



## Introduction to Microgreen Production in Indoor Vertical Farms and Greenhouses

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### Introduction

Microgreens are harvested at a stage that falls between sprouts and baby greens. They are becoming increasingly popular in culinary and health circles, as they come in a variety of colors, flavors, and textures, and are packed with nutrients. Due to their rich flavor and nutrient profiles, microgreens can be used in a variety of ways, such as garnishes or smoothies. Growing microgreens is an excellent option for controlled environments such as vertical farms and greenhouses with a combination of low care requirements and short harvest cycles.

### What Are Microgreens?

Microgreens are immature vegetables, herbs, and grains that are harvested with the stem soon after the first true leaves have emerged (Figure 1).

Microgreens are often associated with sprouts, which are harvested very shortly after germination, before their first true leaves have formed (3-5 days), and baby greens, which are harvested 3-4 weeks after germination. Microgreens are harvested 1-3 weeks after germination and contain different nutrient and flavor profiles than both their less mature and more mature counterparts (Kyriacou et al. 2016).

A survey of U.S. microgreen producers between 2018 and 2019, which included greenhouse, commercial indoor, and residential indoor facilities, found that some of the most common microgreens produced were radish (*Raphanus sativus*), sunflower (*Helianthus annuus*), arugula (*Eruca sativa*), broccoli (*Brassica oleracea* var. *italica*), and kale (*Brassica oleracea* var. *sabellica*) (Misra and

Gibson 2021). Other common microgreens include pea (*Pisum sativum*), mizuna (*Brassica rapa* var. *japonica*), carrot (*Daucus carota*), mustard (*Brassica juncea*), basil (*Ocimum basilicum*), beet (*Beta vulgaris*), amaranth (*Amaranthus cruentus* and *Amaranthus tricolor*), nasturtium (*Tropaeolum majus*), cabbage (*Brassica oleracea* var. *capitata*), bok choy (*Brassica rapa* var. *chinensis*), mustard-wasabi (*Brassica juncea* 'Wasabina'), celery (*Apium graveolens*), chives (*Allium schoenoprasum* and *Allium tuberosum*), and cilantro (*Coriandrum sativum*). While these are some of the commonly produced microgreens, there are many other species, varieties, and cultivars that have been evaluated or are commercially available, primarily in the families of *Amaranthaceae*, *Apiaceae*, *Asteraceae*, *Brassicaceae*, *Chenopodiaceae*, *Lamiaceae*, and *Polygonaceae*.

Microgreens were introduced in the 1980s and were primarily used in high-end restaurants, but they are now commonly found in local grocery stores, farmer markets, and health-focused restaurants (Verlinden 2020). Much of the recent growth in microgreen consumption stems from interest in their health benefits, driven by their high phytochemical content. Additionally, they have varying textures, flavors, and colors. From the production standpoint, they have rapid production times, resulting in very quick crop turnaround times ("2024 Global CEA Census Report" 2024; Kyriacou et al. 2016).

While the minerals, vitamins, and phytochemical (produced by plants, bioactive compounds, beneficial for humans) content of microgreens will vary based on the plant species, cultivar, harvest stage, and production methods, some studies have shown that microgreens have higher nutritional

value (e.g. higher concentrations of essential nutrients or phytochemicals or diversity of nutrients) compared to their mature plant counterparts (Kyriacou et al. 2016; Pinto et al. 2015). It has also been found that microgreens can serve as a good source of both macroelements and microelements, as is the case with *Brassicaceae* microgreens, which were found to be good sources of K, Ca, Fe, and Zn (Xiao et al. 2016). Broccoli in particular was found to be a good source of phytochemicals with higher levels of the phytochemicals polyphenols, carotenoids, and chlorophyll compared to other microgreens evaluated (Marchioni et al. 2021). Microgreens are also beneficial due to their vitamin content, such as kale, radish, arugula, and broccoli, which are high in vitamin C. The phytochemicals, vitamins, and minerals in microgreens have been found to have antioxidant, anti-inflammatory, and anti-cancer properties, among other benefits (Tallei et al. 2024).

Beyond their health benefits, microgreens are valued for their rich flavor profiles, as flavor is an important factor for consumers (Xiao et al. 2015). As with health benefits, the flavor and how these microgreens are used in dishes vary. Arugula has a peppery or spicy taste, while brassicas are more neutral in flavor, and beets are sour (Renna et al. 2017). These are popular additions to salads, sandwiches, sauces, smoothies, desserts, savory baked goods, and garnishes, adding flavor and nutritional value. Recipe examples are available in [this online article about microgreens through N.C. Cooperative Extension](https://lenoir.ces.ncsu.edu/2021/06/micro-greens/): <https://lenoir.ces.ncsu.edu/2021/06/micro-greens/>. Microgreens are also being used in skin care products such as face masks and scrubs (“Exploring the Many Ways to Use Microgreens: From Food to Beauty Products” 2024; Lone, Pandey, and Gayacharan 2024; “Microgreens in Cosmetics” 2023).

## Microgreen Production in Controlled Environment Agriculture (CEA)

Controlled Environment Agriculture (CEA) is a technology-driven approach to crop production under cover with targeted environmental management (e.g., high tunnels, greenhouses, and indoor vertical farms). Crops grown in CEA are typically produced in soilless systems. Space

efficiency and lower resource demands, such as water and fertilizers, can be beneficial for applications in urban centers and areas with limited space availability. Environmental control in CEA enables year-round crop production under consistent conditions. Growing consumer demand for year-round, local, pesticide-free food, combined with technological advancements, lower costs, and increased investments from government, universities, and private investors, has led to a recent rise in edible crop production in CEA.

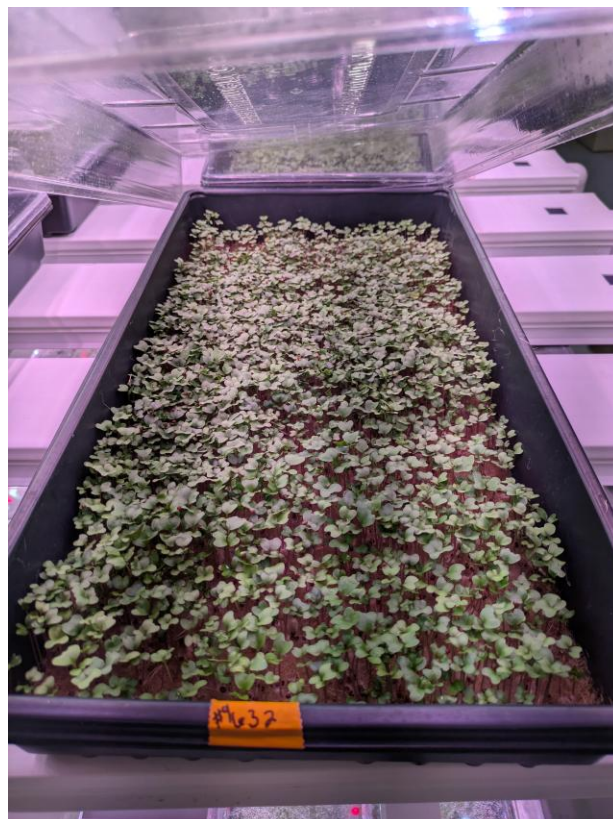


Figure 1. Broccoli microgreens on day 6 after sowing.

Microgreens are common crops grown in CEA (“2024 Global CEA Census Report” 2024). Microgreens grow quickly, resulting in fast crop turnover, and require little space. Microgreens grow well in soilless systems, and environmental and cultural practices can be altered to increase nutritional content, flavor, and aroma of the microgreens. Like any other crop produced within CEA, each producer has a unique combination of facility type, production system and practices, species/cultivars, level of environmental control and automation, and target market.

Microgreens can be produced in a range of systems under high tunnels, greenhouses, or indoor vertical farm conditions. There are advantages and disadvantages to producing microgreens in these diverse environments, such as less control in high tunnels but higher start-up costs in indoor vertical farms. Microgreens are often produced in propagation trays (Figure 1) or hydroponic production systems. Common hydroponic systems used in microgreen production include aeroponics, nutrient film technique (NFT), and ebb-and-flow. These systems can be in a single horizontal row or stacked in vertical racking systems. Vertical stacking can still be used in greenhouses, as well as in indoor vertical farms. Vertical stacking in greenhouses maximizes the use of space while at least doubling production.

## Environmental Settings and Monitoring

Environmental settings such as light, temperature, humidity, and CO<sub>2</sub> can be adjusted to maximize yield, nutritional quality, and flavor/aroma profiles. While additional research is needed to explore different ranges and combinations of these factors, the following general recommendations are provided. When starting a new species, it is best to trial varying environmental settings to customize inputs to your specific species and cultivar, facility, and production system.

**Light requirements** will vary for different microgreen species and to meet the goals of the grower balancing yield, nutritional quality, and energy cost. Microgreens can be produced in greenhouses and high tunnels with no supplemental lighting, but supplemental lighting (e.g. light emitting diodes (LEDS) or high-pressure sodium (HPS)) can be utilized to extend day length or increase light intensity in a greenhouse, or in the case of a vertical farm, providing sole source lighting. The light management strategy will vary depending on the facility and light selection, but some general guidance can be gleaned from current literature (Table 1). The general recommendation for microgreens is a daily light integral (DLI) between 9 and 16 mol·m<sup>-2</sup>·d<sup>-1</sup>, although some research findings offer varying recommendations. At the CEA Innovation Center, we grow microgreens with an 18-hour photoperiod and a PPFD of ~ 250 μmol·m<sup>-2</sup>·s<sup>-1</sup> giving a DLI of 16.2 mol·m<sup>-2</sup>·d<sup>-1</sup>. Light requirements will vary based on plant species, energy

consumption preference, and goals (e.g., higher yield, shorter stems, higher nutritional content). Below is a table of work done with light and microgreens. Note that to learn more about DLI and how to calculate it, check out this [VCE publication on calculating and using DLI: https://www.pubs.ext.vt.edu/SPES/spes-720/spes-720.html](https://www.pubs.ext.vt.edu/SPES/spes-720/spes-720.html)

Table 1. Light recommendations from some recent studies

Microgreen	Recommendation	Source
Arugula	DLI = 9 mol·m <sup>-2</sup> ·d <sup>-1</sup>	(B. Y. J. Allred and Mattson 2024)
Basil	16 h photoperiod at 231 PPFD for the grow period and then increase 3 days before harvest to 300 μmol·m <sup>-2</sup> ·s <sup>-1</sup> using red 638 nm lights	(Brazaityte et al. 2016)
Cabbage and Chinese kale	Photoperiod of 14-16 h per day & 70-90 μmol·m <sup>-2</sup> ·s <sup>-1</sup> PPFD	(Liu et al. 2022)
Cabbage and radish	Photoperiod = 8 h at PPFD of 200 μmol·m <sup>-2</sup> ·s <sup>-1</sup>	(Dmitry and Alexander 2022)
Mizuna and Mustard	DLI = 12 mol·m <sup>-2</sup> ·d <sup>-1</sup> or maybe higher	(B. Y. J. Allred and Mattson 2024)
Parsley	16 h photoperiod at 231 PPFD for the grow period and then increase 3 days before harvest to 300 μmol·m <sup>-2</sup> ·s <sup>-1</sup> using sole red 638 nm or 665 nm lights	(Brazaityte et al. 2016)

For **temperature**, the general recommendation for microgreens is to maintain temperatures between 60 and 70°F (16°C - 21°C; Dubey et al., 2024; Sanchez & Berghage, 2020). **Humidity and airflow** are important factors in regulating water and nutrient movement within the plant and in discouraging pathogen infection. Common humidity levels for microgreens range from 50% to 70% (Dubey et al., 2024). In indoor growing spaces, humidifiers and dehumidifiers can be used to maintain humidity within the desired range. Horizontal airflow fans can

be used in high tunnels and greenhouses to increase airflow, and fans can be placed in an indoor vertical farm to increase airflow.

In all growing environments, CO<sub>2</sub> can be injected to promote plant growth. This is more commonly found in indoor vertical farms and in greenhouses depending on the crop and production environment. Limited research has been conducted on microgreens in this area. One industry member from Microgreens Consulting recommends that CO<sub>2</sub> is not needed in indoor microgreens farms unless other crops are also being grown (Boekhout 2024). One study found that there was an increase in microgreen fresh weight when using 1,000 ppm CO<sub>2</sub> and recommended it could be beneficial if growing in an enclosed production system (B. Y. J. Allred and Mattson 2024). If CO<sub>2</sub> drops below ~400 ppm, it may be beneficial to consider adding CO<sub>2</sub> injection for commercial production.

**Monitoring** environmental parameters is important for understanding what adjustments may be needed. This can be as simple as a digital thermometer and a hygrometer (for the humidity) to check and record in a notebook or a digital spreadsheet each day at the time the microgreens are checked. Light is also important to measure to ensure light levels are within the targeted range. There are handheld light meters that can be utilized to capture data periodically and recorded it in a notebook or a digital spreadsheet. There are also sensors for temperature, relative humidity, light, and CO<sub>2</sub> that automatically log data to a computer or phone that connects over Bluetooth or Wi-Fi. Historical data collected in this way can help identify where adjustments may be needed to improve yield and quality.

## The Systems and Substrates

Various systems and substrates can be used to produce microgreens. Deciding which system to utilize will be based on the facility type, lighting system, labor availability, planned start-up and maintenance costs, type of recirculating or non-recirculating system, and economic considerations. The systems below can be developed for single layers or stacked with appropriate lighting. These production systems include:

- Trays are placed on a greenhouse bench or on a germination rack with lighting (Figure 2).

- 1020 propagation trays filled with substrate.
- Microgreen flats – trays developed specifically for microgreen production.
- Hydroponic Systems:
  - Aeroponics – nutrient solution is delivered to the roots through a mist.
  - Deep water culture – seeds are on a raft or net where roots are suspended in a nutrient solution.
  - Ebb and flow – Trays are flooded periodically with nutrient solution and then drained.
  - Nutrient film technique (NFT) – a thin film of water with nutrients runs under the root system in a sloped channel (Figure 3).

The system you select will affect the substrate used to grow microgreens. Substrate selection will be based on several factors and should be tested within the growing facility and system with the specific plant species of interest. Factors to consider include water-holding capacity that matches the irrigation system, reusability, cost, accessibility, and potential for plant and human pathogens. The substrate used to grow microgreens can affect yield and nutritional quality (Dubey et al. 2024).



Figure 2. Indoor hydroponic vertical farm at the Controlled Environment Agriculture Innovation Center (CEA-IC), Danville, VA. A hydroponic tower

was temporarily set up to be a germination rack for microgreens grown in 1020 trays.

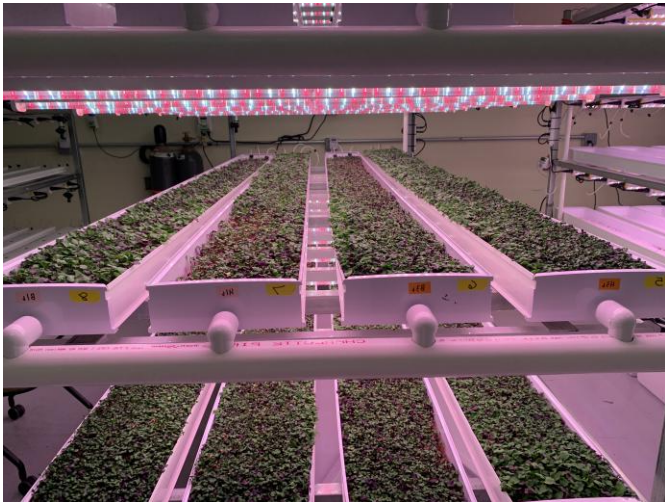


Figure 3. Microgreens produced in nutrient film technique (NFT) hydroponic channels in an indoor vertical farm.

**Below is a list of substrates** used to grow microgreens:

- Soil
- Compost including vermicompost
- Soilless substrate/media – peat, coco coir, vermiculite, or a mix.
- Grow mats:
  - Bamboo fiber
  - Burlap
  - Coco coir
  - Hemp fiber
  - Jute
  - Rockwool
  - Silicone
  - Steel mesh

As an example, we grow microgreens at the CEA Innovation Center in our indoor vertical farm using NFT tower systems (Figure 4). For substrates, we have successfully used hemp and burlap grow mats to produce carrot, broccoli, mizuna, radish, and beet microgreens. In addition, we have grown broccoli microgreens in 1020 propagation trays, where one tray with holes is nested inside another tray with no holes, using hemp mats as the substrate.



Figure 4. Vertical nutrient film technique (NFT) tower with open-faced channels for microgreen production.

## Irrigation and Fertilization

Irrigation method and rate will vary based on the system and substrate type. It is best to utilize a single substrate type in a production system to avoid under- or overwatering. For small-scale microgreen production in 1020 trays, hand-watering via bottom irrigation is an option (Figure 5). Automatic irrigation systems can also be set up utilizing timers and drip irrigation lines. Irrigation rates will change from sowing through harvest.

Some irrigation methods we have used at the CEA Innovation Center include hand irrigating through bottom watering each tray from once every two days to multiple times a day, depending on the growth stage. We also use timers on the NFT tower systems to irrigate multiple times a day (e.g., 10 minutes, 3 times a day). Our irrigation frequency changes depending on the substrate. Hemp has a higher water-holding capacity and requires a lower irrigation rate, while burlap has a lower water-holding capacity and requires a higher irrigation rate.



Figure 5. Stacked medium grow trays (10"x20") containing broccoli microgreens.

Microgreens do not require a high fertilizer rate due to their short production cycle and being harvested at an immature stage (Dubey et al. 2024), but fertilization is recommended to maximize yields and decrease time to harvest. Fertilization will also affect the crop's nutritional quality. Fertilization protocols depend on the substrate type, growth stage, and plant species. Some soilless substrates (e.g., peat-based mixes) contain starter fertilizer and should be considered when developing a fertilization plan. A good starting point is to fertilize microgreens using the same approach as seedling fertilization plans. Penn State Extension recommends 50 to 100 ppm N of a 20-10-20 fertilizer for production in soilless substrate (Sanchez and Berghage 2020), while other research found that 150 ppm N of a 21-2.2-16.6 fertilizer mix maximized fresh weight (J. A. Allred 2017). For hydroponic systems, a standard hydroponic fertilizer for leafy green production can be utilized. Typical recommendations are to use at least an electrical conductivity of  $1.0 \text{ mS}\cdot\text{cm}^{-1}$  and  $\text{pH} = 5.5\text{-}6.0$  (Lerner, Strassburger, and Schäfer 2024; Gomes et al. 2025). There are also organic fertilizers (e.g., bone meal, fish meal) that can be used for microgreen production, but application recommendations are limited.

At the CEA Innovation Center, we use our standard leafy green hydroponic mix, which we maintain in two-part stock solutions (Part A and Part B) at 100x the concentration needed. The stock solutions are diluted in the hydroponic system tank to  $\text{EC} = 1.0 \text{ mS}\cdot\text{cm}^{-1}$  and  $\text{pH} = 5.9$ . We typically start this after most seedlings have germinated and continue until harvest.

In recirculating hydroponic systems, it is important to monitor and adjust the nutrient solution to maintain the target EC and pH range. An EC and pH meter or pen can be used to check on a set schedule, ranging from once a day to at least twice a week, depending on your system and the age of the microgreens. There are also EC/pH sensors with data loggers that automatically measure EC/pH over time, providing historical data to assist in manual adjustment decisions, or options to automate this process with automatic injectors that add pH and EC adjustment solutions.

## Sanitation and Integrated Pest Management (IPM)

Sanitation is important for preventing plant pathogens and food-borne pathogens. CEA environments are conducive to pathogens, and prevention through methods such as sanitation is important. To learn more about best practices and regulations around food safety, reach out to the [VA Fresh Produce Food Safety Team](https://ps.spes.vt.edu/) (<https://ps.spes.vt.edu/>).

Even though microgreens have a short crop cycle, a robust IPM program is needed to manage insect pests and plant pathogens. Prevention is achieved through bringing in clean plant materials, substrate, and water; following strict entry protocols; good cleaning and sanitation between crop cycles; and good horticultural practices in CEA microgreen production. As with any crop, it is important to use sticky cards and inspect plants regularly to monitor insect and plant pathogen activity. Similar to environmental monitoring, it is also important to keep clear records of what was found during scouting. Damping off caused by *Pythium* or *Phytophthora* is of most concern for diseases in microgreens, and due to the moist environment, various mildews can also be a problem.

At the CEA Innovation Center, we clean our hydroponic towers between each microgreen crop by

scrubbing the channels and running the entire recirculating system with a hydrogen peroxide-based sanitizer per the label. After running the sanitizer through the system, we flush it with water.

## Sowing to Harvest

Microgreens are sown by scattering seeds across the selected substrate. Before sowing, it must be determined what the seed density should be, or, in other words, how many seeds will be within a given area (e.g., 13 grams per 1020 tray). There are recommendations for sowing rates for microgreens, but, as with other growing parameters, it is important to test seed density to determine what is best for the facility, system, substrate, and species/cultivar. Penn State Extension has a [Microgreen Seed Density Calculator](https://extension.psu.edu/microgreens-seed-density-calculator) (<https://extension.psu.edu/microgreens-seed-density-calculator>) that can be used to calculate the weight of the seed to sow based on the microgreen type and the size of your channel or tray. Seed suppliers may also have recommended seed densities for the specific microgreens they sell.

If sowing the seed by hand, the seeds can be weighed out for each tray/channel based on the seed density calculations, then placed in brown bags or similar bags or containers. When we are sowing seeds, we weigh out a bag of seeds for each subsection of our NFT channels or for each 1020 tray. The seed can be sprinkled over the tray by hand or placed into a saltshaker-like container where the seeds are put into a small jar with a lid that has small holes drilled in the top. It is better if the holes are only moderately bigger than the seed being sown, as too large holes can result in unequal distribution of seeds. Placing wire hardware cloth on top of the media while sowing can also help ensure a more uniform distribution (Figure 6). If interested in other sowing options, automatic seeders, tabletop seeding machines, and vacuum seeders are available.



Figure 6. Jars with holes in the lids for seed shakers, and metal hardware cloth for evenly sowing seed across the substrate.

Before sowing, the systems and substrates also need to be prepared accordingly. The substrate needs to be placed in the channels or trays and moistened either before or after placing it in the systems, depending on the type of substrate. For example, with hemp mats, we place the mats in the channels or trays and then irrigate using the NFT irrigation lines or bottom-irrigate in the 1020 trays. For burlap, we soak it in hydrogen peroxide diluted in water according to the label's dilution rate prior to laying the mats into the channels. For peat-based substrate, it can be moistened before filling the trays.

The seeds can then be sown on the moistened substrate. After sowing, a humidity dome or plastic cover can be used to cover the seeds. For several common microgreen species, germinating in the dark is needed or beneficial. To achieve this, a blackout dome or plastic cover can be used. Check the specific germination requirements of the seed being used to determine best practice. Once sown, the substrate must be kept moist by misting or irrigation, using the mechanisms appropriate for the system.

The channels or trays can be uncovered when a majority of the seedlings have germinated. Typically, this is 2–5 days, but it varies by species. If the fertilization regime was not started at sowing, fertilization can begin after germination occurs. If supplemental or sole-source lighting is being used, these can now be turned on and set to the desired photoperiod.

The estimated time to harvest for microgreens varies by species (Table 2). Below is a table of the common microgreens gathered from several sources:

Table 2: Estimated time to harvest for several microgreen species

Microgreen	Est. days to harvest <sup>a</sup>	Source
amaranth	10 - 17	(True Leaf Market, n.d.; Johnny's Selected Seed 2017)
arugula	6 - 14	(Beck 2025; Johnny's Selected Seed 2017)
beet	12 - 23	(True Leaf Market, n.d.; Johnny's Selected Seed 2017)
broccoli	8 - 13	Beck, 2025; Ortiz et al., 2024)
carrot	14 - 20	(True Leaf Market, n.d.)
kale	8 - 14	(Beck 2025; Johnny's Selected Seed 2017)
radish	6 - 10	(Beck 2025; Ortiz et al. 2024; True Leaf Market, n.d.)
sunflower	9 - 12	(Beck 2025; True Leaf Market, n.d.)

<sup>a</sup>Days from sowing to harvest

Microgreens are typically harvested within the time frame from when the first true leaves are forming to when they have fully emerged. Yield, shelf life, and nutritional quality are affected by harvest timing (Ortiz et al. 2024), so testing different harvest times can help maximize these characteristics.

Microgreens are harvested by cutting the seedling stem so that most of the stem, cotyledon, and leaves are packaged, leaving the roots behind. For some markets, microgreens may be sold with the substrate and roots still attached.

Microgreen harvest can be done by hand with clean, sanitized scissors or with electric garden shears. If interested in harvesting machines, there are tabletop harvesters that can be run across a greenhouse bench, stationary tabletop harvesters where trays or channels are placed through the harvester, or a fully automated harvester with a conveyor belt. Food safety standards for harvesting fresh produce should be understood and incorporated into harvesting protocols.

Clamshells or plastic bags are typically used for packaging harvested microgreens. There are manufacturers on the market that sell clamshells specifically for microgreen producers. Common plastic clamshell sizes include 5"×5.3"×3.25" or 4.5"×4.5"×2.75". There are also biodegradable paperboard containers available for more environmentally sustainable options. Once harvested and packaged, it is best to move the product to the market as soon as possible. The best storage temperature for microgreens is still being evaluated. It is not only important for extending shelf life and ensuring food safety, but also for understanding the effects on nutritional quality. Some research has found that optimal storage temperatures may vary between species. Penn State Extension recommends storing microgreens in the dark at 41°F (5°C) (Sanchez and Berghage 2020).

## Market and Economic Considerations

The target market to which the microgreens will be sold will have an impact on the facility size, systems utilized, quantity produced, species selected, harvest stage, post-harvest handling, and price. Determining the market is an important first step before starting microgreen production. Common markets for fresh microgreens include restaurants, farmers' markets, direct-to-consumer, community-supported agriculture (CSA) customers, and grocery stores. When determining the target market, transportation distance and cost should also be considered. In addition to the fresh market, there are opportunities to create value-added microgreen products, such as incorporating them into other food items (e.g., pesto, baked goods, microgreen powders [e.g., smoothie powder]), ready-to-eat salads, or even cosmetics. To learn more about strategies to determine and build your market that will direct your production plan, check out these other VCE publications:

- [Marketing Farm and Food Products \(https://www.pubs.ext.vt.edu/content/pubs\\_ext\\_vt\\_edu/en/AAEC/AAEC-284/AAEC-284.html\)](https://www.pubs.ext.vt.edu/content/pubs_ext_vt_edu/en/AAEC/AAEC-284/AAEC-284.html)
- [Hydroponic Production of Edible Crops: Planning for the Market \(https://www.pubs.ext.vt.edu/content/pubs\\_ext\\_vt\\_edu/en/SPES/spes-461/spes-461.html\)](https://www.pubs.ext.vt.edu/content/pubs_ext_vt_edu/en/SPES/spes-461/spes-461.html)

Regardless of the scale of the microgreen production or if it is the sole focus of a farm or one crop of many that a farm produces, creating a new business plan or incorporating them into the farm's existing business plan is essential to ensure that production and profit goals are met and the farm is sustainable long-term. A business plan is an overall look at the business and considers factors such as the budget, market, crops to be produced, start-up costs, required permits/regulations, etc. There are already resources available specifically for microgreen production that can be accessed to build a business plan for microgreen production:

- University of Missouri Extension [Microgreens Planning Budget](https://extension.missouri.edu/publications/g693) – <https://extension.missouri.edu/publications/g693>
- Penn State Extension [Business Planning for Your Microgreens Operation](https://extension.psu.edu/business-planning-for-your-microgreens-operation) – <https://extension.psu.edu/business-planning-for-your-microgreens-operation>

After production begins, ongoing market feedback and customer trends can help growers adjust crop choices and timing. This will help avoid excessive production and minimize profit loss if demand falls. Short harvest cycles of microgreens allow for adjustments to meet changing market demands. A report posted on the Microgreens World website states that North America is the largest producer of microgreens and that, by 2030, the microgreens market value is expected to reach \$3.4 billion (Neves 2024). The microgreen market is continuing to grow due to factors such as its quick crop cycle, high value, and consumer demand.

## Microgreens in Indoor Gardens

Microgreens are not only commonly found in CEA commercial production but are also a popular crop in at-home, community, school, skilled nursing facility, and restaurant gardens. Microgreens make for a quick, fun crop to grow for educational activities or to add variety to meals. Microgreens can be grown at home in trays, tabletop hydronic systems, or hydroponic towers. If considering crops for indoor gardening, microgreens are a great option. Some companies sell microgreen garden kits for beginner growers, or production systems can be built by DIY

guides available online, such as this Penn State Extension guide for growing microgreens at home ([A Step-By-Step Guide for Growing Microgreens at Home](https://extension.psu.edu/a-step-by-step-guide-for-growing-microgreens-at-home) - <https://extension.psu.edu/a-step-by-step-guide-for-growing-microgreens-at-home>) or this Purdue Extension guide ([Grow Microgreens at Home](https://extension.purdue.edu/news/county/allen/2022/02/grow-microgreens-at-home.html) - <https://extension.purdue.edu/news/county/allen/2022/02/grow-microgreens-at-home.html>).

## Conclusions

Microgreens are quick to grow, high in nutrients, and can be profitable. There are many different species available for production, each with its own flavor profile. Microgreens can be produced in CEA using numerous systems, including high tunnels, vertical farms, greenhouses, or even extra counter space. Though there is potential for a high profit margin, growers who wish to sell microgreens should use resources to understand and adapt to local/regional demand.

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## Additional Resources

Controlled Environment Agriculture Innovation Center website: <https://ceaic.org/extension-education/additional-resources/>

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