PRO SETUP TIPS FOR COMMERCIAL GREENHOUSE AQUAPONICS SYSTEMS

PROVEN DESIGN AND BUILD TIPS, BEST PRACTICES,
AND EXPERT ADVICE FOR BETTER PERFORMANCE

PROSPIANT

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INTRODUCTION

In 2024, greenhouse-based aquaponics systems captured around 45% of the global aquaponics market revenue, according to a market analysis report by Grand View Research. [Source: Aquaponics Market Size And Share | Industry Report, 2030]

That growth is no accident. Aquaponics is a sustainable, resource-efficient food production model that lines up perfectly with consumer demand for locally grown, eco-friendly food.

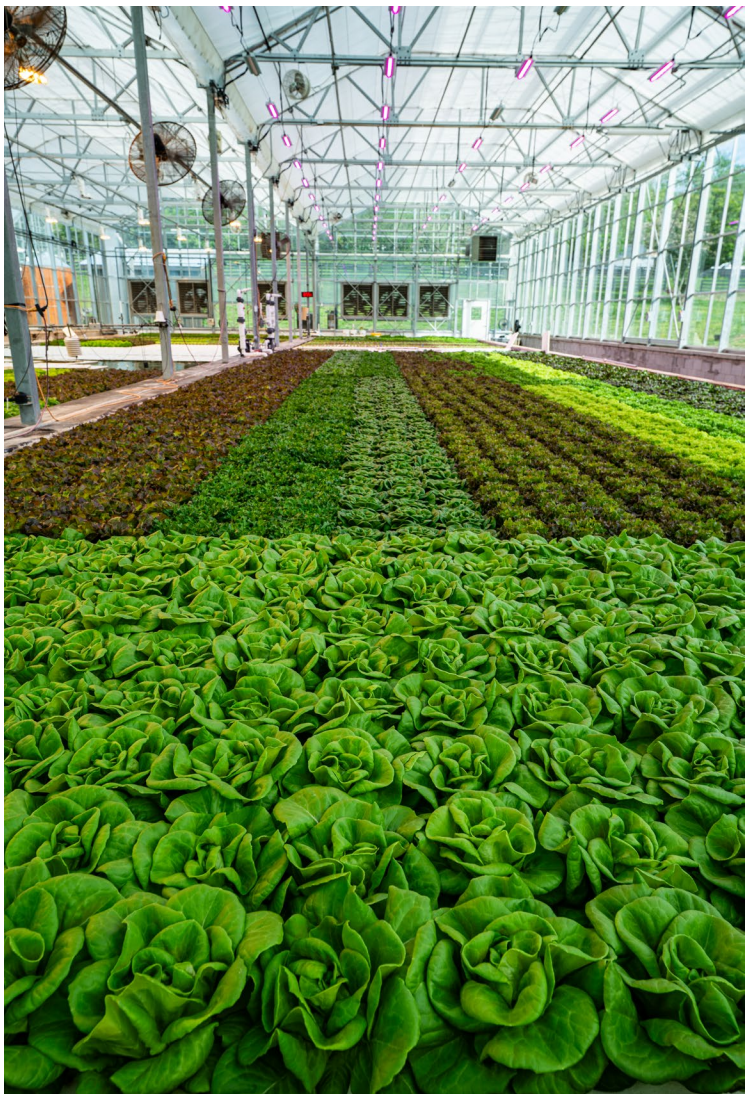
As one of the fastest-growing segments of the controlled-environment agriculture (CEA) industry, greenhouse-based aquaponics systems have strong appeal with the promise of two revenue streams—plants and fish—year-round.

But turning those promises into profits starts with balance.

Fish and plants in aquaponics systems form a symbiotic partnership, each relying on the other to survive. The consequences of an unbalanced aquaponics setup show up fast: sick fish, struggling crops, and costly losses.

The difference between a thriving and failing aquaponics system comes down to planning. The growers who succeed build balance into their system from the beginning, making sure structural layouts, system flow, and operations work seamlessly together.

This whitepaper gives you pro setup tips from the experts at Prospiant to help you design your greenhouse aquaponics system the right way, so your setup stays reliable, efficient, and profitable, without wasting time, money, or crops.



WHAT IS AQUAPONICS AND WHY IT'S TAKING OFF

Aquaponics combines soilless or water-based plant production (hydroponics) with fish farming (aquaculture) in a circular, closed-loop system.

But it's not just two systems side by side. It's mutualistic:

- Fish produce waste — waste becomes nutrients for plants
- Plants absorb nutrients — plants purify water for fish

Compared to traditional agriculture, the merger of these eco-friendly growing systems uses fewer nutrients and resources, reduces the need for synthetic nutrients, and minimizes nutrient pollution in our waterways, all while occupying less space.

A recent forecast from Future Market Insights projects the global aquaponics market will be worth $1.8 billion (USD) in 2025, with growth expected to reach nearly $3.9 billion by 2035.

The rise is largely driven by a growing interest in chemical-free, locally produced food, particularly in water-scarce areas, according to the Future Market Insights report.

WHY A GREENHOUSE IS THE ENGINE OF AN AQUAPONICS SETUP

In a strictly coupled aquaponics setup, where everything interconnects, you need a balanced environment where the fish and plants can each do their jobs without disrupting the other. In this case, consistency is everything.

That's where greenhouses come in. They give you the ability to control the environment with consistency—something outdoor growing simply can't match.

In most aquaponics facilities, the greenhouse side of the operation generates most of the revenue. Plants grow much faster than fish, so your production output is much higher on the plant side.

Molly Stanek, Executive Director of the Aquaponics Association, noted in the CEAg World article "Looking to 2025 and Beyond: Aquaponics", that in her experience, fish have not proven to be the major revenue driver, and operators expecting an even 50/50 split in revenue between fish and plants are likely to be disappointed."

The greenhouse then becomes the engine fueling the aquaponics system, supporting the plants that clean the water, producing the most biomass, and providing the control you need to keep everything running smoothly.

However, the greenhouse is just one piece of the bigger picture. Your entire operation needs to function as a complete system, from where you grow the plants to where you raise the fish, test the water, and process the harvest.

Let's start by breaking down the four core buildings that make a commercial aquaponics setup work.

FOUR CORE BUILDINGS IN A SUCCESSFUL AQUAPONICS OPERATION

A well-designed aquaponics setup for commercial use includes four key buildings, each with its own role to play in keeping your system clean, productive, and efficient.

How you connect and use these buildings depends on your production style, so consider that during the early stages of designing your setup.

Headhouse

- Office space
- Meeting rooms
- Restrooms
- Locker room
- Electrical panels and services
- Water testing lab
- Water management systems

Fish House

- Fish tanks (circular or raceway)
- Water distribution: piping, pumps, filters, aerators, etc.
- Water monitoring stations
- Biofilters or biodigesters for nutrient distribution
- Harvesting equipment
- Packaging equipment
- Shipping and receiving
- Cold storage

The processing methods for fish and plants differ, so operators often opt for two separate areas or separate buildings for processing. Food safety is another key reason for keeping everything apart.

Packing equipment can take up quite a bit of room in your processing house, depending on the level of automation. Keep that in mind when deciding on the size of your processing house.

Greenhouse

- Aquaponics grow beds like deep water culture (DWC) ponds, nutrient-film technique (NFT) systems, grow gutters, etc.
- Cultivation equipment (lighting, fans, shade systems, irrigation, etc.)
- Automation systems for climate and crop care

CHOOSING THE RIGHT GREENHOUSE STRUCTURE FOR AQUAPONICS

If you're serious about your aquaponics setup, don't skimp on the structure because what you choose impacts everything from your startup costs to long-term energy efficiency, crop yields, and crop security.

GUTTER-CONNECTED GREENHOUSES: BEST FOR LARGE COMMERCIAL SCALE

We strongly recommend gutter-connected greenhouses for commercial aquaponics systems, particularly for operations that want to scale. They're easy to expand and let you cover more ground with a single, continuous structure.

You also benefit from energy savings, as gutter-connected designs have less surface area for heat loss and a shared interior climate. Gutter-connected greenhouses also give you the flexibility to add more integrated systems over time.

GROUND-TO-GROUND GREENHOUSES: IDEAL FOR BEGINNERS AND SMALL-SCALE GROWERS

Ground-to-ground or quonset-style greenhouses are a budget-friendly choice for new aquaponics growers and small-sized growers.

They cost less to build upfront, and they're typically easy to put together yourself, which makes them more appealing for small-scale and entry-level commercial operations.

Ground-to-ground and quonset greenhouses are well-suited for rural areas where non-engineered structures can pass inspection. However, in residential and urban areas, you may need to invest in a fully engineered structure instead to meet code.

Check with your local building department before you build to see what types of structures your building codes allow in your area. The earlier you do this during the planning process, the better.

It's also worth noting that ground-to-ground and quonset-style greenhouses don't always give you a lot of flexibility when it comes to coverings.

While using double-wall polycarbonate is sometimes possible, depending on the greenhouse design, rigid coverings tend to push the price up. Poly film is the more commonly used, most affordable option.

Poly film may not be the best choice, though, if you grow produce. During cold periods, condensation can cause issues when it builds up on the poly and drips down on your crop.

You also need to replace poly every three to five years, which can cause concerns about crop contamination.

You must clear out your greenhouse completely or expose the crop to outside conditions to swap out the poly film covering, so there's a tradeoff between long-term cost, downtime, and crop security.

A-FRAME, MULTI-PEAK, AND ARCHED ROOFS: WHAT TO CONSIDER

A-frames (like the Prospiant Vail) or multi-peak (like Venlo houses) are common roof styles used in greenhouse aquaponics.

Arched-style structures (such as Prospiant's Grand Teton) also work well, depending on your materials and goals.

These structures all offer more covering flexibility and energy efficiency than quonsets or ground-to-ground houses.

Vail a-frame and Venlo greenhouses accommodate various types of rigid coverings like single- or double-wall polycarbonate or even glass. These materials offer better insulation, light diffusion, and have a longer lifespan than soft coverings.

BALANCING COST, PERFORMANCE, AND LONG-TERM ROI

Greenhouse structures have different price tiers for every type of budget. Ground-to-ground houses sit on the lower end of the scale. Gutter-connected greenhouses cost more upfront, but they also bring better energy efficiency, easier expansion, and long-term savings.

Some of the popular structures we offer for aquaponics at Prospiant include:

- Vail (a-frame): Flexible roof covering options, great for utility spaces
- Venlo (multi-peak): Ideal for high light transmission
- Grand Teton (arched): Strong, adaptable, roomy design

Vail Greenhouse

Every aquaponics operation has its own unique needs. Before deciding on a structure, compare your options, consult with local suppliers, and tour other growers' facilities. Factor in your climate, crops, budget, and long-term plans—these should guide your choice.

With that groundwork in place, you'll be confident you've selected the right greenhouse and building style for your operation.

Grand Teton Greenhouse

ONE FRAME, MANY ADVANTAGES: STANDARDIZING YOUR FACILITY

Once you've chosen your greenhouse structure, you can simplify your build by using the same frame style across all your core buildings.

This approach gives you the flexibility to adapt the same basic structure type for different purposes by swapping out the coverings and outfitting each building to fit its role. No need to reinvent the wheel.

Take the headhouse or processing house, for example. Instead of covering them with glass or clear poly like you would a greenhouse, you could use insulated metal or opaque polycarbonate to create a more enclosed, utility-focused space that still meets code.

The same principle applies to the fish house, though its needs are a little different.

Unlike plants, fish don't need high light levels—and often do better without them—so shaded or opaque coverings work best.

Because fish houses have water everywhere, material choice is especially important. Non-rusting components are essential. Poly materials often cost less than metal and still hold heat well enough for what these buildings require.

Beyond materials, you'll want to think through how water moves through the fish house. Anything involving concrete or underground plumbing requires extra planning during the design stage.

Using the same frame style for all your buildings brings other advantages, too. It makes it easier to gutter-connect them with the same foundation design. Additionally, it simplifies climate control because ancillary spaces can usually be heated and cooled with the same systems you use in your greenhouse, such as unit heaters or evaporative cooling.

ASK YOURSELF:

- How is water getting to your fish?
- How is water delivered to your crops?
- How is the water drained?
- What kind of tanks will you use?
- Where will you locate your tanks?

When it's time to expand, consistency in your building style pays off. The same crews and manufacturers can supply the equipment and materials, which helps reduce lead times and costs.

In short, sticking with one structure type but customizing each space for its purpose saves you both time and money, while keeping your entire operation efficient and cohesive.

ENERGY EFFICIENCY AND AUTOMATION TIPS

Energy and labor costs consistently rank as two of the largest cost drivers in greenhouse aquaponics, which makes them the best areas to target for savings.

In our experience, these upgrades to the greenhouse/plant side of your operation can offer big returns:

LED LIGHTING

LED (light-emitting diode) systems cost more upfront, but the savings you gain in energy costs make them well worth the investment.

LEDs have a higher PAR (photosynthetically active radiation) output than high-pressure sodium (HPS) lights or fluorescents. That translates to more usable light for plant photosynthesis.

You get precise spectral control with LEDs, and they produce less waste heat while drawing on less power than other forms of supplemental lighting.

ENERGY/SHADE CURTAINS

During hot, sunny weather, shade curtains block the sunlight entering your greenhouse, and the solar heat gain it brings. This reduces plant stress by lowering leaf temperatures and preventing crops from overheating.

Curtain systems split your greenhouse into two zones: the space above the curtain and the growing environment below the curtain.

What happens below the curtain is what really matters. By lowering the “ceiling” of your greenhouse, you have a smaller pocket of air to cool and manage.

Shade curtains diffuse or scatter light evenly across the greenhouse. This creates more uniform crops because the light reaches all parts of the crop canopy.

Energy curtains act like an insulating blanket at night or during cold weather by trapping heat inside the greenhouse and reducing the amount of heat that escapes through the roof.

VARIABLE SPEED PUMPS AND AERATORS

Variable speed pumps and aerators let you dial in on how much water flow and oxygen your aquaponics system needs to keep everything circulating and healthy.

Since your pumps run nonstop, energy use can add up fast. The beauty of variable speed is that you don't always need to run your pumps full blast. You can save energy by making adjustments based on how much water movement or oxygen your pond(s) actually need.

INSULATION

Greenhouses are notorious for energy loss, so insulating materials and efficient heating/cooling systems matter, especially in the fish house, processing areas, and headhouse.

Shade and energy curtains, as mentioned above, add an extra layer of protection, sometimes as much as doubling the R-value (a measure of how well a material resists heat flow) of your roof.

The higher your R-value, the better the insulation. Your building experiences less heat loss in the winter and less heat creeping in during the summer.

AUTOMATION SYSTEMS

If you manage an acre or more, labor is going to be one of your biggest expenses. Automation helps you get that under control.

With automated cultivation systems and environmental controls, you not only cut labor costs, but you also gain a level of precision you just can't achieve doing everything by hand.

Use automation wherever you can to keep your crew focused on high-value tasks, not daily adjustments.

MANAGING CROP AND FISH HEALTH TOGETHER

On the crop side, gaining a thorough understanding of the specific environmental conditions each crop needs to thrive and stay healthy makes all the difference.

Every crop is different. Some want lots of light, others prefer shade. Some do better in cooler conditions, while others thrive on a precise nutrient mix.

The closer you match your growing environment to what each crop needs, the better your results.

This is where aquaponics can get a little tricky. Your water chemistry must work for both plants and fish, but their needs don't always line up.

The waste your fish produce might not supply all the nutrients your crops require, or it might supply too much. On the other hand, the water returning to your fish tanks may not be in the right condition to keep them healthy.

Adjustments are often part of the job with aquaponics. You may need to add phosphorus, cut back on the nitrogen, or rebalance pH. The only way to keep on top of this is to keep a close eye on your water chemistry.

Regular water monitoring is critical because imbalances can result in poor plant growth, fish stress, or even death.

These best practices can help you maintain your water quality:

- Test and monitor water regularly
- Adjust nutrient levels to match crop needs
- Make sure the system delivers enough dissolved oxygen
- Proactively control algae growth
- Address issues as soon as they show up

KEY ITEMS TO MONITOR INCLUDE:

- pH
- Electrical conductivity (EC)
- Ammonia concentrations
- Nitrate levels
- Phosphorus
- Potassium
- Micronutrients
- Dissolved oxygen
- Temperature

THE CASE FOR DECOUPLING YOUR SYSTEMS

When you decouple your greenhouse and fish house systems at startup, you give yourself the flexibility to run them independently when needed. That comes with several advantages.

In a decoupled setup, water flows from the fish house to a biodigester, then on to the greenhouse. It never goes straight from the greenhouse to the fish house.

The biodigester separates solids from liquids in the fish waste stream and breaks down fine solids into plant-ready fertilizer.

This allows you to run your greenhouse much like a stand-alone hydroponic operation, using nutrients from fish waste, but with the freedom to supplement as needed for your crops.

Even better, you can fine-tune your fish and plant environments separately. In a coupled system, you're forced to compromise between the needs of the two; in a decoupled system, both sides get exactly what they need without interfering with each other.

Decoupling is also a huge help at startup. Young fish don't produce much waste, which means they can't generate enough nutrients to sustain crops. With a decoupled design, you can equip your fish house with its own filtration system and run it like a standard aquaculture facility until the fish mature.

The goal of any aquaponics operation is to find a steady balance and rhythm where you harvest fish every month and plants every week. Decoupling makes this possible. The fish side can operate independently, even though it's designed to work symbiotically with the plant side.

When you shut down your greenhouse for maintenance, cleaning, or crop changes, the fish side can keep running without disruption.

A practical way to phase in your operation is to start with the plants first. Get your hydroponics system fully stocked with plants at different growth stages, so you can establish a steady weekly harvest schedule. Then slowly bring your fish side online.

Since fish can take six months to a year to reach market size, while crops can be ready in as little as 60 days, this phased approach creates stability and smooths the path to full production. You can also get revenue coming in more quickly.

LESSONS FROM THE FIELD

Having designed and built several aquaponics systems over the years, we want to wrap up by sharing a few lessons we've learned on the job while working with growers:

✓ DO'S

Invest properly upfront. Plan and budget carefully instead of chasing after short-term savings. You'll avoid bigger problems (and costs) down the road.

Consider DWC in warm climates. Deep water culture (DWC) is more stable and forgiving than nutrient-film technique (NFT) in hotter regions where root zones can easily overheat, especially when you have a passive greenhouse.

The water in the massive tanks used for DWC stays cooler and isn't as prone to temperature swings as the thin streams of water in NFT gutters.

Use chillers when needed to maintain water temperatures. Cooling your water with a chiller helps you protect sensitive crops (like spinach that might bolt) and helps maintain oxygen levels.

Monitor closely. Keep an eye on temperature, ph, EC, and dissolved oxygen. They're key to healthy fish and plants.

Size your headhouse right. If you plan to use part of your headhouse for processing, build it large enough to handle separate workflows: one for processing fish, one for processing plants. Keep these areas separate for food safety reasons.

And don't forget about your future expansion plans for any of your core buildings. You limit your long-term growth when you undersize your buildings.

Plan for growth. Design your structure and systems to accommodate future expansion. You'll find it much easier to scale your operation when you have that built-in adaptability.

Think modular. Adding one new greenhouse or gutter-connected greenhouse to a super structure is no big deal if your first structure is already designed for expansion.

Build for flexibility. Once your aquaculture operation is up and running, you'll quickly find that growing always comes with small, unexpected challenges. That's why it pays to design your structure and systems with adaptability in mind.

Simple things—like adding extra water loops or installing bypasses—give you the freedom to adjust, troubleshoot, and experiment until you find out what works best for your setup.

DON'TS

Don't cut corners. Saving 1%-2% by using subpar materials, structures, or systems almost always costs you more in the long run. Go with the best quality you can afford.

Don't undersize your layouts. Small head houses, fish houses, or processing areas create bottlenecks that are expensive to fix later.

Don't assume paper plans equal reality. Even the best-designed structure and systems need flexibility. Expect to make tweaks and small fixes once you are operational to dial in your setup.

FINAL THOUGHTS: BUILD IT RIGHT, FROM THE GROUND UP

A balanced aquaponics setup doesn't happen overnight. But with the right design, materials, and plan, it's absolutely possible—and profitable.

While there's no one-size-fits-all blueprint for an aquaponics setup, there is a smart way to approach it. The design phase matters the most: from choosing the right structure to laying out and equipping your core buildings. The decisions you make in the beginning set the tone for everything that follows.

We've helped growers across the country build aquaponic systems that are scalable, integrated, and built to perform long-term.

Starting small, just beginning, or scaling big, we'll guide you past the common missteps and help you create a balanced aquaponics setup that runs efficiently from day one.

Let's start mapping out what your aquaculture operation needs to get a successful start.

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