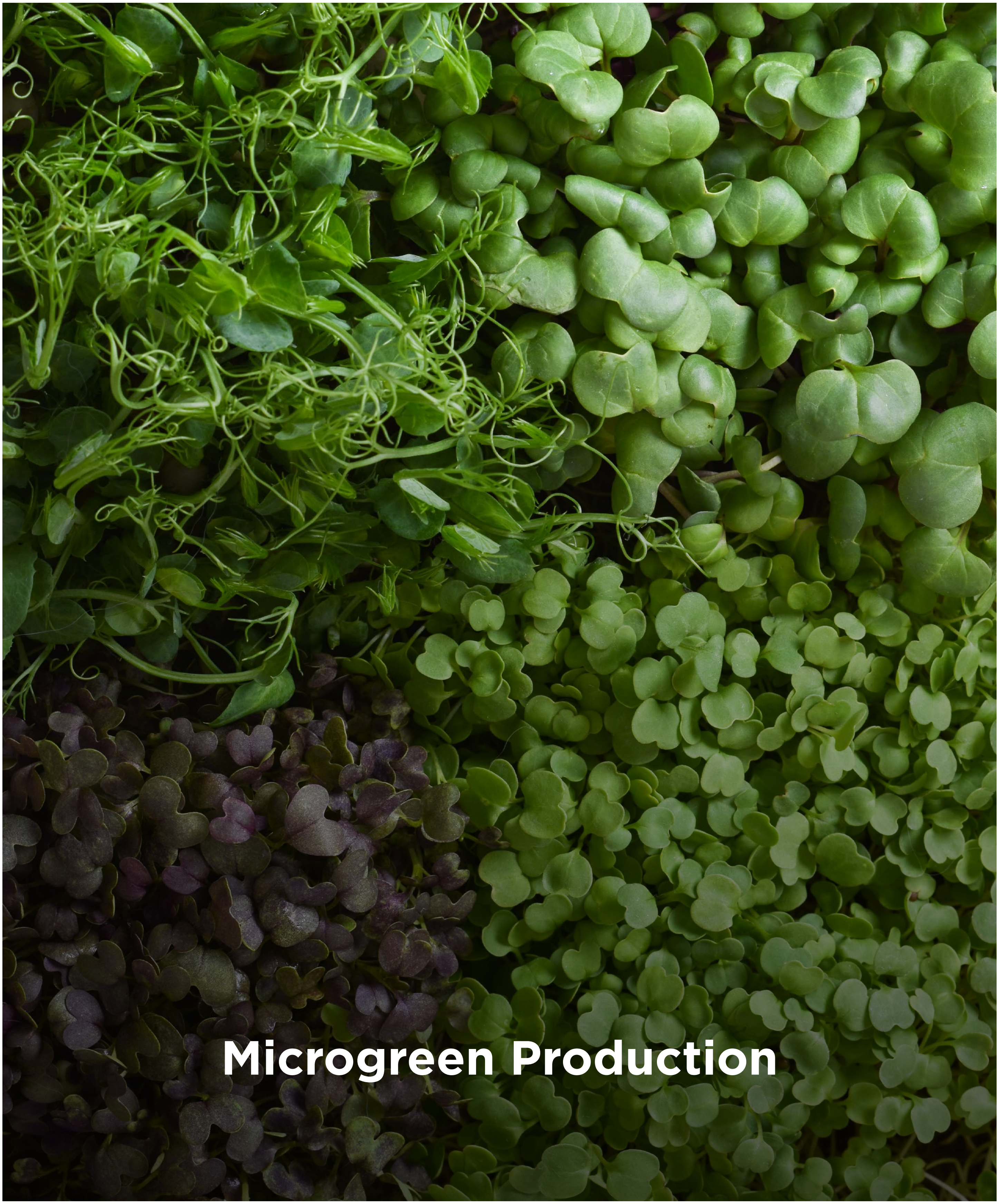

Microgreen Production

Transfarmation
MERCY FOR ANIMALS

Highland
ECONOMICS

Important Disclaimer

This report ("Report") or any written material provided to you by Mercy For Animals, Inc., (including Transfarmation) or any of its affiliates (together, "MFA"), including but not limited to information or written material prepared by third parties, should not be construed as advice or in any way an endorsement or a recommendation by MFA.

The Report should not form the primary basis for any decision that you make in relation to matters referenced herein and is not a substitute for performing any and all necessary due diligence, including consulting independent agricultural, legal, tax, finance, and other expert advisors.

Neither MFA nor any of its officers, directors, agents, or employees makes any warranty, expressed or implied, of any kind or accepts liability for any losses, damages, costs, or expenses of any kind or description relating to the adequacy, accuracy, or completeness of the information contained in the Report.

The Report is for your general information only, and MFA is not soliciting any action based on it. Any views or opinions expressed in the Report are those of the author except where MFA specifically states that they are the views of MFA. Any view or opinions expressed are valid only as of the date indicated. MFA does not accept any responsibility to update any views, opinions, or other information contained in the Report.

Introduction

Microgreens are shoots of vegetables that are picked just after the first true leaves have developed. The market for microgreens is typically driven by restaurants in proximity to the producer, but emerging personal consumption and cosmetic lines are also expected to be important segments for future growth of microgreens in the near term.

Several methods exist for producing microgreens, and production is highly scalable, which facilitates ease of entry for producers. This report explores the market demand, typical production requirements, and a representative enterprise budget for operating a microgreen farm in a 16,000-square-foot converted poultry house.

Market

- Microgreens are found on only 2 percent of menus in the United States. While this figure is small, it represents a 79 percent increase from 2016 (Datassential 2020).
- Around 30 percent of the U.S. population knows what microgreens are, 16 percent have eaten microgreens, and awareness of microgreens is highest among millennials and “foodies” (Datassential 2020).
- The restaurant segment is the dominant sales channel for microgreens. Given this increasing culinary trend, market growth of microgreens is anticipated to rise by over 10 percent annually between 2022 and 2027 (Mordor Intelligence 2021).
- The microgreen-production industry is extremely fragmented and highly competitive (Mordor Intelligence 2021). There are large microgreen-production players but no dominant business, and many smaller producers are carving out small niche markets in local markets. Listed below are the largest microgreen operators in North America:
    - Farmbox Greens, Washington State (Farmbox Greens, n.d.)
    - Farmer Jones Farm at Chef’s Garden, Ohio (Farmer Jones Farm, n.d.)
    - GoodLeaf Farms, Canada (GoodLeaf Farms, n.d.)
    - Living Earth Farm, Canada (Living Earth Farm, n.d.)
- The characteristics of microgreens that are typically most important to restaurants are availability, appearance, and price.
- But individual consumers are most drawn to microgreens for health characteristics. Sunflower microgreens, for example, are 30 percent protein and a popular supplement to a vegan diet, and broccoli microgreens provide 40 times more nutrients per unit than a head of broccoli and are popular with people who have immunity concerns (Dickson 2019).
- Cosmetics is also an emerging niche industry that uses microgreens for their vitamins A and B (as well as microelements) as ingredients in personal care products (Mordor Intelligence 2021).

Production Practices

Due to the fragile nature of the crops, microgreens are typically grown indoors. Microgreen operations of small producers are often supplementary incomes where production occurs in a basement or small greenhouse. Larger commercial operations are capturing economies of scale and are more efficient in terms of cost per unit of output. For this study, we model a converted poultry house (50 feet x 400 feet) and consider the various requirements of producing microgreens indoors and year-round.

Temperature

Bench tubing and a boiler system are likely to be sufficient for heating the tray and microgreen-production area for most (if not all) of the year (Dickson 2019). The ideal substrate temperature will differ by variety; some crops, such as basil, are “heat loving,” whereas others, such as brassicas, prefer cooler temperatures.

In regions of extremely high temperatures (above 100°F), the production area requires cooling in the summer to avoid stressing the plants during the production phase. The 65°F–75°F range is generally considered favorable for ambient air temperature in the greenhouse during microgreen production (Johnny’s Selected Seeds, n.d.).

Light

Microgreen plants can respond differently to artificial light than they do to natural light. The duration, wavelength, intensity, and distance from the crop are all factors that will determine growth rate and quality of the finished product (Johnny’s Selected Seeds, n.d.). We consider supplemental (artificial) light as a line item in the budget (presented below) to provide sufficient lighting for year-round production of microgreens.

Humidity and Air

Fans with sufficient air circulation can help prevent pests and disease. Flats of microgreens must be kept moist but not too wet. The best watering method is debated among growers. Bottom-watering methods minimize soil splash, but overhead watering also cleans the greens when droplet size is minimized and splash avoided.

Growing Mediums

A variety of growing mediums are used for commercial microgreen production. Soil is known for containing nutrients that can add to the flavor of the finished product, but if compost is included in the soil, this can be a soilborne disease risk. Alternatives to soil include coconut coir, wood fiber mats, and other soilless materials.

Seed Selection

Microgreens have a quick turnaround time, but growth rate differs among different types and varieties. Most vegetable varieties grown as microgreens are ready for harvest in about two weeks, although the brassica mustard and radish grow more rapidly and therefore mature before beets, carrots, and chard. Herbs tend to be slow growing, maturing in 16–25 days. Depending on microgreen type and variety, as well as environmental conditions, a production cycle can be as long as four weeks or slightly more (Johnny's Selected Seeds, n.d.).

Figure 1. Various microgreens. (Stephens, n.d.)

Enterprise Budget

Microgreens are a fast-cycle, high-value crop option within the horticultural industry. As the local culinary industry continues to grow and adapt its menus to more intricate flavors and complex plate design, the demand for products like microgreens is expected to increase. This section presents the enterprise budget for costs and anticipated returns for a poultry house converted to a microgreen operation in the United States. Specific geographic differences in costs and unique characteristics of the site in question should be considered before fully adopting a projected budget for a microgreen-production operation.

The number of publicly available microgreen-production budgets is limited. The information presented here relies largely on a publication from Alberta (Morton and Stretch 2018) on the commercial viability of microgreens. We have adapted it to 2022 values and U.S. dollars and included current price information, updated capital cost estimates, and case studies.

Labor

The labor requirements of indoor microgreen production depend on several factors, including the type of growing system, level of mechanization, laborers' familiarity and efficiency with tasks to be performed, and general site conditions. Labor requirements are based on a Canadian operation that employs eight full-time people (320 hours) to produce 2,000 flats per week. This includes three seeding days and three harvest days weekly (six days total), equating to 0.16 hours per tray produced (around 10 minutes). Tasks involve preparing the tray with soil or soilless material (with assistance from a filling machine), seeding (with assistance from a tray seeder), transporting to the grow area, irrigating, maintaining environmental controls, and harvesting a couple of weeks later (with assistance from a tray harvester) (Stone 2018). At an assumed hourly rate of $17.58, the labor cost is estimated at $2.81 per tray.

Inputs

The main inputs required for indoor microgreen production are seeds, soil or soilless medium, and trays. We discuss these below.

Seeds: The seeding rate and associated seed cost depend on the variety of microgreens produced. Table 1 below demonstrates seven different varieties, which range in cost from $0.15 to over $2.00 per tray (Morton and Stretch 2018). If we assume an even distribution of microgreen production across these varieties, the business is estimated to purchase around $11,000 of seed per month throughout the year.

Soil or Soilless Media: For purposes of this analysis, we assume a potting-soil mix would be used to fill the trays, and costs are estimated at $0.41 per tray. The soil cannot be reused in the grow operation unless it is sterilized (at 180°F) for a short period. While we do not consider it here, sterilization may be viable at other scales considered. Growing pads can be reused, but these would be more expensive (around $2.20 per tray) (Bootstrap Farmer, n.d.), and removal of the vegetative material is difficult and may not be viable.

Trays: Our analysis assumes 1020-sized trays (10 inches wide x 20 inches long x 1.25 inches tall) are used, and at our projected volume, we estimate these to cost $1.50 per tray. While it is possible (if not likely) that trays will be reusable after one use, our analysis assumes full cost per use (Handy Pantry, n.d.).

Packaging and Labeling

Microgreens are often sold in whole trays or in 30-gram or 60-gram clamshells. We assume clamshells are used for packaging along with a label of the farm origin. The estimated cost is $0.12 per tray of microgreens produced (Morton and Stretch 2018).

Utilities

The utility requirements of a greenhouse include fuel for heating, electricity for fans, water, sewer, and communication. The estimated utility cost is $0.50 per tray (MicroVeggy, n.d.)—equal to nearly $60,000 per year—to run the boiler system for the heat-mat system on the grow benches, as well as the ambient-air heating and cooling discussed above.

Marketing and Distribution

Marketing and distribution costs will depend on distance to the client and time required for marketing. Kind Organics near Ontario, a large-scale microgreen producer almost double the size of our model operation, has two trucks and two full-time drivers delivering microgreens and other products on a daily basis. But even at this scale, distribution is unprofitable in some areas of the region (Stone 2018). For purposes of this analysis, we estimate marketing and distribution costs as a percentage of gross sales (10 percent). This represents over $122,000 per year.

General Overhead

Overhead includes any office, administrative, or other business expense not directly related to microgreen production. We model these at 5 percent of operating expenses, or $38,900 per year. Operating expenses by microgreen type are itemized in table 1.

Capital Costs and Non-cash Overhead

The capital cost of the greenhouse conversion from the existing poultry house is estimated at $5.47 per square foot, or $87,520 for the structure (16,000 square feet of production area). Additionally, environmental controls for the greenhouse operation, such as lighting and heating equipment, are estimated at $92,800 (BioTherm Solutions, n.d.). We identified other requirements from virtual tours of facilities similar in size, with costs indexed to 2022 dollar values, and modeled them as follows:

- Walk-in cooler (200 square feet): $16,400
- Benches: $107,120 (HydroBuilder, n.d.)
- Irrigation system: $1.29 per square foot or $16,600 for microspray system
- Bouldin & Lawson flat filler: $15,000 (Niagara Greenhouse Equipment, n.d.)
- Blackmore seeder: $2,500
- Hamill microgreen line harvester: $22,000 (Equipped. Farm, n.d.)

In total, we estimate the capital requirements of the poultry house conversion to be $360,020. This analysis assumes the owner could finance the conversion through existing programs offered by the Small Business Administration (SBA), the United States Department of Agriculture, and possibly other lenders. For this analysis, we model the debt-service terms of the SBA 504 program: 10 percent equity requirement (90 percent financed), or $36,000. Further, 10- and 20-year notes, at 6.5 and 6 percent interest, respectively, are considered in the financial analysis below (CDC Loans, n.d.).

Other Fixed Costs

Other fixed costs modeled here are property taxes ($3,000) and insurance ($3,240). These are included in the fixed-cost-per-tray line item ($0.05).

Yield and Sales Price

Microgreens come in several different types. For purposes of this analysis, we demonstrate seven types: sunflower, pea, broccoli, arugula, basil, beet, and Swiss chard. Price-per-pound estimates are based on ranges reported by Total Gardener as reasonable approximations of 2022 microgreen prices by variety (Stephens, n.d.). We expect geographic differences but use this as a baseline assumption for price received. Our yield information derives from 2018 Alberta government estimates by type of microgreen.

Table 1. Representative microgreen-greenhouse enterprise budget

	Sunflower	Pea	Broccoli	Arugula	Basil	Beet	Swiss chard	Total annual
Sale price per pound	$37.50	$25.00	$10.00	$27.50	$27.50	$9.00	$17.00	
Productivity factor	95%	95%	90%	75%	75%	90%	90%	
Yield (lb/tray)	0.66	0.53	0.66	0.40	0.26	0.33	0.33	
Gross income per tray	**$24.78**	**$13.22**	**$6.61**	**$10.90**	**$7.27**	**$2.97**	**$5.62**	**$10.19**
Trays per year	17,140	17,140	17,140	17,140	17,140	17,140	17,140	**119,980**
Total annual sales	**$424,725**	**$226,520**	**$113,260**	**$186,879**	**$124,586**	**$50,967**	**$96,271**	**$1,223,208**
Seed cost per tray	$0.64	$0.15	$1.88	$0.40	$0.69	$2.16	$2.03	
Soil cost per tray	$0.41	$0.41	$0.41	$0.41	$0.41	$0.41	$0.41	
Tray cost	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	
Packaging cost per tray	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	
Labor cost per tray	$2.81	$2.81	$2.81	$2.81	$2.81	$2.81	$2.81	
Utility cost per tray	$0.50	$0.50	$0.50	$0.50	$0.50	$0.50	$0.50	
Overhead cost per tray	$0.30	$0.27	$0.36	$0.29	$0.30	$0.38	$0.37	
Fixed cost per tray	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	
Marketing & delivery cost per tray	$2.48	$1.32	$0.66	$1.09	$0.73	$0.30	$0.56	
Total cost per tray	**$8.82**	**$7.14**	**$8.30**	**$7.17**	**$7.11**	**$8.23**	**$8.35**	**$7.87**
Total expenses per year	**$151,092**	**$122,430**	**$142,290**	**$122,967**	**$121,882**	**$141,044**	**$143,163**	**$944,868**
Profit per tray	**$15.96**	**$6.07**	**−$1.69**	**$3.73**	**$0.16**	**−$5.26**	**−$2.74**	**$2.32**
Profit per year	**$273,633**	**$104,089**	**−$29,030**	**$63,912**	**$2,704**	**−$90,077**	**−$46,892**	**$278,339**
Profit margin	**64%**	**46%**	**−26%**	**34%**	**2%**	**−177%**	**−49%**	**23%**
Debt-service coverage ratio (20-year loan, 6% interest, $28,250 payment)								**9.85**
Debt-service coverage ratio (10-year loan, 6.5% interest, $45,072 payment)								**6.18**

Net Profit and Debt-Service Coverage Ratio

On the basis of assumptions outlined above, including projected yield, we estimate the break-even price of microgreens from a 16,000-square-foot greenhouse to be around $7.88 per tray for the mix identified in the table above. This is lower than the anticipated sale price of most microgreens; thus we expect the operation to be financially viable.

The expected operating profit of $278,339 from the converted poultry house represents a 23 percent profit margin. Debt-service coverage ratio (DSCR) is a measurement of a firm's available cash flow to pay current debt obligations, calculated as the net operating income divided by debt obligations (principal and interest payments). A DSCR less than 1.00 would indicate potential solvency problems, while a DSCR of at least 2.00 is generally considered very strong. The DSCR for this enterprise would be strong to very strong, depending on the terms of the loan undertaken.

Sensitivity

We undertook a sensitivity analysis to evaluate the impact of key assumptions on the net-profit estimate for the model enterprise. These key assumptions are as follows:

- Price received ($/pound) by variety (Stephens, n.d.):
    - Sunflower: $35–$40
    - Pea: $20–$30
    - Broccoli: $5–$15
    - Arugula: $25–$30
    - Basil: $20–$30
    - Beet: $8–$10
    - Swiss chard: $14–$20
- Soil cost: $0.15 to $1.50 per tray
- Labor rate: $15–$20 per hour

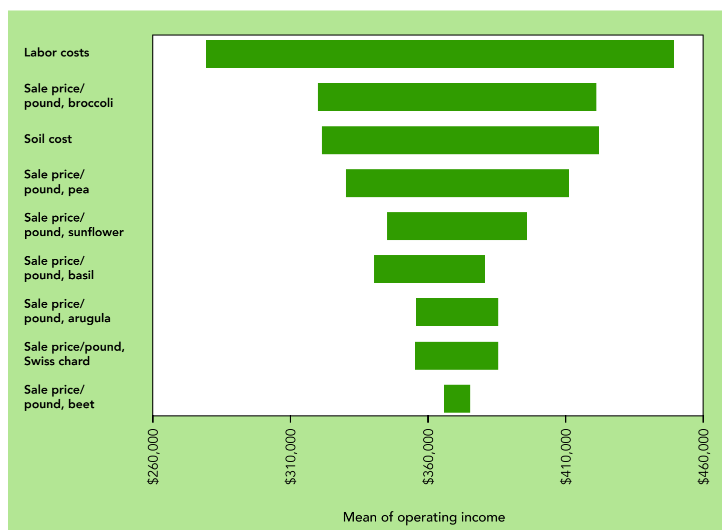

Figure 2. Results of sensitivity analysis.

Worth noting is that none of the uncertainty factors considered in this model would create a negative net-income estimate on its own, as illustrated in the figure above.

References

1. BioTherm Solutions. n.d. "Popular Products." Accessed September 20, 2022. https://www.biothermsolutions.com/popular-products.
2. Bootstrap Farmer. n.d. "Hemp Growing Mats – Bulk Roll." Accessed September 20, 2022. https://www.bootstrapfarmer.com/products/hemp-growing-mat-bulk-rolls?variant=16254698061914&currency=USD&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gclid=CjwKCAjw-8qVBhANEiwAfjXLriQV7LnhXf5L-V43mc1Koo83ZNX70.
3. CDC Loans. n.d. "SBA 504 Rate History." Accessed December 30, 2022. https://cdcloans.com/sba-504-rates/.
4. Datassential. 2020. "Flavor of the Week: Microgreens Add a Healthy Touch." *Nation's Restaurant News*, January 27, 2020. https://www.nrn.com/consumer-trends/flavor-week-microgreens-add-healthy-touch.
5. Dickson, Mike. 2019. "She Built a Profitable & Sustainable Microgreen Business." YouTube. Video, 15.25. Posted August 29, 2019. https://www.youtube.com/watch?v=2YsQSHgNnZ0.
6. Equipped.Farm. n.d. "Standard Microgreens Harvester." Accessed September 20, 2022. https://equipped.farm/shop/robotics/microgreens-lettuce-harvester/.
7. Farmbox Greens, n.d. Mission page. Accessed June 1, 2022. https://www.farmboxgreens.com/.
8. Farmer Jones Farm. n.d. "About Us." Accessed August 1, 2022. https://www.farmerjonesfarm.com/pages/about-us.
9. GoodLeaf Farms. n.d. Home page. Accessed August 2, 2022. https://www.goodleaffarms.com/.
10. Handy Pantry. n.d. "10 x 20 Growing Trays with Drain Holes." True Leaf Market. Accessed June 1, 2022. https://www.trueleafmarket.com/products/10-20-growing-trays-with-drain-holes?variant=38635276488.
11. HydroBuilder. n.d. "Fast Fit 4 Foot Continuous Bench System." Accessed September 21, 2022. https://hydrobuilder.com/fast-fit-continuous-bench-system.html?opts=eyJhdHRyaWJ1dGUxNTYxIjoiMjEzMjIiLCJhdHRyaWJ1dGUxNTY0IjoiMjEzMzcifQ==.
12. Johnny's Selected Seeds. n.d. "Microgreens." Accessed June 1, 2022. https://www.johnnyseeds.com/growers-library/vegetables/microgreens/year-round-micro-greens-production.html.
13. Kardos, Josh, Joy Kuzma, and Sam Ragon. 2022. *Plans for Converting a Chicken House into a Greenhouse and Systems and Crops for Production* (for Mercy For Animals). Blacksburg, VA: Virginia Tech College of Agriculture and Life Sciences School of Plant and Environmental Sciences.
14. Living Earth Farm. n.d. "About Us." Accessed September 21, 2022. https://www.livingearthfarm.ca/about-us.
15. MicroVeggy. n.d. "How to Sell Microgreens for Profit – The Perfect Microgreens Price List." Accessed June 1, 2022. https://microveggy.com/selling-microgreens/#:~:text=the%20cost%20breakdown.-,Cost%20for%20one%20tray%20of%20microgreens,tray%2C%20electricity%2C%20and%20packaging.
16. Mordor Intelligence. 2021. *United States Microgreens Market – Growth, Trends, COVID-19 Impact, and Forecasts* (2022–2027). Hyderabad, Telangana, IN: Mordor Intelligence. https://www.mordorintelligence.com/industry-reports/united-states-microgreens-market.
17. Morton, Dustin, and Craig Stretch. 2018. *Commercial Microgreens: Business Concept and Financial Analysis*. Edmonton: Government of Alberta.
18. Niagara Greenhouse Equipment. n.d. Catalog page. Accessed September 21, 2022. https://niagaragreenhouseequipment.com/collections/used.
19. Stephens, John. n.d. "Microgreens Price List for 2022 (Solved!)." Total Gardener. Accessed September 21, 2022. https://totalgardener.com/microgreens-price-list/.
20. Stone, Curtis. 2018. "Growing 2,000 Pounds of Microgreens per Week." YouTube. Video, 16:13. Posted January 15, 2018. https://www.youtube.com/watch?v=cIdQt1FTGYk.
21. Sullivan, Gary, and Joanne Howard. 2022. *Material and Labor Quotes for Greenhouse Coverings, Optional Equipment and Crop Production Systems for the Conversion of a Chicken House to Crop Production* (for Mercy For Animals). Kingston, NC: Carolina Greenhouses.
22. Wholesale Home Improvement Products. n.d. "NeoTherm – Modulating Condensing Boiler." Accessed June 1, 2022. https://www.wholesalehome.com/products/laars-8?currency=USD&variant=42981761515749&utm_medium=cpc&utm_source=google&utm_campaign=Google%20Shopping&gclid=CjwKCAjw-8qVBhANEiwAfjXLrmzAq8qfs2deTd1UUf3EvgIGzJfkIblVr9qyhiZZflTKD0y7peXt_xoCzUkQAvD_BwE