

# **WINDS OF PROSPERITY** Harnessing Airflow and Crop Steering for Supreme

Harnessing Airflow and Crop Steering for Su Cannabis Yield in CEA

## **eBook Series**

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# Introduction

Indoor cannabis cultivation is an intricate blend of art and science, where every element plays a vital role in nurturing robust, high-yielding plants. Amidst the multitude of factors influencing successful cannabis cultivation, one often underestimated yet profoundly influential aspect is airflow.

In this comprehensive guide, we will explore the nuances of how effective airflow management can make or break your cannabis cultivation efforts. From regulating temperature and humidity to thwarting pests and diseases, airflow acts as the unsung hero in the pursuit of premium cannabis yields.

Through a blend of practical advice, scientific insights, and real-world case studies, we will dissect the multi-dimensional role of airflow within indoor cannabis facilities. Whether you are an experienced cultivator refining your methods or a beginner building your operation, this ebook equips you with the knowledge and tools needed to maximize the potential of your cultivation environment.

Join us on this enlightening journey as we unveil the secrets of airflow management and unlock the key to a bountiful harvest of superior cannabis.

## **Defining Crop Steering**

**GOOD CROP STEERING:** measured changes in variables that impact plant growth with predictable results that positively impact KPIs important to the business.

**AIR FLOW CROP STEERING:** Air flow crop steering is a cultivation technique used in indoor cannabis cultivation facilities to optimize plant growth and increase yields. It involves controlling the direction and speed of air flow within the grow space to manipulate the microclimate around the plants. And influence stomatal conductance that can drive phenotypic expression, biomass accumulation and overall plant vitality.





## Computational Fluid Dynamics and Airflow Crop Steering

Computational Fluid Dynamics (CFD) modeling is a simulation and analysis method for understanding the behavior of fluids, such as air, and their interactions with objects or environments, including cannabis plants and lighting.

#### What about when we apply it to airflow crop steering in Cannabis **Controlled Environment Agriculture?**

In the context of cannabis cultivation, CFD modeling enables you to create a computerized simulation of your growing environment, the air within it, and how it circulates when the ventilation system is operating. This simulation helps you analyze temperature distribution, airflow patterns, and the efficient delivery of CO2-rich air to the plants. By manipulating various variables, you can optimize your facility's design, improve ventilation system efficiency, and enhance overall plant growth.



- curing processes.
- Temperature and Humidity Control: Identifying areas of heat accumulation and temperature gradients, guiding dehumidification
- Optimization of Gas Exchange: Enhancing CO2 uptake for photosynthesis, growth rates, plant defense systems, and metabolite production.
- Prevention of Micro-climate Variations: Predicting and mitigating micro-climate variations to ensure uniform crop development and reduce susceptibility to pests and diseases.
- excessive air movement and optimizing HVAC systems for reduced energy consumption.
- **Decision Support and System Design**: Providing insights and support for system design and operation.

While CFD modeling presents challenges in cannabis CEA, ongoing advancements in modeling techniques and improved understanding of cannabis cultivation may overcome these limitations in the future. Trusting but verifying remains crucial when applying CFD modeling to your facility.

(CFD Model Created by Grow Glide)

Here are some advantages related to airflow crop steering in Cannabis Controlled Environment Agriculture:

• Visualization of Airflow Patterns: Identifying areas of stagnant air or insufficient/excess flow, optimizing airflow distribution, and enhancing

system design, and ensuring uniform temperature and humidity levels.

**Energy Efficiency and Resource Optimization**: Identifying areas of



## Influencing the Cardinal Parameters

To maximize yields and profits in cannabis cultivation, optimizing the ten cardinal parameters that influence plant performance in all aspects of the growing environment is essential. Controlling airflow offers opportunities to influence these parameters.

**Light:** Top-down airflow dissipates heat from lights, maintains consistent leaf temperatures, and increases photosynthetic photon flux density (PPFD) for higher yields.

Humidity: Adequate airflow prevents mold and mildew by maintaining consistent transpiration and humidity levels.

**Airflow:** Good airflow prevents the buildup of stale air, excess moisture, and heat pockets.

**Nutrient Levels:** Proper canopy airflow supports consistent transpiration and nutrient uptake.

Water in the Root Zone: Appropriate airflow maintains controlled dryback periods and optimal media moisture.

**Root Zone Temperature:** Consistent root zone temperature requires controlled airflow.

**Oxygen:** Airflow promotes respiration in the lights-off cycle, aiding oxygen recovery.

**CO2:** Providing CO2-enriched air with suitable velocities enhances assimilation and yield.

**Microbes:** Good airflow prevents pathogen proliferation by breaking up microclimates.

**Temperature:** Airflow maintains consistent environmental conditions and influences leaf temperatures.

In conclusion, manipulating airflow in a cannabis cultivation environment is a critical aspect of creating a healthy and productive growing environment. It helps maintain consistent conditions, promotes optimal plant growth, and reduces the risk of various environmental stressors and issues.



**Tools and Airflow Management** 

To effectively manage airflow in cannabis cultivation, several tools are invaluable. These next two pages explore the essentials.

**ePAR Meter:** An ePAR meter is a specialized tool used in indoor cannabis cultivation facilities to optimize SOPs for efficient use of your lighting solution. It accurately measures light intensity, providing crucial data for maximizing plant growth through optimal photosynthesis and influences where and when to defoliate to optimize light penetration and create space for airflow.

Hot Wire Anemometer: The airflow tool that really helps you get in the weeds, the hot wire anemometer allows you to collect granular data on airflow around the plant. Correlating successful KPIs to baselines in airflow allows you to find deficiencies in performance, justify investment and measure impact of purpose built airflow solutions.

Substrate sensor: What temps do you want to maintain in your root zone? Is your room consistent from front to back, top to bottom? In order for your fertigation regime to be most effective you need consistent media management from PH to temperature. It is important to know the ranges you're expecting in order to make adjustments in water temperature, fertigation frequency, and bottom up or top down airflow velocities.

HVACD Regular Maintenance: There are a lot of pieces of mechanical equipment that benefit from regular servicing. Fans, drain pans, coils, performance assessment, air balancing to check the ductwork, damper management strategy and even filter management. A clean air filter can effectively remove airborne contaminants, including potentially harmful microbes like bacteria, fungi, and mold spores while making sure we are getting the most airflow possible from our system. By maintaining a sanitized air supply, growers can create a controlled environment that minimizes the risk of microbial contamination and prevent the need for remediation.

Hot Wire Anemomete

Quantum Flu apggee 0

ePAR Meter

Substrate Sensor

## Tools and Airflow Management

**Digital Hydrometer:** As the relative humidity of the air surrounding the plant increases, the transpiration rate decreases. It is easier for water to evaporate into dryer air than into more saturated air. Increased movement of the air around a plant will result in a higher transpiration rate. This device accurately measures the moisture content in the air, providing crucial data for maintaining optimal growing conditions and consistency to reduce risk and influence expression.

**Emissivity-Adjusted IR:** A specialized tool that allow for accurate temperature measurements of surfaces and plants, even in diverse environments. By accounting for emissivity, it ensures precise readings, crucial for identifying potential hotspots or areas with inadequate airflow. Additionally, accurate data allows you to utilize convective cooling (like a breeze when you are sweating) and understand the impact of your airflow strategy on leaf temperature.

#### Water activity / Moisture Content Meter:

Adjust airflow to control water movement and delivery of conditioned air to dense walls of cannabis. This tool allows for testing throughout the curing process to predict rates of sublimation and access biological safety. The finding can trigger adjustments in curing itineraries and lead to standardized curing setpoints on a day by day basis.

**Senors and Sensor data**: Data from sensors provides environmental information linked to activities such as fertigation, defoliation, IMP, and transitions from day to night. This data can be confirmed using handheld devices like Aroya, Gorsense, or Growlink. It reveals patterns that enable you to fine-tune airflow based on the effectiveness of your HVAC, fertigation, and lighting systems. For instance, you can adjust fans during Integrated Pest Management (IPM) activities, using lower settings for application and higher settings immediately after to aid in even distribution and expedite dehumidification. This approach helps ensure Compliance, Accountability, Performance, and Adaptability (CAPA).

Water activity / Moisture Content Meter

Digital Hydrometer



## **Tools and Airflow Management**

FLIR Thermal Imaging Camera: FLIR cameras can help optimize airflow in Controlled Environment Agriculture (CEA) by providing valuable thermal imaging data that allows growers and HVAC (Heating, Ventilation, and Air Conditioning) professionals to assess and improve the efficiency of the environmental control system.

#### Here's how FLIR cameras can be used for optimizing airflow in CEA:

- Identifying Airflow Patterns
- Detecting Stagnant Air Zones
- Checking HVAC System Efficiency
- Monitoring Ventilation System Performance •

## **Light Fixtures with Air Glide ON**



## **Canopy with Air Glide ON**





- Optimizing Fan Placement
- Balancing Temperature Zones
- Preventing Condensation Issues

## **Light Fixtures with Air Glide OFF**



### **Canopy with Air Glide OFF**



For a more comprehensive guide to these tools, plus more be sure to download our <u>GG Toolkit eBook</u>.

landheld FLIR Camera

Flir iPhone Application

ALIBRATI

Thermal Imaging

## Airflow Profit Plan

## Control + Data = opportunity to improve

You are mother nature. You control the temperature, the water, the sun and the breeze. What will you do with it? What KPIs can you influence? How will it impact your profit?

Effective airflow management streamlines the cultivation process, reducing the time required for manual labor. This translates to significant cost savings in terms of labor hours, allowing you to allocate resources more efficiently and divert labor to other crucial tasks, ultimately impacting your bottom line.

#### let's tie airflow crop steering in cannabis to increased financial performance using the concepts we've mentioned:

- **Risk Reduction**: Maintaining precise airflow controls and optimizing microclimates can significantly reduce the risk of mold, mildew, and other environmental stressors. This risk mitigation can save millions of dollars by preventing potential crop loss or contamination, preserving product quality, and safeguarding your investment.
- **Phenotypic Expression:** Airflow crop steering can lead to enhanced phenotypic expression, resulting in premium-quality cannabis. A higher Certificate of Analysis (COA) due to increased cannabinoid and terpene content can command a higher price per pound in the market, potentially resulting in substantial financial gains.

- **Bag Appeal and Sell-Through:** Better bag appeal, achieved through optimized airflow management, results in guicker sell-through rates. Cannabis with a more appealing appearance attracts more buyers and (ROI) and increased revenue for your cultivation operation.
- HVACD System Efficiency: Homogenizing leaf temperatures and management not only enhances plant health but also reduces energy consumption. Improved HVACD performance leads to energy savings, which directly impacts your operating costs and contributes to higher profit margins.
- Gas Exchange and Yield: Airflow management, particularly in the context Even a minor increase in yield per square foot, such as 5 grams, can operation.

Incorporating advanced airflow strategies not only improves the health and growth of your cannabis plants but also has a direct and measurable effect on your financial performance. By optimizing airflow, cultivators can reduce costs, minimize risks, increase product quality, and ultimately boost their profitability in the highly competitive.

#### **CONSIDERATIONS:**

What is one more gram worth? \$59,361/year for one more gram per SF 10 grams would be \$593,610/year\* \*3500 sf x 1gram = 7.7lbs x 5.5 harvests a year = 42.4lbs x \$1400

moves off the shelves faster. This translates to faster return on investment optimizing the high points of your HVACD system through proper airflow

of efficient carbon dioxide (CO2) delivery, can increase the yield of highquality flowers while reducing the proportion of lower-value popcorn buds. have a substantial financial impact when scaled across a large cultivation

## Our Airflow Solutions



- INNOVATIVE DESIGN
- DURABLE MATERIALS
- MODULAR COMPONENTS
- QUALITY CONTROL
- BREAKS THE LEAF BARRIER
- REDUCES MICROCLIMATES
- HOMOGENIZES AIR FLOW



## **SLAB TRAYS**

- ELEVATED TRAY WALLS
- ACCOMMODATES A VARIETY OF CULTIVATION MEDIA
- INCREASED AIR MOVEMENT BETWEEN TIERS
- REDUCES MICROCLIMATES
- ADDITIONAL SPACE BETWEEN TRAYS HELPS WITH FIRE COMPLIANCE.

## What's in it for you, the Cultivator?

Effective airflow management is the unsung hero in your quest for successful cannabis cultivation. It's the art of balancing the conditions that nurture healthy, high-yielding plants. While it may seem like a minor detail, it can have a major impact on your bottom line.

• Time is Money: With proper airflow, you can streamline your cultivation processes, reducing the time your workforce spends on manual tasks. This efficiency can save you precious labor hours, allowing you to allocate resources where they're needed most.

- Risk Mitigation: Airflow isn't just about keeping the air moving; it's about reducing the risks of mold, mildew, and other environmental threats. A well-managed airflow system can prevent crop loss and contamination, potentially saving you millions.
- Ouality Equals Profit: Enhancing phenotypic expression through airflow management can lead to higher-quality cannabis. A higher Certificate of Analysis (COA) with increased cannabinoid and terpene content can command a higher price per pound. The financial benefits of producing premium cannabis are evident.
- Faster ROI: When your cannabis boasts better bag appeal, it sells faster. A visually appealing product moves off the shelves quickly, leading to a faster return on your investment.

- **Energy Efficiency**: Smart airflow management not only promotes plant health but also reduces your energy consumption. This translates to direct cost savings, improving your profit margins.
- **Yield Boost**: Optimized airflow can enhance the yield of high-quality flowers while minimizing the less valuable popcorn buds. Even a slight especially when scaled up across your entire operation.
- Gas Exchange and Yield: Airflow management, particularly in the of high-quality flowers while reducing the proportion of lower-value popcorn buds. Even a minor increase in yield per square foot, such as 5 grams, can have a substantial financial impact when scaled across a large cultivation operation.



increase in yield per square foot can have a significant financial impact,

context of efficient carbon dioxide (CO2) delivery, can increase the yield

## What's in it for you, the Scientist?

As a scientist, you play a crucial role in advancing the understanding of airflow crop steering in cannabis cultivation. Your research can offer valuable insights that benefit cultivators and business owners alike.

- Innovative Techniques: Your research helps cultivators adopt innovative techniques for airflow management. By studying the complex interplay of factors, you can provide practical solutions that enhance the financial performance of cultivation operations.
- Data-Driven Decisions: Your studies help cultivators make data-driven decisions, allowing them to fine-tune their cultivation environments. This leads to better resource allocation, optimized plant growth, and ultimately, improved financial outcomes.
- **Risk Assessment:** Your work in understanding and mitigating risks associated with mold, mildew, and other threats is invaluable to business owners. Your findings enable cultivators to implement strategies that protect their investments and product quality.
- **Quality Assurance:** By exploring phenotypic expression and its impact on product quality, you contribute to the marketability and value of the cannabis being produced. Higher-quality cannabis can command premium prices, which has financial implications for businesses.

## What's in it for you, the **Business Owner?**

Airflow crop steering isn't just a cultivation technique; it's a financial strategy. As a business owner, here's how you can leverage airflow management for profit.

- line.
- safequards product quality, and ensures consistent revenue.
- **Premium Product, Premium Prices**: Producing higher-guality cannabis prices in the market. This translates to better profit margins and a competitive edge.
- Energy Savings: Smart airflow management not only improves plant healthier bottom line and a more sustainable operation.

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scale.

• Efficiency is Profit: Streamlining your cultivation processes through airflow management can significantly reduce operational costs. It's about getting more value out of every hour worked, ultimately boosting your bottom

• **Risk Management:** Understanding the risks in cultivation and using airflow to mitigate them is a sound business strategy. It protects your investments,

through proper airflow management allows you to command premium

health but also reduces energy costs. The cost savings contribute to a

• Yield Optimization: Maximizing yield through airflow management can significantly impact your revenue. Even a slight increase in the yield of high-quality flowers can mean substantial financial gains, especially at



# GROWGLIDE

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# ELEVATING CULTIVATION to new heights

We are always happy to help fellow cultivators achieve their goals and maximize their yields.

If you have any questions or require further assistance, please feel free to reach out to us.



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