



Guide to Smart Technologies for Cannabis Cultivation

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The emerging cannabis industry is shining a light on the need for cultivation facilities to push the technological boundaries of commercial LED grow systems.

Cannabis legalization is sweeping the nation—and opening new markets.

Decades of activism have led the cannabis industry from the fringes of society into the bright lights of mainstream culture. And as cannabis moves into a future of acceptance and profitability, science-minded cultivators will need innovative technologies to meet commercial demand.

The World of High Tech Cannabis Cultivation: Growing with AI and Machine Learning

Blooming cannabis markets open the floodgates to new levels of competition.

To maximize your yield and quickly bring a high-quality product to the marketplace, you must take advantage of the benefits of cutting-edge tech.

Cannabis industry facts and figures:

- A [Gallup poll](#) reveals that almost half of adults have tried cannabis, up nearly 10 percent from less than a decade ago. Enthusiasm for cannabis continues to grow!
- [Research shows](#) that cannabis sales in the U.S. increased 40 percent in 2021 to \$25 billion. Global cannabis sales increased to \$31 billion in 2021.
- [Acceptance of recreational cannabis has grown exponentially](#), with recreational consumption now legal in 18 states. 44 percent of Americans live in states with legal access to recreational cannabis.
- [Wall Street now predicts](#) the cannabis industry will skyrocket to a value of \$100 billion by 2030. Consumer demand for cannabis is far exceeding analytical expectations.
- [States earned](#) more than \$3.7 billion in tax revenue from recreational cannabis sales in 2021. Officials are more receptive to green on the shelves when it generates more green for the state.

Using artificial intelligence (AI) and machine learning to grow cannabis helps you meet industry demands.

The benefits of AI and machine learning have affected industries ranging from healthcare and finance to manufacturing and retail. In fact, a study found that during four recent global economic downturns, companies using AI were able to increase sales and profit margins. These companies offer a blueprint for using AI that can benefit the cannabis industry.



How Cannabis Cultivators Can Use AI and Machine Learning

AI and machine learning platforms can help cannabis cultivators optimize the production process and minimize the cost of an indoor operation.

Here's how cultivators implement AI solutions in the growing process:

- **High-Resolution Sensors**
- **Lighting Technology**
- **Automated Monitoring**
- **Data Analysis**
- **Harvest Forecasting**
- **Management Systems**
- **Plant-Tracking Sensors**
- **Growth Rate Monitoring**
- **Nutrient Measuring**
- **Pest and Disease Detection**



Successfully integrating AI into any agricultural production depends largely on the cultivator's operations, machinery, and facilities. But as we dig deeper, we'll discover why many of the industry's top cultivators welcome these advancements.

Why Integrating Automation into Cannabis Cultivation is Crucial

When the pioneers of the cannabis industry planted their first seeds, everything was done manually. It was hard work. In many ways, it still is. But as cannabis operations across the globe evolved and vertical integration became essential, cultivation managers began to automate the production process.

In each step of cultivation, automation can:

Lower operating costs: Automation reduces labor costs, improves control over the growth environment, provides metrics in a software tracking system, and manages crops to reduce costly waste.

Streamline processes: Automation helps streamline processes such as seed-to-sale tracking, **Metrc (Marijuana Enforcement Tracking Reporting Compliance)** reporting, and other compliance standards that vary state-by-state.

Increase efficiency: Sensors can track every stage of a plant's development, measuring all available data and providing recommendations to help growers produce healthier plants more efficiently.

Automation can be applied to:

- **Climate Control**
- **Lighting**
- **Environmental Monitoring**
- **Water Treatment**
- **Irrigation and Fertigation**
- **Transplanting**
- **Trimming**
- **Grinding and Processing**
- **Packaging**

Result in higher yields and crop consistency: Automated systems can pinpoint what's working and what isn't, from moisture levels to the overall environment, and this knowledge ensures plant consistency and greater yields.

Allow for real-time visibility: Automated systems collect data with sensors and relay that information via the internet. This allows the grower to make remote changes to every aspect of the system, including climate control, moisture, and lighting.



Cannabis Industry Success Through Automation

The benefits of automation in the cannabis industry are shown through anecdotal evidence from growers who have experienced notable success. In 2021, brothers **Rich** and **Mike Kwezell** of [Heartland Industries](#) and Colorado's [Strawberry Fields](#) dispensaries told [Cannabis Business Times](#) that automation is the only way to grow in the modern age.

“If I could have done it again, hindsight 20/20, I would have taken all these steps to automate sooner,” Rich Kwesell told the publication. “I would have done it as fast as possible. You can drive yourself crazy looking at your analysis on each decision, but if we would have dove in quicker, we would’ve had a much bigger advantage.”



Cultivation Grows

Smart technologies like automation allow for greater control of the growth environment. **These in-field advancements can be applied to the three specific types of cultivation:**

- **Indoor Farming**
- **Greenhouse Cultivation**
- **Vertical Farming**

The tools and technologies associated with automation—as well as AI and machine learning—tightly manage growing conditions, allowing cultivators to develop, monitor, and manipulate the environment to produce desired yields. But how you manage the environment differs depending on where your cannabis grows.



Indoor Farming

Growing cannabis indoors gives cultivators more control over the environment; avoiding unpredictable weather and pests is an added benefit. The classic, single-level indoor setup improves environmental control, reduces issues with the ambient environment, and offers consistent lighting.

Greenhouse Cultivation

Greenhouses let cannabis cultivators harness the warmth and light of the sun while protecting plants from poor weather conditions and pests. Much like classic indoor growing, using a greenhouse allows cannabis seeds to germinate much earlier than compared with outdoor cultivation.

Thrive Agritech Greenhouse Supplemental Lighting Designs

Vertical Farming

In what many industry insiders are calling the future of cannabis cultivation, vertical farming produces plants in vertically stacked layers or vertically inclined surfaces. This method reimagines the indoor growing method to house as many plants as possible and increases profits. Data shows that the top cannabis growers in North America typically use a combination of indoor, greenhouse, and vertical farming.

So where are indoor, greenhouse, and vertical cultivators applying smart technologies to grow cannabis for the industry's flourishing marketplace? **Everywhere!**

- **Lighting**
- **Feeding Schedule and Nutrients**
- **Water Controls—Irrigation**
- **Climate Control—HVAC and Dehumidification**
- **Waste Control**
- **Control Systems and Integration**
- **Harvest Automation and Control**
- **Data and Analysis Software Control**

We'll shine a light on each of these areas in the following sections.

Lighting

Let's start with one of the most important ingredients in successful cannabis cultivation: sufficient lighting. Calling the sun an excellent source of light would be an understatement; it is the light all other light sources are based on. Unfortunately, for all of its brightness, the sun isn't especially reliable. Sure, it rises every morning and sets every night, but what happens in between is unpredictable. When clouds roll in and block the sun's rays, that's just tough luck.

LED Lights for Cannabis Cultivation

Anybody got a light? If you're staging an indoor cannabis growing operation, you'd better. For experienced indoor cannabis cultivation pros, LED lights are the ultimate lighting solution. LEDs don't just let growers control their operation more accurately, they're also cost-effective and sustainable.

Control

You can tune LED lights

LED lights can be adjusted depending on what your crop needs. These lights can be dimmed, the intensity can be raised or lowered, and they can even be switched to different spectrums. Traditional high-pressure sodium lights are much less versatile; you only get one light, one color.

Sustainable

You don't have to change LED Lights

Traditional high-pressure sodium lights deteriorate quickly and have to be changed often. LED lights can last up to 50,000 hours! Think of how many light bulbs don't end up in a landfill. What's more, LED lights run cool, so there's no danger of overheating.

Cost-Effective

You save electricity with LED Lights

LED lights can be adjusted depending on what your crop needs. These lights can be dimmed, the intensity can be raised or lowered, and they can even be switched to different spectrums. **20 to 30 percent more energy-efficient** Traditional high-pressure sodium lights are much less versatile; you only get one light, one color.

LED Adoption is on the Rise in Cannabis Cultivation

According to a report by the [Cannabis Business Times](#), LED usage for cannabis cultivation has skyrocketed more than 45 percent for all stages of plant growth since 2016. What's more, nearly 60 percent of growers who aren't currently using LEDs plan to switch over in the near future. **A closer look at Cannabis Business Times' research into the types of lighting used by growers during propagation shows:**

- 69 percent use LED lights
- 33 percent use fluorescent lights
- 22 percent use high-pressure sodium fixtures
- 13 percent use metal halide lights

During the flowering stage:

- 62 percent use LED lights
- 37 percent use high-pressure sodium lights
- 8 percent use fluorescent lights
- 6 percent use metal halide lights

With the number of LED light users on the rise, the results must be favorable.

LED Light Automation

The automation of LED systems is perhaps the biggest reason why cultivations flock to this style of lighting. LED light automation brings the “set it and forget it” selling point into the cannabis industry, with control presets dictating various grow details, **including:**

- **Lighting Scheduling**
- **Dimming**
- **Spectral Tuning Controls**
- **This is all achieved through a centralized environmental control system.**

Growing Cannabis with LED Lights: Stages of the Plants

Cannabis goes from prospect to product in three main stages: seedling, vegetation, and flowering. LED grow lights affect each of these stages differently, so your LED lighting approach must be calibrated for each stage.

Seedling

This is the cannabis plant’s most vulnerable stage, and LED lights should blaze with minimal intensity. An overabundance of light could dry out the soil, so LED lighting rigs should be placed higher up and farther away from the plant. Depending on the wattage of your LED grow lights, cannabis seedlings should be safe between 24-36 inches from your lights.

Vegetative

Cannabis plants need more light in order to power photosynthesis, so LED lights should be moved closer to the plant. Generally, the tops of your cannabis crop should be between 12-24 inches from the LED source. Blue LED lights are ideal for vegging, as they promote sturdy leaves and stems.

[Thrive Agritech Lighting Designs for Vegetative Growth](#)

Flowering

After cannabis is fully vegged, it's on its way to blooming and eventual harvest. LED lights should be placed between 16-36 inches from the cannabis canopy in order to maximize photosynthesis. Red LED lights work wonders during the flowering stage, as they promote bud development and stem acceleration.

[Thrive Agritech Lighting Designs for Flowering Cannabis](#)

Feeding Schedule and Nutrients

Grow automation technology for the cannabis industry has evolved beyond LED lighting rigs into a host of other processes. Automation can now deliver the vital nutrients cannabis plants need to flourish.

Nutritional Needs of Cannabis Plants

- Cannabis requires three primary macronutrients for optimal health: nitrogen (N), phosphorus (P), and potassium (K), or N-P-K. Plant food includes N-P-K levels on labels. Secondary macronutrients include calcium (Ca), magnesium (Mg), and sulfur (S).
- Micronutrients, or trace elements, are equally important, but only tiny amounts are necessary. Boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn) are often available in potting soils without the need for additional micronutrients.

Nutritional Deficiencies

Cannabis plants that don't receive nutritional care will not function properly. They become stressed and lose defense mechanisms that protect them from mold, bugs, and pathogens. Malnourished cannabis plants will show signs of stunted growth and produce paltry yields. Stark discoloration of the leaves is an early indicator of nutritional deficiency; however, nutritional deficiency in cannabis can be expressed in many unique ways. [A study from 2019](#) investigated each deficiency in-depth.

Why are pH Levels Important?

If the pH level is too high or too low, your plants cannot uptake the nutrients they need to thrive. Keeping a pH between 5.8 and 6.8 for soil gardens—or between 5.5 and 6.5 for hydroponic grows—is absolutely necessary for your plants to reach their full potential.

What is a Feeding Schedule?

The best way to ensure your plants get the nutrients they need to survive and thrive is to keep track of everything throughout the growing cycle. Feeding schedules—a time-honored tactic employed by growers in all areas of agriculture—are applied to cannabis based on size, strain, and growth stage.

Nutrient vendors can help novice growers by providing feed charts that contain relevant information about what type of nutrients each plant food contains, how much of each product you should use, and what pH level you should maintain depending on the plants' growth stage.

How Automation Solves Feeding Schedules and Nutrients

Systems designed to auto-feed and irrigate effectively are out there. Often referred to as “fertigation,” the incorporation of a nutrient feeding system into an automated irrigator is a popular approach in the commercial cannabis industry. Automation streamlines every aspect of the feeding schedule, calculating the correct amount of nutrients and mixing those crucial elements directly into the irrigation system. This results in:

- **More precise nutrient levels**
- **More efficient nutrient delivery**
- **Less water consumption**
- **Less manual labor**

Water Controls — Irrigation

Irrigation is crucial to every successful cannabis cultivation, and a fully automated irrigation system can deliver H₂O to cannabis more accurately than hand-watering.

Watering Commercial Cultivation

Bottom line: Hand-watering plants is not an option if you're a commercial cultivator.

- **It's not cost-effective**
- **It's time-consuming**
- **It's impractical**
- **It's imprecise**

Spending some extra time and money upfront to install an irrigation system is a surefire way to decrease operating costs in a highly competitive industry. It also gives growers more control over the amount of water and nutrients their plants receive compared to hand-watering.

Benefits of Automated Drip Irrigation

Drip irrigation maximizes cost savings and grow room efficiency. By “drip irrigation,” we're referring to the precise application of water directly to a plant's roots. Drip irrigation comes in a few forms: a spray, a mist, or a standard drip emitter. Drip emitters don't consume gallons of water per minute like traditional sprinklers. Instead, drip emitters are engineered to emit a specified amount of water, measured in gallons per hour. An automated drip system can water all plants at exactly the same time, cutting the hours-long ordeal of watering plants down to a few minutes. It allows you to control the accuracy of watering your plants in a highly efficient manner

Drip irrigation is 90 percent efficient at allowing plants to use the water applied. It reduces runoff and evaporation. Compare that to the other forms of irrigation, such as sprinklers, which are only 65-75 percent efficient.

What is a Flood Table?

A flood table is another alternative to hand-watering cannabis plants. Basically, the plant sits on a table or in a bucket, and a nutrient solution is pumped in from a reservoir. The nutrient solution floods the table/bucket and then drains back into the reservoir when the pump is switched off. Flood tables use a timer to control the frequency of floods and drains.

Climate Control — HVAC and Dehumidification

The health and well-being of your indoor crop relies on the climate inside of the grow room. Commercial cannabis cultivators can't afford to misstep in this area; anything less than an ideal climate can decimate your crops and destroy any chance of turning a profit.

Master the Grow Room Climate

To achieve homeostasis within your grow room and inspire buds that will pop in the cannabis marketplace, **you must control the environmental aspects that contribute to changes in the climate, including:**

- **Lighting**
- **Temperature**
- **Humidity**
- **Airflow**
- **Carbon Dioxide (CO2)**

Lighting

Yes, certain types of grow lighting contribute to the climate. Most types of light add a lot of heat to the room, and high temperatures can be lethal for plants. Traditional high-pressure sodium lighting systems can elevate the temperature of the room by around 20 degrees Fahrenheit. This offers yet another reason to transition to LED lights.

Temperature

You want your grow room to be warm enough so your plants don't freeze and cool enough so they don't burn. This is generally between 65-85 degrees F. Maintaining this temperature is not always achievable with a simple window or wall AC unit. When you scale up operations, it's imperative you use central air, similar to what's installed in homes.

Humidity

Humidity is the primary climate control aspect for high-performance grow rooms. Controlling humidity doesn't just prevent mold; it also influences your plant's [transpiration rates](#). Most cannabis growers prefer a range of 40-70 percent relative humidity, depending on the growth stage.

CO2

Though it could be considered a nutrient, CO2 belongs squarely in the climate control conversation. It's a key element in photosynthesis, and when there's enough light and plenty of water, increasing CO2 can drastically improve that natural plant process. The average CO2 concentration in the environment is about 400 ppm (parts per million). However, indoor cannabis grows may reach as much as 1,000 ppm by injecting compressed CO2 into the space.

- **Streamline the process:** Program your system to operate on its own without any stops and starts.
- **Solve problems quickly:** If the system shuts down, you won't have to search for the source of the problem. The system itself will tell you.
- **Save time, money, and energy:** A system with independent, smart controllers can monitor itself and self-diagnose problems without a human technician.

Airflow

During the transpiration process, water evaporates from the plant. Proper airflow helps circulate that evaporated water. Without it, leaves can get waterlogged and develop mold and fungus. For the most part, large commercial operations can utilize simple oscillating fans to circulate the air.

Automated HVAC and Dehumidification

As people across multiple industries know, HVAC refers to heating, ventilation, and air conditioning. While essential in the cannabis industry, it's important to add a D for dehumidification. An automated HVAC/D system removes water from the air of the grow room environment and keeps the room temperature-controlled and well-ventilated.

An automated HVAC/D system allows you to:

Waste Control

All industries create waste. The ones that truly make a difference dispose of their waste properly and efficiently. As more and more states legalize cannabis for recreational and medicinal consumption, the level of waste created by the industry will naturally rise.

In Washington state alone, close to 2 million pounds of cannabis waste was created in the first three years of legalization. The industry desperately needs a solution; however, the highly regulated nature of cannabis waste makes disposing of it a challenge and requires an airtight waste management plan.

What is Cannabis Grow Room Waste?

Grow room waste is any material left over from the growing process. This includes run-of-the-mill dirt, cultivation tools, and nutrient-rich wastewater. Trimmings and unused plant sections, such as roots, would all be considered organic waste.

How is Cannabis Waste Disposed?

Typically, there are four ways to dispose of cannabis waste.

- **Landfill:** Certain landfills specifically accept marijuana waste. In order to utilize a landfill, cannabis waste must be made “unusable and unrecognizable.”
- **Composting:** For businesses that want to limit their waste footprint, composting offers a simple and eco-friendly solution.
- **In-Vessel Digestion:** Using bacteria and other biological elements, a digester system breaks down organic cannabis byproducts.
- **Incineration:** While fast and cost-effective, you cannot simply pour gasoline on a pile of cannabis and set it ablaze. You have to work with a licensed incineration company.

The Problem with Traditional Disposal Methods

The above disposal methods are all well and good, but they're not without shortfalls.

- **Regulations:** Since no federal guidelines are yet in place on how to handle cannabis waste, companies must follow individual state laws that often shift.
- **Ecological Concerns:** Cultivating and refining cannabis results in some byproducts that are not compostable or recyclable.
- **Transportation:** Trucks and drivers have to be licensed and permitted to transport cannabis waste, which takes time and resources. The ever-rising price of fuel is another concern.

Automating Your Cannabis Waste Management

With advancements such as solar-powered trash compactors, recycling apps, and pneumatic waste pumps, smart technology is changing the way we manage waste. Combine that technology with the acceleration of the cannabis industry and a global move toward sustainability, and we have the opportunity for real change in cannabis waste management.

Control Systems and Integration

For optimized growth, exceptional yields, and impressive profits, cannabis plants must exist in perfect harmony with the grow room environment. Control systems powering full integration within the cultivation facility coordinate all of the moving pieces, optimizing performance and plant production.

One Source of Truth

The old saying “too many cooks in the kitchen” may be cliché, but there’s some truth to it. An overabundance of advice makes it challenging to know what’s true. A centralized platform and total systems integration remove the guesswork.

Integrated systems in your facility coordinate and automate processes to optimize plant production, reduce labor costs, and increase yields. When you’re able to conduct all systems from a centralized platform, you can operate lighting, HVAC/D, water systems, and more in a fully coordinated way.

Benefits of Centralized Data and Analytics Software Control

Utilizing data and analytics in your cannabis grow can be effectively leveraged to gain a competitive advantage in the marketplace. Data in a centralized platform automates tasks, supports data reusability and sharing, and ensures a more productive workflow without disruption. Centralized data is proven to push businesses toward marketplace disruption. **In a [2022 study](#), of the businesses that use centralized data:**

- **64 percent experienced more efficiency**
- **57 percent saw more business growth**
- **44 percent gained actionable insights**
- **32 percent lowered business expenses**
- **28 percent had far fewer data-related errors**

Cannabis cultivation creates an amazing amount of data. How that data is collected and deployed separates successful companies from those that die on the vine. Enterprise Resource Planning (ERP) is one way that mainstream businesses collect and use historical data to their advantage. And with the cannabis industry's newfound position in the same mainstream, it's high time [cultivation managers got on board with ERP.](#)

- An ERP solution is a management system in which all data related to a grow operation is centralized—accounting, human resources, growing, cultivation, quality, production, inventory, sales, and reporting.
- Automated data management and recordkeeping within ERP streamlines processes, reduces errors, and requires less time than manual methods or juggling various systems.
- Real-time access to information provides visibility to company stakeholders and eliminates previously siloed factions of the business, laying the foundation for transparency across the entire cannabis operation.

It's no tall tale: Data analytics in growing facilities deliver a competitive advantage for cannabis companies with the foresight to leverage smart technologies.

Cannabis Operations Grow with Smart Technologies

Smart technologies such as automation amount to more than merely presetting lights or gearing an irrigation system to water plants; it's also about data collection, analysis, discovery, and action.

And these have the potential to generate massive returns in the cannabis industry.

Automating your plants' growth cycle with smart technologies provides you with a daily record of how your plants are reacting—instantaneously—to nutrient feed, pH, LED light spectrum, CO2, and the environmental conditions of your grow space.

The software used in smart technology makes millions upon millions of calculations throughout the grow, giving you the power of unimpeded insight into how to make a meaningful difference in your cannabis crop's output.

Thrive Agritech lights up the start of your conversion to smart technologies with LED lighting systems for cannabis cultivation facilities. **Connect with us today to brighten the future of your business.**

