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# ***MJBizDaily* Buyers Guide**

## **Cannabis Greenhouse Components**



# A Tailored Growing Experience

Modular, easily assembled and designed to last, Wachsen Pro's new Rolling Benches are here to raise the industry's standards

## ROLLING BENCH

Modular System



Since 2018, when Hydrotek Hydroponic launched its Wachsen Pro line, professional growers took notice of the then, new, product line and gave them a fair chance. They were pleased. Now, in 2021, Hydrotek Hydroponics has unveiled a new rolling bench line of products and accessories that is as tough, durable, and smartly engineered as their cloning carts, drying racks, and bud sorters. While certainly not the first rolling bench on the market, the Wachsen Pro Rolling Bench could be shaping up to be one of the best on the market.

### Wachsen's Rolling Benches

Wachsen Pro's Rolling Benches offer a tailored growing experience. Like all of Wachsen's quality product, these benches are designed with the needs of the professional grower in mind. These built-to-last, modular rolling benches are customizable to fit easily into any sized grow room. Each bench is extendable and can accommodate various add-ons to make them uniquely, and seamlessly fit into your operation.

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operation. Consider these features that are available with each and every Wachsen Pro Rolling Bench:

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Wachsen rolling benches can be assembled more quickly and with more ease than their competitor's rolling benches. With a handful of common tools, and no specialized labor required, these benches can be out of the box and in use in little time. These benches help you to utilize your available square footage more profitably. They are easily installed and maintained, helping to keep labor costs down, because we know that your time is just as valuable as your crops. Reduce the cost per square foot of your operation with these extremely user-friendly benches.

Consider these optional add-ons to fully optimize your Wachsen Rolling Bench:

### Wachsen's Trellis Supports



Wachsen manufactures trellis supports to bolster your high value crops growing on their benches. No need to stake each individual plant and no need for concern that your plant will not be able to grow to its full potential. Like the rolling benches, there are several sizes available, sold separately, so that you can customize your setup.

Wachsen's trellis supports install easily onto any of their rolling benches. They will help keep your crops growing upright and strong. Available with 4' or 5' horizontal posts that attach to the upright trellis support posts. Keep those heavy, valuable buds up high. Optional 6.5' posts are available for additional strength and support. Mesh sold separately.

### Wachsen's Plastic Trays

Wachsen also manufactures trays that are designed to fit like a glove into their rolling benches. Made from non-BPA high impact ABS plastics, these optional, modular trays are available in a full range of sizes and drainage options.

At 6.5 feet long and widths ranging from 3 to 6 feet, there is a tray that will fit your bench. Wachsen manufactures trays that interlock, with left and right ends and multiple middle sections. No matter the size of your table, or what crop you grow, Wachsen has tray options to fit any bench or table setup.

# INTRODUCTION



**Laura Drotleff**

*MJBizDaily*

Building a greenhouse and choosing the components that will aid in efficiently producing a high-quality cannabis crop is more complicated than building a house and picking out the furniture that goes inside.

Developing an ideal environment for high-value cannabis production can be full of obstacles, from zoning and building approval to ensuring there is enough power and quality water on the building site, not to mention the actual construction process and evaluating the environmental controls and growing systems that are needed.

But all these considerations are important and getting it right the first time can mean savings down the road when it's time to scale your business.

That's why *MJBizDaily* has developed the Cannabis Greenhouse Components Buyers Guide. We want to provide greenhouse producers with all the considerations needed for building and outfitting a greenhouse, floor to roof and everything in between.

In addition to a list of greenhouse structure and components suppliers, greenhouse owners and facilities managers will find smart content from industry experts covering:

- Building a profitable greenhouse.
- Designing an irrigation system.
- Choosing the ideal benching system.
- Greenhouse automation.

All of this is accompanied by checklists and a glossary to help sort out the terms and considerations that will optimize the growing environment.

We appreciate the efforts of contributor Georgie Smith for her work on this guide.

We hope you find this content helpful in aiding the decisions you need to make in your next building project, and we welcome any feedback at [laura.drotleff@hempindustrydaily.com](mailto:laura.drotleff@hempindustrydaily.com).

# HOW TO DESIGN AND BUILD A PROFITABLE CANNABIS GREENHOUSE

There's no such thing as being too prepared when it comes to designing and building out a cannabis greenhouse facility.

Once up and running, a profitable cannabis greenhouse facility successfully balances operational costs with a high-quality, uniform harvest. It's common to undermine success from the start of the project if detail isn't top of mind through each step, from design to build-out, and selecting operational components such as benching systems and environmental controls.

Greenhouse cannabis producers should start with their business goals and think backwards. What do they want their brand to represent in the marketplace?

"It comes down to understanding your craft and what you're going for. Knowing what you want will increase or decrease what you're going to spend on that greenhouse," said Hamilton Nelson, a veteran cannabis producer and the sales and operation manager at Square One Starts, a hemp young plants provider in Aurora, Oregon.

At an estimated \$35 to \$50 per square foot in upfront costs, greenhouse cannabis producers can save significant money by spending the time on a well thought-out and executed plan.

The last thing a grower wants to do is retrofit their greenhouse after they built it because it doesn't work well for growing cannabis.

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## CHOOSING A GREENHOUSE STRUCTURE AND LOCATION

Producers should start by asking what they want in a greenhouse, said Derek Smith, executive director of the Resource Innovation Institute, a non-profit organization working to promote efficiency in resource-intensive agricultural sectors like cannabis.

Greenhouses can be built from many different materials. For example, polyethylene-covered hoop houses with roll-up sides are relatively inexpensive and straightforward compared to large glass or polycarbonate facilities using sophisticated environmental controls.

“In other words, how much of a controlled environment is it? There’s a huge difference between a hoop house and a state-of-the-art, fully sealed, highly automated greenhouse that is, to some degree, operating like an indoor environment but with sunlight,” Smith said.

# A cannabis greenhouse buyer’s checklist

## What to Know and What to Ask

### Before purchasing anything (including land) ask:

- What are the goals of my cannabis business? Is quality or quantity more important?
- How much volume is needed to meet business goals?
- How many plants will we grow in each greenhouse zone?
- What are my plans to scale the business?
- What will the company ultimately need for infrastructure?
- How will we access needed electricity and water?
- What state and local zoning and permitting regulations will affect the proposed operation?
- What are the chances the site will not be approved and what is our contingency plan?
- Will my marijuana production license include deadlines to get the build completed?
- What is the water quality at the site?
- What are the light levels at the site?
- What outside temperature extremes should be built into my plans?

- How can labor costs be reduced through greenhouse design, workflow and choice of components?
- Does the builder have an engineer that specializes in greenhouses for cannabis growers, along with a proven track record?

### Ask cannabis greenhouse and component manufacturers:

- Have they worked with cannabis growers?
- How long is the design and build process?
- What kind of information and support do they provide?
- What can be done in advance to avoid delays in the design and build process?
- What information do they need from the beginning?
- Can their equipment be integrated with other systems in the greenhouse?

### Don't be afraid to:

- Get multiple quotes.
- Talk to fellow growers, especially in your chosen location.
- Visit manufacturers and operating greenhouses.

Next, think about where the greenhouse is located.

Climate and light levels can significantly influence construction materials and other greenhouse components. For instance, location can impact your heating and cooling systems and lighting needs, and ultimately determine fundamental requirements such as electricity, Smith said.

Understanding total infrastructure needs can also help drive efficiency.

“You’ve got to understand what your power needs are and then determine the right mix of energy that you can bring to the site,” Smith said.

“You may need propane, natural gas or delivered fuels. You could set up a micro-grid and do on-site renewables in tandem with natural gas ...but it all starts from knowing how much power you’re going to need.”

Another crucial consideration is the water table and soil composition at the construction site, Nelson said. Install drainage before building if a site is located on top of a high water table or downhill from areas of significant run-off.

### THE PERMITTING PROCESS

Growers also need to think about the planning and permitting process, said Johnny Burgoon, solutions architect for the cannabis greenhouse division of Prospiant, a Cincinnati-based controlled-environment greenhouse solutions provider.

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Many states have time limits on their licenses, requiring growers to be in operation or at least show significant process, Burgoon said. West Virginia has a six-month requirement.

“We’ve had people lose their license because they didn’t get up and running fast enough,” Burgoon said.

Zoning is another complication most greenhouse operators don’t consider beforehand, Burgoon said. Local approval will depend on land-use regulations, which typically include buffering requirements or proximity to other public facilities, like a church or a school. The population density of an area can also restrict zoning for a greenhouse facility.

Other local land-use regulations might include odor management, noise requirements, impact on traffic, signage and even the facility’s appearance, Burgoon said. This is above and beyond typical state licensing requirements for marijuana growers for requirements such as security.

“Before you even get into the actual building permits and codes, zoning is the most important thing because that will let you know if you can even have it there or not,” Burgoon said.

Marijuana growers need to understand that since marijuana production is governed under per-state manufacturing rules, not a federal agricultural rule like hemp, their greenhouse will be required to meet standard building codes. Not all greenhouse designs meet building requirements for things like snow load, wind or fire suppression, Burgoon said. However, hemp greenhouse facilities are typically exempt from needing building permits, providing more flexibility for hemp greenhouse facilities.

# CONNECTING DATA POINTS ACROSS THE ENTIRE CANNABIS SUPPLY CHAIN

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Ideally, growers consult with him before they start anything else, Burgoon said.

“Quite often, we get people that come through who don’t have all three necessities — they’ve got a license, but they don’t have a property and they don’t have funding,” Burgoon said. “It’s really smart on their part if they engage a design-build before they even have all three.”


### MINIMIZING PROJECT DELAYS

Expect about 12 to 16 months of designing and building time for a standard, non-expedited cannabis greenhouse project, Burgoon said. That time frame can increase significantly every time the plan changes and something has to be redesigned or engineered.

Greenhouse operators typically follow one of two processes — a design-build or a design-bid-build, Burgoon said.

In a design-build, they hire a single entity to “handle the project all the way through to fruition,” Burgoon said. In a design-bid-build, they hire an architect to design the facility and then send the plans out for bid from a general contractor.

If speed-to-market is important, Burgoon strongly recommends going with the design-build process, which can deliver a project up to 30% faster than the design-bid-build process.



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“The earlier you can get a design-build contract in, the earlier you will get to market, get open, and get revenue coming in as fast as possible,” Burgoon said. This can be especially important for operators in a newly legal state, where first-to-market is an important brand strategy, according to Burgoon.

### HIRE EXPERIENCED BUILDERS

Regardless of the design-and-build process they choose, greenhouse cannabis growers should use a builder with cannabis greenhouse-building experience.

Cannabis is a high-value crop with requirements that can be affected for better or worse during the building process, including:

- Light deprivation and supplementation.
- Strict temperature and humidity control.
- Odor mitigation.
- Security requirements.

Whether it’s building the structure or installing the components inside the greenhouse, don’t use a general contractor who says, “yeah, I can figure this out,” said Michael Williamson, director of cultivation for vertical grow rack manufacturer Pipp Horticulture Inc. in Walker, Michigan.

“This is a really big issue in the cannabis industry across the board,” Williamson said.

“(Operators) buy a high-quality greenhouse and spend millions of dollars. And then the installation is just really done wrong and has to be redone. That costs more money.”

Because builders with cannabis greenhouse experience are limited, Nelson recommends investing the resources to visit builders before hiring them.

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**Because builders with cannabis greenhouse experience are limited, it's wise for growers to visit builders and greenhouse manufacturers before hiring them.** *Courtesy Photo*

He also advises cannabis greenhouse growers to skip the “mega-store” providers and go directly to those who deal with cannabis greenhouses specifically. They understand the specific requirements of cannabis and have the components that work for growing it.

“Not that you couldn’t grow amazing ornamentals in a cannabis greenhouse, but you know, cost-wise, it just doesn’t pan out the other way,” Nelson said.

## SELECTING GREENHOUSE SYSTEMS

The systems installed in the cannabis greenhouse can be just as important as the structure itself.

Ideally, the structure and the components in it are designed to work in tandem, but deciding which greenhouse components to buy is often determined by the operation’s budget, Burgoon said.

“We typically recommend everyone have everything put in their facility. But they may not have the budget for that,” Burgoon said. “It’s like a car. (You start) buying all the bells and whistles, but it’s out of your price range, so you start backing off.”

There are obvious necessities in a cannabis greenhouse facility, like blackout curtains and supplemental lighting, but operators should also consider several other factors.

Almost everyone ends up coming back for some level of dehumidification if they didn’t initially install it, Burgoon said.

“The biggest battle everyone fights with this product is powdery mildew,” Burgoon said. “Keeping humidity levels at bay (is critical) unless you live out West, where it’s more arid.”

He pointed out that 60% of the North American coastline has high ambient humidity.

Another add-on that manufacturers often get calls for is odor sanitization, which also has to do with powdery mildew, Burgoon said, although in this case it's using an odor sanitization process to control powdery mildew outbreaks when they do happen.

Nelson recommends taking a close look at the insect pressure based on the operation's location. That can determine whether a producer needs to invest in screening off the equipment, vents, and structure to prevent insect infestation.

Next come systems like benching, irrigation and environmental controls that might seem like a significant upfront cost, but that can make a huge difference in labor costs once the greenhouse is up and running.

"We have a lot of people who choose to hand water, which is just another useless labor cost," Burgoon said.

"A little bit of investment up front can save you long-term in the labor pool."

Plan to build enough space and utilities to power machinery and equipment that will reduce labor costs, Nelson said.

### **PLANNING FOR SCALE AND EFFICIENCY WITH PROPER INFRASTRUCTURE**

Cannabis producers need to design and build greenhouse facilities with future expansion in mind, Nelson said

"Everybody should be thinking on the expansion scale, even though you may never get there. Build it with that in mind," he said.

Developing infrastructure at the beginning of a project can end up saving significant costs in the long run, Burgoon said. Some states, like Ohio, are limiting growers to an initial 30,000-square-foot facility, with the potential to build additional greenhouses.

Understand the final project goal. Consider things like how much power the site will eventually need or whether the operation will eventually need more water pressure — and therefore bigger pipes.

Many clients underestimate how much infrastructure they will need to run the facility, which ends up costing them as they scale, Burgoon said.

"You want to understand your final plan and really use your money wisely," Burgoon said. "Why develop a property twice?"

# AUTOMATING THE CANNABIS GREENHOUSE

Environmental controls are a must-have for efficient greenhouse cannabis production.

But it's not just efficiency for efficiency's sake. Automating the cannabis greenhouse is about understanding and putting the crop's needs first, said Henry Vangameren, regional marketing manager for the Americas at Vineland Station, Ontario-based Priva North America, a global provider of controlled environmental agriculture (CEA) solutions.

"You have to approach automation from the plant's perspective," Vangameren said.

"If you start with the greenhouse and build your way to the plant, the plant is never going to thrive. You have to start from the plant."

That means anticipating plant needs and integrating all systems in the greenhouse to work together toward that goal, Vangameren said.

For instance, when the shades open or the lights come on, the plants will need irrigation and start to transpire. The HVAC system should automatically turn on, lowering the humidity before it has a chance to get too high and encourage disease.

"Having integration, allowing all systems to talk to each other and anticipate what is going to happen to that plant before it happens, puts that plant in a perfect place to thrive," Vangameren said.

CEA enterprise software systems connect monitors, alarms and sensors with operational greenhouse equipment such as lighting, HVAC systems, fans and irrigation, allowing the grower to monitor and control the greenhouse from computer, tablet or smartphone. The software systems also collect data as they go, becoming "smarter" and better able to anticipate crop needs.

Automation can be applied to every aspect of greenhouse management. Light, temperature, CO2, humidity, irrigation, fertigation and water conservation, energy efficiency and even labor management can be managed through the software.

## THE CASE FOR AUTOMATION

Growing cannabis in a greenhouse involves more variables than growing cannabis in an enclosed indoor environment, said Hamilton Nelson, sales and operation manager at hemp young plants provider Square One Starts in Aurora, Oregon.

Natural light in a greenhouse varies at different times of the year due to outside weather conditions. That means growers "don't have a perfect schedule all the time," Nelson said.

And greenhouses make factors such as CO2 enrichment more complicated. For example, open a roof vent and all the CO2 escapes. But that doesn't mean automation isn't worthwhile - it's a matter of understanding cannabis needs in the greenhouse and dialing them in, Nelson said.

Johnny Burgoon, solutions architect for the cannabis greenhouse division of Prospiant, a Cincinnati-based provider of controlled-environment greenhouse solutions, agrees.

"At the end of the day, it's a giant recipe. You're trying to create the best environment for these plants," Burgoon said.

## SCALING AUTOMATION

A good greenhouse control system should scale with the operation, Vangaremen said.

Scale could mean adding more greenhouses on the same property, or even controlling multistate facilities through the same software system.

Greenhouse operators vetting environment control manufacturers should discuss how they envision scaling before they purchase a system.

“The last thing (growers) want to do is invest in a costly system and then find they have to invest in another system because it can’t grow with them,” Vangaremen said.

## ENERGY MANAGEMENT AND CROP CONSISTENCY

Energy management plays a “huge part” in greenhouse control systems, Vangaremen said.

Integrating all the different systems means less energy is needed to help plants thrive. For example, turning on the HVAC, opening vents and activating fans after the air becomes too humid may force those systems to work hard to bring the humidity back in range. But because an integrated, automated system takes care of this before it’s needed, less energy is used to achieve the same goal.

“When systems aren’t working together, they are inefficient,” Vangaremen said.

Automated systems can be set up to take advantage of site-specific savings, like turning on lights during non-peak electricity hours to save growers on their power bills.

Another big benefit to greenhouse automation is crop consistency, Vangaremen said. A cannabis company building its brand aims for a consistent product that customers can depend on.

“If the company cannot grow a consistent cannabis product, customers are not going to ask for that product anymore,” Vangaremen said.

“How do you deliver on that? You need precision controls that work together and provide the best environment for that plant.”



**Every time a grower changes their plan, more money must be spent on engineering and finding the right parts. Typically, that causes a project delay.** *Courtesy Photo*

## DESIGNING A GREENHOUSE IRRIGATION SYSTEM

The biggest challenge to designing and installing an effective irrigation system in a cannabis greenhouse is settling on a plan.

Growers need more than simply a “basic idea” before they begin the design process, said Kurt Becker, executive vice president at Dramm Corp., a commercial irrigation supplier in Manitowoc, Wisconsin. Even deciding to add 20% more plants changes everything in a drip irrigation system and can be the difference between a functioning system and one that doesn’t irrigate and fertigate uniformly or well.

Cannabis greenhouse operators often use overhead boom irrigation for propagation and young seedlings, but the industry standard in cannabis is drip irrigation at the plant base for maturing plants. Drip irrigation helps avoid moist conditions that perpetuate mold and disease as the plants start to flower. It also conserves water and reduces fertilizer needs.

“We encourage growers as they design (to) really think about how they plan to crop the facility early on in the process, really get that nailed down,” Becker said.

Every time a grower changes their plan more money must be spent on engineering and finding the right parts. Typically, that causes a project delay, Becker said. Especially since the COVID-19 pandemic began, supply chain shortages have made it difficult to keep different sizes of PVC in stock. A changed crop plan can equal more time waiting on supplies.

“Nobody who is putting a cannabis facility together wants delays,” Becker said. “Figure out what you’re doing up front; don’t change the design midway through.”

If growers do end up adding more plants after the design is installed, that can compromise the entire irrigation system. Becker said that when growers complain they have a pressure issue in a zone, the first thing he asks is, “Did you add plants?” Even though growers typically design their systems to handle more capacity, many exceed that once they are operating and, as a result, run into problems.

“(Adding plants) impacts the drippers, the plumbing, the tanks, the pumps. It impacts everything that is touching your water, including the HVAC system that is now handling (more capacity),” Becker said.

## THE IRRIGATION DESIGN PROCESS

The first step in designing an irrigation system for a cannabis greenhouse is knowing the water source.

Quite often, growers don’t think about what they will use for water until after they have bought property, Becker said. That can be a costly mistake.

“Your water source is what delivers everything to your plants,” Becker said. “Every plant is touched by your water. Water should be a primary consideration.”

Once a grower has a water sample, the design process moves into the filtration stage. With city water, chlorine typically needs to be removed. With surface water, there will need to be a process for removing particulates.

After that, a grower should look at how to store enough water to accomplish all the irrigating needs—typically in an 8-hour period with the ability to refill the tank within 24 hours, Becker said. That means understanding how many plants a grower will have, how many are in a zone and what irrigation cycles are needed. With that information, the grower can size the right tank.

Once the tank system is engineered, a grower can add in water treatment, such as ozone, to prevent pathogens from growing in the plumbing system.

“Once you put water in your pipes, biofilm starts growing,” Becker said. “If you have a pythium outbreak, it will end up living in your pipes and reinfesting your plants.”

From there, a grower pressurizes the system and plans for fertigation. Depending on what growers want to fertigate with and how often they want to change fertigation needs to different zones, growers must choose between a batch tank and an on-demand fertigation system.

Finally, at that point, the design process moves into accommodating the plants in the room.

## RECONSIDER REVERSE OSMOSIS

Most cannabis growers believe they need to have a reverse osmosis (RO) system installed, but that is not the case for most of Becker’s clients.

“Ninety-five percent of (cannabis growers) don’t really need RO, but 75% of them buy it,” Becker said.

The push for RO came from fertilizer manufacturers who advised stripping out the ions in water so they would not bind to the fertilizer and interfere with delivery. But cannabis plants like most of the ions that are naturally in the water.

Growers are finally starting to “get smart” and are asking fertilizer companies to make a custom mix that works with their water, according to Becker.

“You don’t want to pay for a jug of fertilizer with water already in it. You want to buy a bag of water-soluble fertilizer,” Becker said.

Plus, an RO system ends up discarding 40% to 50% of the water that comes into the facility, according to Becker.

“Are you paying for water? Plus, you may not be allowed to throw that water away. The municipality may not want it, the state may not want it,” Becker said. “RO isn’t a quick, ‘Yeah we’ll get RO’ (decision). You have to think about it and go through the process.”

### PLUMB FOR FUNCTION OVER BEAUTY

Growers should look at ways they can conserve water and reduce their water needs, said Johnny Burgoon, solutions architect for the cannabis greenhouse division of Prospiant, a greenhouse provider in Cincinnati.

Growers can collect the condensate off their HVAC system and use it, plus they can capture and treat water that has already gone through the system for reuse. Not only will that save on a grower’s water bill, but local municipalities often have restrictions on dumping wastewater.

“If you can collect, retreat it and reuse it. You save on nutrients and on water consumption as well,” Burgoon said.

Finally, the grower should make sure the plumber installs the irrigation system for function, not beauty, Becker said. That means, avoid elbows that allow a change of direction.

Multiple elbows can end up reducing pressure; that can lead to failures of uniform water delivery, Burgoon said.



**Cannabis growers don’t often think about water quality until after they have bought property, but that can be a costly mistake.**





**Crowding plants on benches can sacrifice plant quality.** *Courtesy Photo*

## CHOOSING THE RIGHT BENCHING SYSTEM FOR A CANNABIS GREENHOUSE

A successful greenhouse cannabis benching system balances maximizing space for the most plants possible with labor needs, good growing practices and a budget.

Growers tend to focus on the operational impacts of the benching system while investors want to get as many plants in a facility as possible, said Michael Williamson, director of cultivation for Pipp Horticulture Inc., a manufacturer of mobile vertical grow racks in Walker, Michigan.

But prioritizing quantity over quality could restrict space and increase labor.

“Sometimes it’s worth it and sometimes it’s not,” Williamson said.

### LABOR IS THE PRIMARY CONSIDERATION

Labor, labor, labor is what Williamson preaches when it comes to choosing a benching system.

Fixed costs like electricity might have some seasonality to them, but they’re predictable. Labor costs can come as an unwelcome surprise, he said.

While running five 1-acre greenhouses, Williamson discovered that reducing any individual human task by just 5 seconds saved up to 27 hours of human labor to get the entire project done. That saved him about \$500 in labor costs per project.

He uses that anecdote to frame the conversation about why proper benching systems can have such an impact on the long-term operational costs.

“How do you get equipment in? How do you do your tasks? You’re either going to grow more product to make more money, or you’re going to reduce labor,” Williamson said. “Ideally, you do both.”

Hamilton Nelson, sales and operation manager at Square One Starts, in Aurora, Oregon, is a fan of the Dutch-style (palletized) benching systems in cannabis greenhouses because they reduce his need for labor. Instead of having to send employees out to lift and move every plant between different growing zones or to bring product to the headhouse, he moves tables.

“You can’t just throw labor at it every time you have a task,” Nelson said. “For certain tasks that’s going to have to happen, like trimming. But you need to save money in your overhead for those specific tasks and reduce labor anywhere else you can.”

Another place to consider labor cost is in the cleaning and sanitizing of your benches, Williamson said.

Stationary benches and rolling benches that can’t be moved easily are hard to clean and sanitize underneath. As a result, employees will have to crawl or squat underneath the tables to get the task done. That’s hard on employees and reduces morale, Williamson said.

## Pros and cons of common cannabis benching systems

**Stationary Benches**—Benches that are not designed to be moved.

**Pros:** Inexpensive. Can be made from various materials and sized in different ways. Irrigation is easy to set up.

**Cons:** Least efficient benching system as far as labor and space. Hard to clean and sanitize underneath.

**Rolling Benches**—Benches with a fixed leg but the benchtops are supported on a rolling frame that can be rolled from side to side, creating a single, movable aisle.

**Pros:** Saves aisle space, which allows more room for plants. Sturdy, not a lot of parts to break. Inexpensive.

**Cons:** Requires employees to move plants to the headhouse or between zones. Hard to clean and sanitize underneath. Narrow aisles. Can’t be adjusted to have more than one aisle open simultaneously.

**Palletized Rolling Benches (aka Dutch trays)**—A container benchtop system. Plants are held in trays that can be moved in both directions.

**Pros:** Easy to rotate the crop within the greenhouse space or take to the headhouse. Saves labor and space. Easy to clean and sanitize underneath. Can use automated systems for moving, sanitizing and storing benchtops.

**Cons:** More expensive, complicated system typically requiring automation and additional moving parts. Can be complicated to set up irrigation.

**Vertical Rack on Carriage System**—Vertical racks installed on a carriage system allow moving the entire frame. Prevalent in indoor operations but also greenhouse systems with enclosed rooms.

**Pros:** Uses vertical space. The carriage structure creates a movable aisle system, maximizing floor space, and can be opened for wide aisles. Racks can be easily adjusted to accommodate different sizes of plants. Easy to clean and sanitize.

**Cons:** Expensive. Requires lighting since rows of plants are stacked.

## CONSIDER BENCH LENGTH AND HEIGHT

Decide the best height and length for greenhouse benches before taking delivery. Removing benchtops to chop down legs because you chose the wrong height equals operational downtime, Williamson pointed out.

Many cannabis growers are now starting to install shorter benches for mother plants, Williamson said. Because those plants are typically quite tall, having a lower bench height for them to sit on means fewer ladders needed and less chance of employee injury.

Vertical racks based on pallet racking frames are nice for adjusting for plant height because rack heights can be self-adjusted to accommodate different sizes of plants.

Williamson cautions against going for long benches, advising growers to choose benches no more than 40 to 65 feet in length.

“I’ve had rolling benches as long as 120 feet. It was great in theory that they were so long, but from a labor standpoint, they weren’t great,” Williamson said.

“Not only is it a long distance to travel, but it’s a big climate to control. You can see pretty big temperature swings depending on how well the greenhouse is set up between the back and the front of the row.”

## TRELLISING AND IRRIGATION

Don’t forget to consider trellising.

Many generic horticultural benching systems aren’t built to accommodate the heavy-duty support cannabis requires.

“Oftentimes, you’ll see very weak (trellising tubes) that aren’t well-braced. Over time, they start to flex in and get loose,” Williamson said.

Irrigation is more complicated in automated benching systems, Williamson said. In non-cannabis horticulture, automated benching systems are typically used with overhead or misting watering systems. But cannabis growers often install drip irrigation to prevent disease.

Since irrigation is usually installed per table, use quick disconnects to save labor when it comes time to rotate and move tables, Williamson said. It adds some time to the process but will still save labor in the end.

## BENCH CONSTRUCTION AND INSTALLATION

Bench construction is essential to consider.

“You pay for what you get. Not all benches are the same. There’s a lot of qualitative differences,” Williamson said.

He recommends going to a factory or visiting another operation using the benching system before you purchase it.

The facilities manager often will have hands-on experience, advising on what worked and what needed to be adjusted or fixed, Williamson said.

Installation is another place where new cannabis greenhouse operators make mistakes. He’s seen rolling benches installed incorrectly with sharp galvanized metal edging that ends up injuring employees.

“It’s not uncommon to buy a high-quality product that gets installed improperly. It won’t function as designed,” Williamson said.

## PLANNING FOR SCALE

The more expensive, automated palletized benching systems are costlier up-front than fixed rolling benches or standard bench systems. Still, the automation component is usually a one-time purchase that growers won't need to buy again when it comes time to scale up, Williamson said.

For instance, a grower can install an automated picker and stacker system in a palletized system that picks up a bench and brings it to the sanitation tank for cleaning and stacking for storage. If the operation expands, that system can usually accommodate more benches.

By comparison, scaling up with stationary or non-palletized rolling benches is a “redundant expense” of more benches, offering minimal or no savings, Williamson said.

Vertical racking on carriage systems are conducive to scaling up, Williamson said. If growers oversize their initial racking height in phase one of the project, they only need to add more horizontal beams and buy more trays when they get ready to expand.

There's no “messy construction, you don't have to pull any permits,” Williamson said when it comes to scaling up a vertical racking system.

“You can essentially phase and scale your project over a weekend versus months (spent) on contractor and biosecurity issues.”



**Irrigation is more complicated in automated benching systems. Since drip irrigation is usually installed per table, use quick disconnects to save labor when it's time to rotate and move tables.**

# UNDERSTANDING CANNABIS GREENHOUSES (AND EVERYTHING THAT GOES IN THEM)

## A glossary of common terms

The language surrounding cannabis greenhouse operations is a mishmash of horticulture and growing terminology specific to cannabis, combined with names of the various greenhouse systems, equipment and control options.

Cannabis greenhouse operators should understand the most common terminology and have a solid grasp of the concepts they will need to understand to successfully navigate design, purchase and build-out of a profitable cannabis greenhouse facility.

**Airflow fans:** Hanging circulation fans to facilitate air exchange. Not the same as exhaust fans.

**Airflow management:** A system of managing airflow to prevent mold and mildew by reducing humidity and condensation.

**Benching systems:** Raised platforms that support cannabis plants. Different benching systems are used, including stationary benches, rolling benches, palletized rolling benches and vertical tray racks.

**Boom irrigation system:** A system used to uniformly and automatically provide overhead watering, reducing labor and water waste. Typically used on young cannabis plants and plugs, while maturing plants are often watered with drip irrigation to prevent disease.

**Canopy area (or canopy space):** The surface area used to produce mature plants, calculated by square feet, often used to permit licensed marijuana growing facilities.

**Canopy management:** A term for the techniques and considerations used to maximize the efficiency of cannabis grow space.

**CO<sub>2</sub> enrichment:** Providing additional carbon dioxide in an enclosed greenhouse system to support cannabis plant growth.

**CO<sub>2</sub> generator:** A piece of equipment that produces carbon dioxide, typically using natural gas or propane. It can be set to turn on and off automatically.

**Dehumidification:** A system of evacuating excess condensation inside a commercial greenhouse. May be accomplished through venting, heating and venting, using dehumidifier units or a heat pump to capture humidified air and exchange it with warm, dry air or a desiccant dehumidification system.

**Desiccant dehumidification:** Uses chemicals to absorb liquid and reduce humidity with the ability to reuse the heat from the regeneration process for additional heating.

**Diffused roof coverings:** A roof covering that improves the light penetrating the crop and generates better and more even growth. It does so by diffusing the light, reducing excess heat and crop stress while eliminating shades caused by structural elements in the greenhouse.

**Drip irrigation:** An irrigation system that slowly drips water to cannabis plants. A low-pressure and low-volume system can also deliver fertilizer (aka fertigation).

**Environmental controls system:** An automated system that controls all the growing processes in a greenhouse to maximize efficiency and standardize quality. Typically uses wireless sensors.

**Exhaust fans:** Fans that draw in cooler air through vents, louvers or doors.

**Evapotranspiration:** Water movement and loss (aka transpiration) via evaporation of water at the leaf surface.

**Fertigation:** Delivery of nutrients through a watering system.

**Greenhouse glaze:** The material used to cover a greenhouse that includes properties to diffuse direct sunlight, which promotes better growth. Materials may be single- or double-layer polyethylene film, corrugated polycarbonate, double-strength glass or multiwall polycarbonate.

**Headhouse:** A section of a greenhouse facility that serves as a work center without sacrificing growing space. May act as storage, office, seeding and potting, harvest and shipping space.

**HPS:** High-pressure sodium (HPS) lamps are high-intensity light bulbs that produce large amounts of light and considerable heat energy. They had been the industry standard for horticultural (and cannabis) lighting until the advent of LEDs.

**HVAC:** Heating, ventilating and air conditioning. Should be engineered per greenhouse to accommodate the size, amounts of plants and temperature requirements depending on location and growing goals.

**Insect screening:** A system of screening to prevent insects from getting into a cannabis greenhouse facility. Screens might include vent screens or screening for equipment like HVAC systems or the greenhouse itself.

**Insulated wall panel:** Insulated wall panels are used to enclose grow rooms and provide a solid moisture-resistant barrier and help prevent contamination from mold, pests and airborne pathogens.

**LED:** Light-emitting diode (LED) lights. More energy efficient at producing high intensity than HPS lamps. Used to provide supplemental lighting in a greenhouse.

**Light deprivation greenhouse:** A greenhouse set up to artificially control the amount of light cannabis plants receive. Typically done by manual or automatic shade covers.

**Odor misting:** High-pressure fogging techniques typically on automated controls that eliminate cannabis odors. May be required, depending on the location of a cannabis greenhouse operation.

**Palletized rolling benches (aka Dutch trays):** Benches with tabletops that roll in both directions in a greenhouse, perpendicular and parallel to the headhouse. Palletized rolling benches allow the benches to double as the plant material handling system.

**Polyethylene:** Common plastic used to cover many cannabis greenhouse structures.

**Relative humidity (RH):** The amount of moisture in the air. It must be controlled to prevent the development of mold and disease in cannabis plants.

**Rolling benches:** Benches designed with rolling tabletops that move from one side to another, eliminating non-efficient aiseways.

**Rolling screen:** Improves energy management and blackout for sidewalls, preventing unwanted sunlight and heat from entering.

**Roof vents:** Vents on the roof of a greenhouse structure that open to reduce heat and humidity. Often set up on automatic controls and used in conjunction with side vents to encourage natural ventilation.

**Shade systems:** A system of shading out light to provide blackout times to meet cannabis light-deprivation needs and induce flowering. Typically a mounted curtain that can be rolled out or in as needed.

**Shuttle rolling bench system:** A type of palletized rolling bench system equipped with an automatic greenhouse cultivation system, including ebb-and-flow irrigation devices and an operational control system.

**Side vents:** Vents in the sidewall of a greenhouse that open to reduce heat and humidity. Often set up on automatic controls and used in conjunction with roof vents to encourage natural ventilation.

**Supplemental lighting:** Providing plant-appropriate lighting either in addition to natural sunlight or in enclosed areas of the greenhouse to meet the cannabis plant's specific light needs for that period of the plant's growth.

**Trellis system:** A system of supporting and organizing cannabis plant growth to promote airflow and space that encourages fuller flower formation, without protecting against bud rot and mold. May consist of wooden, plastic or metal frames and typically a square netting draped over the plant that it grows through.

**Vapor pressure deficit (VPD):** Calculating the exact combination of temperature and relative humidity to achieve peak plant performance.

**Vertical racking system:** A tiered racking system that takes advantage of vertical space and stacks plants on multiple racks. Used with supplemental LED lighting. Can be installed on carriage systems to automate moving the racks.

**Zone segmentation:** Areas within a greenhouse separated for different growing requirements like propagation versus vegetative stages. Typically achieved with inside gable walls or sidewalls and properly designed HVAC systems with good environmental controls.

COMPANY NAME	WEBSITE
Accelerated Growth Solutions LLC	ag-solutions.net
AIR Sniper	www.airsniper.ca
Atmosphere Inc.	www.atmosphere.com
CGEE Solutions	www.CGEEsystems.com
Coldcore Inc.	www.coldcoreinc.com
Current Culture H2O	cch2o.com
gPod by Data Aire	gpod.dataaire.com
DAG (DominionAG)	www.dagfacilities.com
Envirotech Cultivation Solutions	www.envirotechcultivation.com
FabricAir, Inc.	www.fabricair.com
FolioGrow	www.foliogrow.com
AiroClean420	www.airoclean420.com
MJ12 Design Studio, Inc.	www.mj12designstudio.com
Next G3N Greenhouse	www.nextg3ngreenhouse.com
Nudo Products, Inc	www.nudo.com
Porta-King Building Systems	www.portaking.com
Surna Cultivation Technologies	www.surna.com
urban-gro, Inc.	www.urban-gro.com
Van der Hoeven Horticultural Projects B.V.	www.vanderhoeven.nl/en
Sevenpoint Interiors	www.sevenpointinteriors.com
Multifan	www.vostermansusa.com
CaNavis International	www.canavis.ca
ZeroCool Systems	www.zerocoolsystems.com
Tricarico Architecture and Design PC	www.tricarico.com
CandyWorx	www.candy-worx.com
Nuform Building Technologies Inc.	www.nuformdirect.com
Merchney Greenhouses	www.merchneygreenhouses.com



COMPANY NAME	WEBSITE
DASERCO CANN	daserco.com
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Cannabis Facility Solutions	www.cannabisfacilitiesolutions.com
Bud Construction	www.buildwithbud.com
Lead Funding LLC	leadfunding.com/cannabis
DVO	www.dvoeng.com
Argelith Ceramic Tiles	www.argelithusa.com
Tate	www.TateInc.com
Estes Construction	estesconstruction.com
Acoustic Ceiling Products (ACP)	acpideas.com
Atlas Greenhouse	atlasgreenhouse.com
Patterson Fan Co.	www.pattersonfan.com
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Roberts Gordon LLC	www.robertsgordon.com/greenhouse-infrared-heating
ARCO/Murray	www.arcomurray.com
JPT Architects	www.jptarchs.com
Advanced Extraction Labs	www.advancedextractionlabs.com
Echelon Constructors	echelon810.com
Trusscore	trusscore.com
Mi Farm Pod	www.mifarmpod.com
SmartBee Controllers	www.smartbeecontrollers.com
Enwave Corporation	www.enwave.net
Greenbox Builders, Inc	greenbox.build
Agricova	www.agricova.com

COMPANY NAME	WEBSITE
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Capstone Green Energy	www.capstonegreenenergy.com
Constellation Cannabis	constellationcannabis.com
Hansen-Rice	Hansen-Rice.com
Boxvana	www.boxvana.com
IDC	idcsupply.com
Britten Woodworks	brittenwoodworks.com
Global Garden	www.globalgardenco.com