in	Add acid slowly while stirring. Use citric acid stock (1 g/mL) or commercial pH Down (phosphoric). Dose 0.5–1 mL per gallon to start, more if needed.	Bicarbonates react with the acid — water visibly **fizzes** as CO_2 releases.
3. Wait for fizzing to stop	Stir gently every minute. The fizz dies off as bicarbonates run out. This typically takes 5–15 minutes. Do not move to the next step until the surface is calm.	All bicarbonates are neutralized — the buffer is gone.
4. Adjust pH to 5.8–6.0	Add small additional doses of pH Down (or pH Up if you overshot) and wait 5 min between checks. With bicarbonates removed, pH responds quickly and stays stable.	pH is now stable — it will not bounce back up overnight.

Step	Action	What happens
5. Add nutrients in correct order	Add Masterblend → Epsom → calcium nitrate in that order, dissolving each before the next. **See Guide 4 for the full recipe.**	Nutrients dissolve cleanly into pre-treated, stable water. No precipitation, no lockout.

WARNING

Never skip Step 3. Adding nutrients while bicarbonates are still active causes calcium and magnesium to precipitate as carbonate scale within hours — visible as cloudiness, white film on tub walls, or chalky residue at the bottom of the reservoir. Your nutrients are now locked up and your plants are starving.

Always add calcium nitrate LAST. Even in pre-treated water, adding calcium nitrate to a concentrated Masterblend slurry causes immediate calcium-sulfate precipitation and nutrient lockout. Dissolve each component fully before adding the next. This rule is the same in every hydroponic system in this library — it is repeated in Guide 4 for that reason.

Step 3 — Choose your acid and base

Acid (pH Down)	Strength	Notes
Prickly pear vinegar (foraged)	pH 3–4	Best local option — unlimited supply once you have a patch. Ferment crushed prickly pear juice open to air 2–4 weeks. Gentle, easy to dose. See Guide 4 Part 3 for the full recipe.
Food-grade citric acid (powder)	Precise	Best purchased option — very accurate dosing. Dissolve in water to make 1 g/mL stock. Standard choice for the protocol above.

Acid (pH Down)	Strength	Notes
Phosphoric acid (commercial pH Down)	Very strong	Most reliable for hard well water. Adds a small amount of phosphorus — a benefit, not a problem, during fruiting.
Sulfur burn	pH 1–2	Strong — fumes are irritating, outdoors only. Not recommended for routine use.

Base (pH Up)	Strength	Notes
Oak ash lye	pH 11–13	Local option — also adds potassium. Pack ash in a container, pour rainwater through, collect the dark liquid. Dilute heavily. See Guide 4 Part 3.
Potassium hydroxide (commercial pH Up)	Strong	Most reliable and precise. Standard commercial choice.
Baking soda	Gentle	Easy to dose but **sodium accumulates** in the reservoir over time — use sparingly.

RELATED GUIDES

For step-by-step recipes for every acid and base listed here — prickly-pear vinegar, fermented citric acid, phosphoric-acid dilution, oak-ash lye — see **Guide 4 Part 3 · pH adjustment**.

Step 4 — Water source quality ranked

If you have a choice of water sources, rank them like this. The cleaner you start, the less work the protocol does.

Source	Baseline EC	Baseline pH	Treatment needed	Rating
Monsoon rainwater (collected)	< 20 ppm	6.0–6.5	Minimal — just pH fine-tune	Best
RO filtered water	< 50 ppm	6.5–7.0	Light pH adjustment	Excellent
RO / rain 50:50 blend	0.1–0.2	6.5–7.0	Light pH adjustment	Very good
Treated well water	0.3–0.8	After protocol	Reduce nutrient dose to account for base minerals	Usable
Untreated well water	0.3–0.8	7.5–8.5	Full 5-step protocol — do not skip	Difficult

LOCAL TIP

Monsoon tip: July–September monsoon rainwater is your best possible source water — < 20 ppm, near-neutral pH. Set up even a simple roof catchment system. A 500 sq ft covered patio collects 3,000+ gallons per monsoon season. Store in dark, covered tanks. Using monsoon water eliminates the bicarbonate problem entirely for the second half of the season — Step 2 collapses to a small pH nudge.

5 · Plumbing, Power, and Solar Pump

RAINPOINT setup · supply line · cycle limits

RAINPOINT solar pump setup

Item	Specification
Solar panel	Mount south-facing with 4–6+ hours of direct sun. In a high-desert SE Arizona location this is rarely a constraint. The adjustable bracket optimises angle by season.
Intake tube	Submerge in 15-gal reservoir — clip or weight below waterline, off the bottom to avoid drawing up settled minerals.
Outlet / supply line	1/4” tubing from RAINPOINT outlet along bench. Tee off at each bucket with barbed fittings; run spaghetti segment to drip stake at base of each plant.
No outlet needed	RAINPOINT handles pumping and scheduling in one unit. No separate submersible pump or cycle timer required.

What the timer can and cannot do

The RAINPOINT timer supports a **minimum interval of 8 hours** between cycles. Three cycles per day (6:00 AM / 2:00 PM / 10:00 PM) is the maximum frequency this timer supports. This is a hardware limit, not a setting — you cannot reduce it further.

For the Dragoons’ typical pepper/tomato schedule this is fine — coco/perlite holds moisture comfortably across 8-hour intervals through most of the season. The exception is the pre-monsoon stretch (mid-May through late June), when daytime highs cross 100°F and the air is still bone-dry. The interventions for that period live in §6.

LOCAL TIP

Backup pump trick: If hot-month wilting between cycles becomes a recurring problem, add a second small pump on a separate $15–20 ACE hose timer set to a short midday cycle (5 min at 12:00). This sidesteps the RAINPOINT’s 8-hour floor without replacing the main system.

Figure 2: Freshly-filled bato buckets with the perlite/coco mix packed and the 1/4-in supply line teed to each drip stake. The overhead LED rail is mounted but not yet powered — this is the state of the bench the day before transplant.

6 · Operating the System

Irrigation programming · runoff · daily and weekly maintenance

Irrigation programming

Parameter	Setting
Cycle duration	10 minutes per cycle
Cycle interval	Every 8 hours — 3 cycles per day
Example schedule	6:00 AM / 2:00 PM / 10:00 PM
Transplant stage	Reduce to 5 min / 8 hr for week 1. Step up to 10 min once roots are visibly active.
Runoff target	10–20% of feed volume per cycle — a steady drip from the low-end drain elbow after each cycle.

Stage	Cycles/day	Duration	Notes
Transplant week 1	3	5 min	Keep medium moist, not saturated. Coco retains well — err toward drier.
Vegetative	3	10 min	Standard schedule. Coco/perlite holds moisture comfortably through 8-hour intervals.
Fruiting / peak	3	10 min	Standard schedule. Add manual cycle if wilting observed mid-interval.
June pre-monsoon (critical)	3 max	10 min	Highest risk period — 8-hr intervals may not be sufficient above 100°F. Monitor closely. Shade cloth and reservoir insulation are essential.

Stage	Cycles/day	Duration	Notes
Peak summer heat (100°F+)	3 max	10 min	RAINPOINT cannot cycle more frequently. If wilting persists between cycles, shade cloth and reservoir cooling are the primary interventions.
Monsoon (July–Sept)	3	10 min	Ambient temps drop and humidity rises — the 8-hr interval becomes comfortable again. Rocoto and habanero hit peak production.

Pepper Mg rule: Once fruit sizing begins, increase Epsom salt in the reservoir to **2.4 g/gal** — double the standard rate. This is the single system-operational nutrient knob you adjust at the bucket level. The full Masterblend program (Masterblend / calcium nitrate / Epsom by stage) lives in **Guide 4**.

Operating the system day-to-day

The Masterblend program in Guide 4 drives what goes in the reservoir; this guide drives what happens between reservoir changes. Treat them as separate jobs.

RELATED GUIDES

Nutrient program: All Masterblend doses (per-stage Masterblend / calcium nitrate / Epsom rates, target EC, mixing order, and stage-by-stage adjustments) live in **Guide 4 — Hydroponic Nutrients (Part 1)**. Operate this system; refer to Guide 4 for what to mix.

Reading runoff

Observation	Diagnosis
Target runoff	10–20% of feed volume — a steady drip from the low-end drain elbow after each 10-min cycle.
Zero runoff	Under-watering or clogged emitter. Check stakes immediately.
Excessive runoff (> 30%)	Cycle too long. Reduce to 7–8 min and observe.
Drain EC higher than feed EC	Roots concentrating solution — top off with plain water; consider partial reservoir change.
Drain EC much lower than feed	Plants drinking nutrients heavily — top off with half-strength mix.

Daily checks

- Confirm RAINPOINT solar panel is unobstructed and battery shows adequate charge.
- Verify all drip stakes are flowing during a cycle — walk the row and check for dry buckets.
- Check reservoir level — top off with plain pH-adjusted water between full nutrient changes.
- Log EC and pH daily — track drift direction to catch patterns before they damage plants.
- During hot months: check for wilting 4–5 hours after the morning cycle. Wilting before the next cycle is a heat stress signal requiring shade or reservoir cooling.

Weekly tasks

- Full reservoir drain + fresh nutrient mix (every 7–10 days during fruiting; every 14 days during vegetative growth).
- Flush 2×3 drain channel with clean water — root debris accumulates.
- Inspect and replace any clogged drip emitters.
- Check RAINPOINT intake filter screen — clear scale and sediment.
- Inspect high-end downspout elbow and cover — check for blockage or root intrusion.
- Soak RAINPOINT intake strainer in white vinegar — clears calcium scale from bulk nitrate.
- Wipe solar panel clean — dust and debris reduce charging efficiency.
- Check supply line tee fittings for drips or separation.
- Calibrate pH meter with buffer solution (pH 4.0 and 7.0) — inaccurate meters are the #1 cause of unexplained deficiencies.

- Check bench slope — settlement can reduce drainage over time.

End-of-crop system flush

1. **Drain and strip.** Drain reservoir. Pull plants, remove coco/perlite — coco is best replaced each season; perlite can be sanitised and reused.
2. **Water flush.** Fill with plain water and run RAINPOINT through several cycles to flush lines, stakes, and drain channel.
3. **H_2O_2 sanitise.** Mix 3 mL/gal of 3% hydrogen peroxide. Run through entire system once. Sit 15 min, then flush with plain water.
4. **Descale emitters.** Soak RAINPOINT intake screen and drip stakes in white vinegar 30 min. Rinse thoroughly. Calcium nitrate scale is the primary flow restrictor in this system.
5. **Clean buckets.** Rinse Cropking buckets — sloped floor drains completely. Flush downspout channel and inspect both elbows. Air dry before next crop.

> **WARNING**
>
> **Never reuse irrigation water from a previous crop that showed root-zone disease.** *Pythium* (a warm-water root-rot pathogen that thrives in reservoirs above 72°F), *Fusarium*, and other root pathogens survive in the recirculating solution and downspout biofilm. If a crop showed wilting, browned roots, or stem-base mush at any point, perform a full H_2O_2 sanitise plus a 10% bleach flush of the downspout channel before replanting. When in doubt, replace the medium and the supply line, not just the solution.

7 · Adapting the System

Peppers → cool-season → tomatoes · between-crop sanitation · nutrient retuning

The bato system is designed around peppers, but the bench, plumbing, reservoir, and solar pump are crop-agnostic. With minor changes you can run a fall/winter cool-season crop in the same buckets, or switch to determinate tomatoes for summer. This section is the operational checklist for switching crops. The cultivation details for each crop live in the matching guide.

Figure 3: A two-tier bato rack on a covered patio — the same components stacked vertically to double yield per square foot of slab. Overhead LED rails are mounted per tier; the lower tier picks up bounce light and shoulder-season sun. Potted citrus behind shows the same patio doing multiple jobs at once.

What changes between crops

System parameter	Peppers	Cool-season (greens, brassicas)	Tomatoes
Bucket spacing	12” centers	10–12” centers; 8” for cut-and-come-again lettuce	18–24” centers (rebuild downspout holes)

System parameter	Peppers	Cool-season (greens, brassicas)	Tomatoes
Cycle frequency	3×/day, 10 min	3×/day, 5–7 min (lower transpiration)	3×/day, 10–12 min (higher transpiration)
Target EC	1.4–2.6 by stage (see Guide 4)	1.0–1.6 (lower — easy to overdo)	2.0–3.0 by stage (highest of the three)
Target pH	5.8–6.2	6.0–6.5 (especially brassicas)	5.8–6.2
Mg dosing	1.2 g/gal Epsom; 2.4 at fruit sizing	0.6 g/gal Epsom — much less	1.2–1.8 g/gal Epsom
Reservoir temp goal	Cool — peppers tolerate warmth but roots prefer < 75°F	**Cool — < 70°F.** Greens bolt and brassicas struggle above this.	Cool — < 75°F. Tomatoes split fruit at high root temps.
Trellising	In-bucket stakes for peppers; multi-string for Rocoto	None for most greens; light for brassicas	Heavy — overhead twine system, not in-bucket stakes
Companion guide	**Guide 2**	**Guide 6**	(Future — uses Guide 4 program scaled to tomato EC)

Switching from peppers to cool-season (fall changeover)

In the Dragoons this is typically a late-September to mid-October transition — peppers wind down, lettuce and brassicas come in. The whole bench can stay in place.

1. Pull peppers and roots. Strip coco/perlite as in §6 End-of-Crop Flush.
2. Run the full sanitation cycle (water flush → H_2O_2 → descale → rinse).
3. **Replace coco** in any bucket that showed root-zone problems; reuse otherwise. Perlite can always be reused after rinse.
4. **Drop target EC** to 1.0–1.6 in Guide 4's program. Greens are far more sensitive to over-feeding than peppers — a 2.4 g/gal Masterblend pepper dose will burn lettuce.
5. **Raise target pH** to 6.0–6.5, especially if running brassicas. See Guide 6 for the crop list and per-variety notes.
6. **Shorten cycle duration** to 5–7 min — leafy crops transpire less than fruiting peppers.
7. **Insulate the reservoir** through fall: cool-season crops want cooler roots, not warmer. The reservoir under partial shade is usually sufficient through October–

February at Dragoon elevation.

Switching from peppers to tomatoes (or running both)

Determinate slicing tomatoes work in the same buckets with two adjustments — wider spacing and a real trellis system.

1. If you can, **redrill the downspout** at 18–24” centers; tomato roots crowd at 12” pepper spacing. If you cannot redrill, leave every other bucket empty.
2. Build an **overhead twine trellis** above the bench — a horizontal 2×4 cross-piece supported by posts at each end, with a length of jute twine dropped to each bucket. Train the main stem up the twine, prune suckers weekly. This replaces the in-bucket pepper stake system entirely.
3. **Raise target EC** to 2.0–3.0 across the program — tomatoes are heavier feeders than peppers and tolerate higher EC at fruiting (see Guide 4 for a future tomato column; for now, scale the Masterblend pepper program proportionally).
4. **Increase Mg slightly** — 1.2–1.8 g/gal Epsom — but not as high as the 2.4 g/gal pepper fruiting dose. Tomato Mg demand is real but lower than pepper.
5. **Reservoir cooling matters more.** Tomato fruit split correlates strongly with hot-root events. In June, shade or insulate the reservoir tub directly.

Cleaning and sanitizing between crops

Between any two crops — same crop family or not — run the full §6 End-of-Crop Flush. Between crops that showed disease symptoms, escalate to the bleach pass in the §6 warning callout. The downspout channel is the single most-overlooked reservoir of root pathogens; flush it deliberately.

RELATED GUIDES

- **Guide 2 — Peppers in the Dragoons** for pepper cultivation, varieties, and staking.
- **Guide 4 — Hydroponic Nutrients** for retuning the Masterblend program to each crop (target EC, Mg adjustments, stage tables).
- **Guide 6 — Cool-Season Crops** for the brassica/lettuce/allium track that runs October through March in these buckets.

8 · Materials List & Cost Breakdown

One-time infrastructure · per-season consumables · where to buy

Estimated costs for a 20-bucket, 2-row build. Prices approximate as of 2025 — verify before purchasing.

Bench & infrastructure (one-time)

Item	Source	Est. cost
Cropking Bato Buckets — case of 10 with elbows	cropking.com — free UPS shipping	~$70–80 / case
20 buckets = 2 cases		~$140–160 total
2×4×8 lumber (×4 per bench)	Home Depot / Lowes	~$20–28 per bench
8×8×16 concrete building blocks (6 per bench)	Home Depot / Lowes	~$25–35 per bench
2×3 vinyl downspout (10 ft lengths)	Home Depot / Lowes	~$20–25 total
2×3 downspout elbows + end caps	Home Depot / Lowes	~$12–18 total
RAINPOINT solar pump (B0DQ4DQL33)	amazon.com/dp/B0DQ4DQL33	~$35–50 each
15-gal ACE Hardware utility tub (×1–2)	ACE Hardware	~$15–20 each
1/4” drip tubing + tee fittings + stakes	Amazon / irrigation supply	~$15–25
pH meter + EC/TDS meter	Amazon	~$25–55 total
2” hole saw bit	Home Depot / Amazon	~$8–15
Infrastructure subtotal — 20 buckets, 2 rows		**~$315–490**

Nutrients & consumables (per season)

Item	Source	Est. cost
Masterblend 4-18-38 — 25 lb bag	Amazon / powergrowsystems.com	~$60–75
Calcium nitrate — 50 lb bag (bulk)	Amazon / local farm supply	~$35–55
Epsom salt (magnesium sulfate) — 25 lb	Amazon / local	~$15–25
Coco coir — loose bag or compressed brick	ACE Hardware / Amazon	~$20–40

Item	Source	Est. cost
Perlite — large grade, 4 cu ft bag (×2–3)	ACE Hardware / Amazon	~$50–105
pH Down (citric or phosphoric acid)	Amazon / hydro shop	~$10–18
pH Up (potassium hydroxide)	Amazon / hydro shop	~$8–15
Replacement drip emitters (annual)	Amazon	~$8–12
Consumables subtotal per season		**~$206–345**

LOCAL TIP

Cost note: Bulk Masterblend + calcium nitrate + Epsom salt costs under $0.05 per gallon at 2025 bulk pricing. A 25 lb Masterblend bag paired with a 50 lb calcium nitrate bag produces approximately 2,000+ gallons of full-strength solution. The RAINPOINT solar pump eliminates the cost of a separate submersible pump (~$25–50) and digital cycle timer (~$20–40).

Where to buy

Item	URL / source
Cropking Bato Buckets (case of 10)	cropking.com/collections/bato-bucket-systems/products/bato-buckets-2-elbows
RAINPOINT Solar Pump (B0DQ4DQL33)	amazon.com/dp/B0DQ4DQL33
Masterblend 4-18-38 (25 lb)	amazon.com/dp/B071V8B4FL
Masterblend 3-part bulk combo kit	powergrowsystems.com — Masterblend Master Kit
Calcium nitrate 50 lb bulk	Amazon — search “calcium nitrate 50 lb hydroponic”
Coco coir + perlite	ACE Hardware (in-store) or Amazon bulk
2×3 vinyl downspout & elbows	Home Depot / Lowes — gutter & roofing section
8×8×16 concrete blocks	Home Depot / Lowes — masonry section
15-gal utility tub	ACE Hardware — black/yellow utility tub, in-store

9 · Troubleshooting Common System Issues

System-side failures only — crop and nutrient issues live in Guide 2 and Guide 4

This troubleshooting table is for **system** issues — pumps, drains, scale, pressure, flow. Symptoms that look like crop or nutrient problems (deficiency colours, fruit deformities, blossom drop) belong in Guide 2 (cultivation) or Guide 4 (nutrient deficiency reference).

Symptom	Likely cause	Fix
No flow from any drip stake during cycle	Solar panel discharged, intake clogged, or supply line kinked	Check RAINPOINT battery indicator. Inspect intake screen for calcium scale — soak in vinegar 30 min. Walk supply line for kinks.
Flow from some stakes but not others	Clogged individual emitter or tee fitting	Pull suspect drip stake, flush backward with water. If scale-blocked, soak in vinegar; if root-grown-in, replace stake.
Reservoir level dropping faster than expected	Drain channel not returning to reservoir; low-end elbow misaligned; leak in supply tubing	Watch a full cycle. Confirm drip from low-end elbow into tub. Check every tee fitting for spray.
Reservoir level not dropping at all	No flow reaching plants, or pump not running	Verify pump cycling at scheduled time. If pump is silent, check solar battery; if pump runs but no flow, check intake screen.
White crust on tub walls or buckets	Calcium carbonate scale — bicarbonates not fully neutralized in Step 3 of §4	Confirm fizzing stops fully before adding nutrients. Drain and rerun the protocol on next reservoir. Soak tub in vinegar at next changeover.
Cloudy reservoir within 24 hr of mixing	Calcium-sulfate precipitation — nutrients added in wrong order, or calcium nitrate not fully dissolved	Drain, restart from Step 1 of §4. Always Masterblend → Epsom → calcium nitrate, fully dissolved between each.
Algae bloom in reservoir	Light reaching solution — lid off, or translucent tub	Replace lid. Switch to opaque (black/yellow) tub. Drain, sanitize with 3 mL/gal H_2O_2, refill.

Symptom	Likely cause	Fix
Drain solution warm to the touch	Tub in direct sun without shade or insulation	Move tub to shade or wrap with reflective insulation. Reservoir temperature above 80°F invites root disease.
Drain channel smells sulfurous / sour	Anaerobic biofilm in the downspout — root debris fermenting	Flush channel with plain water; run H_2O_2 at 3 mL/gal through next cycle. Inspect high-end elbow for clogs.
Buckets sitting in standing water	Bench not sloped, or downspout flat	Recheck level. Add/adjust the 1/4” wedge under the uphill end.
Pump runs but no audible flow	Air lock in intake, or pump fully scaled	Lift intake briefly to clear air. If no improvement, dismantle and soak pump head in vinegar 1 hr.
Visible roots growing into drain channel	Drain channel access through bucket port — roots seeking moisture	Trim back at the port. Normal in late season; flush channel weekly.
Solar pump never charges fully	Panel dusty, shaded, or angled wrong	Wipe panel. Reposition for 4–6 hr direct sun. Adjust seasonal angle on the mounting bracket.
pH climbs back overnight	Bicarbonates were not fully neutralized (Step 3 truncated)	On next reservoir, wait visibly longer at Step 3 — surface must be completely calm before moving on.

10 · Sources & references

Reference material consulted, suggested for further reading, and where to verify or extend the claims in this guide.

Local resources

- **UA Cooperative Extension — Cochise County office (Sierra Vista)** — soil and water testing, alkalinity workups, and Cochise-specific irrigation bulletins. Phone 520-458-8278.
- **ACE Hardware (Sierra Vista, Benson, Willcox)** — 15-gallon utility tubs, 2×3 vinyl downspout, concrete blocks, lumber, and most non-specialty hardware in this guide.
- **Sulphur Springs Valley feed and farm supply stores** — bulk calcium nitrate (50-lb bags) and bulk Epsom salt at agricultural pricing rather than hobby pricing.
- **Native Seeds/SEARCH (Tucson)** — local pepper, tomato, and basil seed adapted to high-desert hydroponic systems.

Books & references

- *Hydroponic Food Production* by Howard Resh — the standard commercial reference. The Dutch / Bato bucket lineage, drip-irrigation engineering, and reservoir-management theory all originate here.
- *Hydroponics: A Practical Guide for the Soilless Grower* by J. Benton Jones — water chemistry, EC management, and the bicarbonate problem in arid-region wells covered with unusual depth.
- *Hobby Hydroponics* by Howard Resh — the small-system / homestead companion to the production text, closer in scale to a Dragoon backyard build.
- *The Vegetable Gardener's Guide to Permaculture* by Christopher Shein — for integrating a hydroponic bench into a rain-catchment and graywater landscape.

Online resources

- **Cropking** (cropking.com) — Bato bucket case orders, replacement elbows, and original Dutch-bucket engineering documentation.
- **UA Cooperative Extension publications** (extension.arizona.edu) — alkalinity, sodicity, and well-water treatment bulletins specific to SE Arizona aquifers.
- **OMRI (Organic Materials Review Institute)** (omri.org) — verify hydrogen peroxide, citric acid, and any other system-sanitation input for organic-program compatibility.
- **PennState Extension hydroponics bulletins** (extension.psu.edu) — generic recirculating-system disease management (*Pythium*, *Fusarium*) with protocols that adapt cleanly to the Dragoons.

The Dragoon Mountains go dry in May and dry again in October, and well water in Cochise County is stubbornly hard year-round. A bato bucket on a 2×4 bench and a 15-gallon reservoir solves both problems at once: every drop of water is pre-treated for bicarbonates, fed precisely at the right EC, and captured again on the drain side of the channel. This is how Rocoto and jalapeño keep producing when the monsoon is late, the well is salty, and the summer sun is at its hardest. Build the benches, treat the water, and refer to Guide 4 for the nutrient program — the peppers will take care of themselves.