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AUTHORS: Nicole Enssle

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Name of Project Advisor

David Grooms

David Grooms
David Grooms (Aug 4, 2020 12:07 PDT)

8/4/2020

PROJECT ADVISOR

SIGNATURE

DATE

Name of Second Reader

Mohammad Oskoorouchi

Mohammad Oskoorouchi
Mohammad Oskoorouchi (Aug 4, 2020 12:42 PDT)

8/4/2020

PROJECT SECOND READER

SIGNATURE

DATE

Microgreens: Market Analysis, Growing Methods and Models

Sponsored by: Solutions Farms, LLC.

Prepared by:

Nicole Enssle

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California State University San Marcos

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Executive Summary

Microgreens, the young greens grown from vegetable, herb, or grain seeds, have been increasing in popularity amongst small and urban farmers over the past several years. Microgreens are relatively easy to grow, can be grown indoors with limited resources, and have a short grow cycle. An increasing number of recent studies attest to the health benefits of microgreens due to their high density of vitamins and nutrients. They are popular amongst health-conscious consumers and chefs that use microgreens as colorful and flavorful garnishes. Solutions Farms, the social enterprise subsidiary of nonprofit organization Solutions for Change, seeks to diversify its product offerings in the local market. Solutions Farms is interested in learning more about the microgreens market and existing models for microgreens production. This report is divided into three sections: research and analysis of the microgreens market, research of existing microgreens models, and recommendations for Solutions Farms. The first section includes a PESTLE analysis of macro environmental forces, an analysis of local competitors and distribution channels, and a SWOT analysis of Solutions Farms pertaining to the organization's ability to succeed in the microgreens market. The second section of the report includes research of existing microgreens models, including materials and growing methods and associated costs. Finally, the third section includes recommendations for Solutions Farms go-to-market strategy and suggestions for further research.

Company Background: Solutions Farms

Solutions Farms is the social enterprise subsidiary of Solutions for Change, a Vista based non-profit organization combatting homelessness in San Diego. Solutions for Change was founded by Chris and Tammy Megison with the mission of solving family homelessness using sustainable and impactful programs. Solutions' model solves homelessness using three distinct approaches: education, social enterprise, and community development. Within the social enterprise function Solutions for Change operates affordable housing real estate development, property management and maintenance services, and Solutions Farms, a certified organic aquaponics farm in Vista. Solutions Farms owns a two-acre property with approximately 7,000 square feet of greenhouse space and produces an average of 1,000 to 2,000 pounds of lettuce per week. Along with serving as a platform for professional training, the farm provides residents the opportunity to develop their understanding of sustainable food production and healthy food products.

Research Problem

Solutions Farms wants to diversify its product offerings in the local market and is interested in learning more about microgreens. The problem is two pronged. First, Solutions Farms would like to understand the microgreens market, including key competitors, sales channels, and the potential impact of macro-level events like the 2020 pandemic. Next, they would like to research various methods by which Solutions Farms could execute the microgreens operation.

Research Methods

Existing research dedicated to the microgreens market and the health benefits of microgreens is limited but growing. To develop insight into the microgreens market and growing methods, I performed primary research through observation of organizational websites, field observation, and phone and email interviews with participants in the microgreens market. I compiled secondary research from local and regional news sources, literary journals, business databases, and reports from top research institutions and consulting agencies. To supplement missing information about the microgreens market I refer to the larger organic fresh vegetable market and assume the microgreens market will act similarly.

Literature Review

Microgreens

The concept of microgreens is fairly new, having originated in San Francisco in the late 1980's. Microgreens are young greens grown from vegetable, herb, or grain seeds. They are usually harvested when the first pair of fully expanded leaves appear, within one to three weeks from seed germination. While existing research into microgreens is limited, several recent studies have attested to the health benefits of microgreens as the result of their high density of phytonutrients and minerals. USDA research reports that microgreens have approximately five times the number of vitamins and carotenoids as mature vegetables. Each microgreen is packed with such nutrients as Vitamin E, Vitamin C, and beta-carotene, as well as minerals like Calcium and Magnesium, and each variety of microgreen contains different levels of phytonutrient (Xiao et al.; Marios). Microgreens are eaten raw and used as additions to a wide array of healthy homemade foods, including salads, juices, and sandwiches. In addition to their nutritional benefits, microgreens are diverse in flavors, textures, and colors. Chefs worldwide use microgreens as garnishes or flavorful additions to dishes across cuisines. Microgreens possess unique flavors ranging from spicy to sweet. Leaves and stems range in shape and color and can lift the aesthetic character of a dish. Microgreens are aptly called “vegetable confetti” and are gaining popularity on a global scale (Koppert Cress).



Figure 1. Microgreen Varieties. Courtesy of Shutterstock.

Microgreen Production

Microgreen production is becoming increasingly popular amongst small scale and urban farmers. Microgreens usually require a limited upfront investment, use little resources and space, enjoy quick turnover, can be grown year-round using a variety of methods, and are generally very profitable. Because microgreens are harvested between one to two weeks after seed germination, production volume can be adjusted quickly to meet demand and prevent waste. However, the high turnover rate also necessitates a relatively large amount of labor to constantly seed, harvest, and pack the microgreens. Microgreens are also delicate and easily damaged, so it is important to protect them from unwanted environmental stressors like rain and wind (Kyriacou et al.).

Microgreens versus Sprouts

It is important to distinguish microgreens from sprouts, as the terms are often used interchangeably, and the consumption of sprouts has resulted in illness and even death related to bacterial infection. Sprouts are simply germinated seeds that are eaten with their roots still attached to the seed. Sprouts are grown in environments that are warm, low light, and near 100% humidity. These conditions are ideal for bacterial growth. The Food and Drug Administration has enacted regulations for sprout producers because of known bacterial outbreaks associated with sprouts (FDA). Furthermore, the Center for Disease Control and Prevention lists sprouts as one of the “Foods Most Likely to Cause Food Poisoning” from bacteria such as *Salmonella*, *E. coli*, or *Listeria* (CDC). Sprouts must therefore be cooked before consuming to kill germs. Microgreens, however, have not been associated with any bacterial infections. Microgreens require different growing conditions than sprouts and are more mature plants than sprouts. Microgreens are harvested above the soil, so the stem and small leaves are consumed (Xiao et al.; Marios).

Part I: Research and Analysis of the Microgreens Market

Analysis of External Environment

The COVID pandemic is actively impacting supply chains across industries. Restaurants have experienced closures or substantial drop-off in demand, and many farms have adapted their business to try to stay afloat. Unexpected external impacts are important to anticipate when determining the viability of a market. The level of risk or opportunity presented by external impacts can guide the business strategy of a new operation. The PESTLE framework analyses the external environment by identifying the political (P), economic (E), sociocultural (S), technological (T), legal (L), and environmental (E) forces influencing a market.

Political

Food safety, accessibility, and quality is often the subject of public policy and political discussion due to the role it plays in public health. Shifts in regulation at the federal, state, and municipal level can affect economic activity at various parts of the supply chain. Most microgreen production is currently domestic; however, the food supply chain in its entirety is becoming increasingly globalized, making food production and trade a growing area of domestic policy and foreign relations (McKinsey 2015). Subsidies and tariffs on agricultural products can affect demand, costs, and funding. The Farm Bill of 2018 provided the USDA's National Institute of Food and Agriculture with up to \$10 million of annual funding toward a competitive grant program supporting the development of urban, indoor, and emerging agriculture practices (USDA). Government-funded programs have the potential to increase funding opportunities for aquaponics and hydroponics farms.

Economic

Microgreens trade at a premium when compared to other vegetables, with average prices ranging from \$25-\$45 per pound (Mir et al.). According to the IBISWorld industry report for organic crop farming, general economic factors such as disposable income levels, the unemployment rate, and economic recession have historically impacted the sales of organic produce and specialty products (IBIS World). The 2020 pandemic is expected to decelerate demand growth for organic crops due to a decline in discretionary spending. Furthermore, large-scale producers forced to halt exports will need to raise domestic prices to protect revenue. According to the USDA's April 2020 outlook for fresh vegetable sales, the shift in demand for food to grocery store channels may decrease demand for products more commonly found in restaurant dishes, such as garnishes and vegetables not as commonly found in consumer home cooking.

Sociocultural

Pew Research Center reports that consumer food ideologies are closely linked to food-purchasing habits. Growing awareness of and interest in healthy eating has led to the increase in consumption of organic foods and "superfoods". Based on a 2016 survey, Pew estimates that most adults purchase organic food because of perceived health benefits, while the second most common reason to purchase organic is for perceived benefits to the environment (Funk). Certifications such as "Organic" and "Non-GMO" signal high quality to these consumers. In a post-COVID climate, consumers are likely to continue prioritizing cleanliness and food safety. This could present a threat to microgreens if consumers perceive them as being associated with the negative health effects caused by sprouts. It will therefore be important to educate consumers on the difference between the two, along with the health and sustainability benefits of aquaponic or hydroponic microgreen farming.

Technological

Advancements in robotics systems, GPS technology, sensors, and imaging have led to significant improvements in agricultural efficiency and profitability. Precision agriculture utilizes advanced growing methods and data driven analysis to minimize unnecessary use of resources and to increase yield (USDA). Aquaponics systems use less land, recycle most of the water used to grow crops, and require less labor than traditional farming methods. Indoor growing mitigates the presence of pests and leads to better

working conditions for farmers. The use of modern growing methods and advanced technologies can provide farms with competitive advantage by minimizing costs and increasing yield.

Legal

The regulatory environment surrounding organic food and farming is heavily influenced by the political stance toward food, farms, and the economy. The organic food industry is regulated by the Food and Drug Administration, which determines requirements for labels and definitions of terms like “Non-GMO” and “Organic” (FDA). Changes in these requirements can impact farming methods and branding strategy. Environmental policy can also influence farmers if regulations are placed on resource use, runoff, or other farming related operations.

Environmental

While growing conditions for microgreens are subject to changes in temperature and humidity, San Diego’s climate is ideal for growing crops and livestock. However, San Diego has relatively high water and land costs (San Diego Farm Bureau). Growing methods like aquaponics and hydroponics are therefore an important strategy for minimizing costs associated with water and land use. Indoor farming is also less vulnerable to extreme weather and environmental catastrophes, and soilless growing systems are less prone to pests and soil born bacteria.

Local Competitor Analysis

According to San Diego County’s 2017 Crop Report, vegetable production accounts for roughly 8% of total San Diego farm production, a value of \$137 million. The “Miscellaneous Vegetables” category holds a value over \$55 million. Microgreen producers in San Diego County include both large-scale distributors and small urban farmers. Current similarities between competitors include offering online direct-to-consumer purchasing, and both one-time and subscription-based purchase options. Other similarities exist amongst the packaging and pricing of microgreens amongst competitors. One competitor, TERI, is a non-profit organization offering its target population agricultural learning programs like those of Solutions Farms. Aside from TERI, most small microgreen participants do not have a clear brand or value proposition but do differ in the microgreen products they offer.

TERI (Oceanside, CA)

The Training, Education, and Resource Institute, or TERI, is a private non-profit organization that aims to “improve the quality of life for children and adults with developmental and learning disabilities” (TERI). According to TERI’s website, the organization has an agricultural network consisting of three organically certified urban farms and nine backyard gardens. These farms provide TERI residents and staff with fresh produce and serve as a venue for learning opportunities for residents. Regarding microgreens, the website states:

“One of TERI’s newest social enterprises is growing organic microgreens for local restaurants and retailers. Microgreens have provided a new vocational opportunity for our students as well as modeling program sustainability and creating community awareness around special education.”

TERI is currently developing a 20-acre lot in San Marcos, where the organization plans to construct a sustainable community center with 111,000 square feet of building space and a 6.5-acre organic garden and farm training center (San Diego Union Tribune). At the facility, called Campus of Life, TERI plans to “develop innovative, sustainable and organic methods for food and plant production that allow people of all abilities to be active participants in the process” (TERI). TERI is developing plans to grow heirloom vegetables for sale to local restaurants, and plans to develop a line of sauces, rubs and herbs to be sold at a larger scale. There will be a greenhouse on the Campus, in which TERI can grow plants for sale at farmers’ markets, or to gardening centers and private clients. Finally, TERI plans to host a farmer’s market on the “Central Park” lawn of the Campus. The Campus of Life is planned for 2021 completion.

Fresh Origins (San Marcos, CA)

Fresh Origins is a for-profit microgreens producer based in San Marcos, CA. According to the Fresh Origins website, “Fresh Origins Farm is America’s leading producer of MicroGreens and Edible Flowers”. The farm began growing microgreens in 1995 and continues to experiment with various strains of microgreens. Fresh Origins website mentions relationships with such businesses as Marriott La Jolla, Hilton Gaslamp, and Yellowtail Japanese Restaurant at the Bellagio Las Vegas. Fresh Origins hosts a product list with over 500 items, most of which are available year-round, and houses over 120,000 trays of greens in its greenhouses. The organization’s “About Us” page focuses on its efforts to operate using sustainable practices such as zero pesticide use, hand watering greens to conserve water, and reusing and recycling growing trays. Fresh Origins also has a three-acre bird and wildlife preserve with “dozens of species of native flora and fauna.”

Sun Grown Organics (San Diego, CA)

Sun Grown is a family-operated large-scale commercial producer of microgreens, sprouts, seeds, and wheatgrass. The farm supplies its products to distributors and vendors throughout San Diego, Orange County, and Los Angeles County. In a 2020 interview with *Edible San Diego*, Sun Grown stated it operates 80,000 square feet of production space (Hormick). According to field observation at Sprouts locations in Tustin, Irvine, and Vista, Sprouts currently purchases microgreens from Sun Grown Organics. The Sun Grown website lists eight varieties of microgreen products: sunflower greens, pea greens, microgreen mix, radish, mizuna, broccoli, kale, and arugula. Sun Grown does not offer all varieties of its microgreens for consumer purchase online, but available varieties are priced at \$8 for 4 ounces of microgreens.

Fred’s Urban Farm (La Mesa, CA)

Fred’s Urban farm is a small family-owned farm. They operate a microgreen stand, named the “Salad ATM”, on site at their 6-acre La Mesa farm. According to the Fred’s Urban Farm website Fred’s Urban Farm sells produce at La Mesa Farmer’s Market and La Jolla Open Aire Farmer’s Market. The farm allows customers to place orders through its website and offers pickup and delivery options. Microgreen varieties include fenugreek, broccoli, fava beans, sunflower and peas. Clamshells of all

microgreen varieties are priced at \$6 online. Aside from raw microgreens, products include a blended broccoli microgreen shot, ready to eat microgreen salad, and a one-pound bag of microgreen salad mix. The farm offers subscription options for weekly deliveries of five microgreen salads, ranging from \$19 to \$24 per week (Fred's Urban Farm). An *Edible San Diego* article from September 2019 states that Fred's Urban Farm grows its microgreens using coconut coir as a growing medium (Stansbury).

Quantum Microgreens (City Heights, CA)

Quantum Microgreens is a small family-operated microgreens farmer that sells microgreens at the North Park Farmer's Market and offers direct online purchasing with pickup and delivery in San Diego. Quantum home grows microgreens outdoors and sells trimmed microgreens as well as planted trays of microgreens that consumers can harvest themselves. Quantum's website lists microgreen varieties including arugula, broccoli, a micro salad, radish, wasabi mustard, and a wellness medley. Products include individual containers of microgreens as well as boxes and subscriptions containing a mix of microgreen varieties. A 3 oz clamshell of microgreen salad mix is priced at \$6. Individual round trays of microgreens are priced at \$4 per tray. Quantum also sells "grow-it-yourself" microgreen kits and hand carved wood growing trays on its website and on Etsy. Grow-it-yourself kits include a mister bottle, growing tray, blackout lid, two seed pouches, two growing bags, and a set of instructions. Quantum's Etsy page lists 184 sales and grow-it-yourself kits sell for \$20-\$25 (Etsy).

Scintilla Farms (San Diego, CA)

Scintilla Farms is a small home grower that offers free organic microgreen delivery and dedicates a page of its website to links to equipment and supplies the farm uses to grow its microgreens. Customers can purchase a clamshell containing 4-5 oz of sunflower, pea greens, arugula, radish mix, daikon radish, cilantro, or leek microgreens for \$14 online. According to Scintilla Farms' website, the farm also supplies microgreens to local restaurants. Scintilla Farms does not list if it sells product at local farmer's markets.

Distribution Channels

The primary distribution channels for microgreen producers include wholesale selling to mid- to high-end restaurants and grocers, and direct-to-consumer selling through farmer's markets, farm stands, and online ordering. The 2020 pandemic led to a major shock to the food supply chain, with temporary closures of in-person dining and farmer's markets leading to a shift in consumer purchasing habits. While many of these habits are temporary, industry analysts believe some changes to consumer behavior are more permanent. In July 2020, McKinsey reported it anticipates 30 to 49% growth in online grocery purchases and 15 to 29% growth in food takeout and delivery post-COVID. US consumers are likely to shop for new brands based on convenience, value, and availability (Arora et al.).

Restaurants and Brewpubs

Microgreens are a favorite of chefs for their variety of colors, textures, and flavors. Local mid- to high-end sit-down restaurants, brewpubs, and juice bars are the most likely to incorporate microgreens into their menu offerings. Restaurants have arguably been the most negatively impacted by the COVID

pandemic, primarily due to closures of in-person dining. In the post-COVID climate, IBISWorld expects in-person restaurant dining to stay relatively lower than it was pre-COVID. Takeout dining will be more popular amongst consumers, which will require chefs to adapt the presentation of their dishes (IBISWorld). According to the referenceUSA database, there are over 8,000 verified restaurants, including brewpubs, located in San Diego County.

Grocery Stores

According to IBISWorld, the US grocery industry has grown at a steady 1% annually from 2015 to 2020 (IBISWorld). In an email interview Andrew Paiz, Associate Team Leader of Produce at Whole Foods Market Laguna Niguel, said microgreen sales are increasing at his store and on the entire West Coast, with sales up 10% compared to last year. He is unsure as to whether this is a temporary food trend, which can occur often in health foods markets. California Whole Foods locations only purchase microgreens from two distributors that supply stores regionally, which Paiz says “helps assure good quality product along with traceability and transparency”. Both Sprouts and Whole Foods purchase from Sun Grown Organics.

It is unlikely that small local farmers in San Diego can secure business with large grocers due to limited production capacity and the preference of grocers to buy from fewer regional distributors to ensure consistency and transparency. Small specialty grocers are more likely to purchase from small, local farmers. These grocers, such as Lazy Acres and Frazier Farms, do not operate many locations and often serve consumers that prefer local health-food brands. However, selling to end users through grocers would still require small farms to abide by more stringent regulations for product packaging, labeling, and availability. This might present a challenge for small farmers with limited resources.

Farmer’s Markets

Farmer’s markets are one of the most popular sales channels amongst small farms. According to the USDA, farmer’s markets are growing in popularity as consumers place more importance on purchasing fresh products directly from farms (USDA). This direct to consumer channel allows farmers to practice in person selling and develop relationships with customers. Farmer’s markets create the opportunity for small producers to collaborate and form strategic partnerships. The San Diego County Farm Bureau lists 38 certified farmer’s markets on its website (San Diego Farm Bureau). While farmer’s markets were closed during the 2020 pandemic, San Diego farmer’s market vendors Jessica Davis of Edible Alchemy and Amanda Waterman of Double Batch Almond Cheese created Market Box, a website where consumers can purchase boxes full of locally produced goods for delivery or pick up. Davis recently opened a co-packing commercial kitchen that carries all necessary permits for Market Box to use the kitchen as a hub for receiving, packing, and distributing local goods. According to the *San Diego Reader*, Market Box hosts almost 50 vendors, including Quantum Microgreens, and delivers as far as Los Angeles County (San Diego Reader).

Direct-to-Consumer

Along with direct selling to consumers at farmer’s markets, many farmers have developed online or onsite direct to consumer channels. The 2020 pandemic catalyzed this shift even more, due to closures of or decreased demand in normal selling channels. Every producer evaluated in the microgreens market competitive analysis offered online ordering of their products for either pick up or delivery. Many

offered subscriptions for weekly microgreen boxes and additional products like juices, additional produce, seeds, or grow-it-yourself kits. In May 2020 NPR reported that community supported agriculture (CSA) boxes, another example of partnerships between local producers, were surging in popularity nationwide (Westervelt). Farms purchase products from other farmers and compile a variety of goods in a box for pick up or delivery direct to consumers. While this trend toward direct purchasing in lieu of purchasing from grocers and supermarkets may subside in the post-COVID climate, offering convenient online ordering and subscription models will likely help farmers retain customers who want fresh, high-quality products without the hassle of grocery stores.

Internal Analysis of Solutions Farms

To determine can compete in the microgreens market, it is important to perform an internal analysis of the organization. A SWOT analysis will determine strengths and weaknesses of Solutions Farms as it pertains to the ability to enter the microgreens market. It will also analyze the opportunities and threats Solutions Farms can encounter in the marketplace.

Strengths

Solutions Farms has several strengths that would benefit it in the microgreens market. First, Solutions Farms already has an existing lettuce operation and growing CSA business. Acquiring new customers is often more expensive and challenging than persuading existing customers to try a new product. Solutions Farms offers online ordering for its CSA boxes through its website and can add additional products to the existing storefront. Solutions Farms' aquaponics growing system allows the farm to maximize capacity of its greenhouses and minimizes the cost of expensive resources like water and land. Solutions Farms also has unused space in its greenhouse. This area, along with the farm's existing aquaponics infrastructure, are existing resources that could be used for a microgreen operation.

Weaknesses

Microgreens require a relatively high amount of consistent labor to keep up with short grow cycles and regular demand. Because much of Solutions Farms labor is provided by volunteers and participants in the Solutions for Change program, the source of labor may be inconsistent and present a weakness for Solutions Farms. However, this high labor need could benefit the Solutions for Change program as it will generate consistent opportunities for volunteers and workforce training. Solutions Farms would be a late entrant to the microgreens market, so it may be difficult and costly to acquire new customers.

Opportunities

Solutions Farms' social mission and sustainable growing methods are appealing to consumers and help the farm differentiate itself from most competitors. Customer preferences were already leaning toward locally produced, fresh, and healthy produce prior to the COVID pandemic. These habits became even more common during the pandemic, along with the shift to online ordering and convenient delivery or pick up options. In an April 2020 survey of 1,000 adults, conducted by the International Food

Information Council (IFIC), approximately half of respondents said their concerns about climate change at least sometimes impact their food and beverage purchases (Food Insight).

Threats

The ease of growing microgreens and increasing interest in urban farming makes the threat of new entrants high in this area. Individuals can grow small amounts in their own homes for consumption, and home gardens can be very profitable (Espiritu). There are already several competitors in the microgreens market, including TERI, which operates a similar environmentally and socially sustainable model to Solutions Farms. However, with over 8,000 restaurants, 38 farmer's markets, and over 3 million residents, San Diego county is a large market with multiple available sales channels.

Part II: Investigation of Microgreen Methods and Existing Microgreens Models

Materials, Methods, and Environments

Microgreens are grown using a variety of materials and methods and can be produced in several different environments. Key materials involved in the growing of microgreens include seeds, growing media, light, water, and trays. Methods include both soil and soilless production methods like hydroponics. Finally, microgreens are grown in greenhouses, indoors, and in urban farming environments like shipping containers.

Materials and Growing Conditions

Seeds

Because microgreens have a short growing cycle, seeds will be a regular expense in microgreen production. Seed costs vary by variety. Farmers usually determine which variety to grow based on the texture, color, flavor of the microgreen. Single microgreen varieties or mixtures of multiple varieties. Commonly cultivated microgreens include radish, spinach, beets, broccoli, peas, and red cabbage. Farmers can work closely with local chefs to determine which variety will best compliment dishes. Each variety of microgreens has different growth cycle lengths, so it is important that mixtures contain species with similar grow cycles.

Seeds are usually broadcast densely over growing media, but growers should avoid such a high density that the microgreen stems become elongated or susceptible to disease (Kaiser). A handheld broadcast spreader can help save time in the seeding process and can be purchased for as little as \$20 at Lowe's or Home Depot. Buying seeds in bulk quantities will help keep costs lower. 5-10 lb bags of seeds are the recommended amount for smaller scale growers, while commercial growers with high demand can purchase 25 lb buckets of seeds. Mountain Valley Seed Company, based in Utah, produces over 40 varieties of organic microgreen seeds and almost all varieties can be purchased in 4 oz, 1 lb, 5 lb,

and 25 lb quantities from True Leaf Market or Home Depot. Seed prices range from \$2 per lb to over \$50 per lb (True Leaf Market).

Growing Media

Microgreens usually require growing media with a depth of 0.5 inches to 2 inches, depending on the efficiency of the irrigation system being used. Along with being grown in loose soil, microgreens can be grown in soilless media. Peat and peat-based materials are most often used to grow microgreens. Coconut coir is another possible media commonly used in hydroponic growing (Kyriacou et al.). Synthetic materials like rockwool and polyethylene terephthalate (PET) are another potential growing material but are difficult to dispose of. Alternatively, fibrous materials like food grade burlap can be used as a seeding bed. Some crops can grow with a burlap mat alone, while others might need additional soilless media after germination (Kyriacou et al.; Kaiser). Naturally occurring fibrous materials like cellulose pulp, cotton, and hemp fibers offer potential low-cost sustainable alternatives.

Flat Trays

Microgreens are most often grown in shallow plastic seed trays, either with or without drainage holes depending on whether the microgreens are grown with or without soil. A commonly used tray is a 10x10" or 10x20" plastic nursery tray with a depth of 1-2.5 inches. These vary in quality and price, but if a farm expects high demand and regular turnover, investing in durable trays may prevent the farm from incurring the cost of replacing flimsier trays. A 10-pack of 10x20" plastic trays with drain holes costs approximately \$24 on True Leaf Market's website, and 50-packs of trays are available on Amazon for \$79.99. Polypropylene proofing trays used in baking are a reusable alternative, costing approximately \$10-15 online.



Figure 2. Microgreens grown in plastic and wood trays in a greenhouse environment with natural light. Image courtesy of Eco Farming Daily.

Light, Temperature, and Air Flow

Microgreens can be grown with natural or artificial lighting. Using grow lights gives farmers the option to grow microgreens that have different light needs. LED lighting is becoming the most used artificial light amongst small- and mid-sized growers, because they use less energy, produce little heat, are more durable than glass, and are becoming less expensive over time. It is important to select lights that have a high light temperature, at least 4,000K, because the light will be more like natural light. 2ft and 4ft LED integrated strip lights range in price from \$20 per light to \$50 but can be purchased in bulk for less from Amazon, Lowe's, or Home Depot. Ideal microgreen temperatures vary by variety, but microgreens can generally be grown in 75-degree temperatures. Air flow is important to prevent humidity from building up and causing mold to grow on microgreens. A fan can help promote air circulation around the microgreen growing area (Mir et al., Xiao et al., Kyriacou et al.).

Water

Microgreens roots and grow medium should be kept moist to maximize seed germination. Microgreens can be misted once or twice a day, and bottom watering is usually preferred as it is more efficient for plants to absorb and prevents water from weighing down delicate microgreens growing above the soil level (Kyriacou et al.).

Methods and Models

One of the benefits of microgreens is the ease at which they can be grown. Microgreens can be grown with soil or soilless methods and using various structures. Producers should select the growing method that best aligns with available resources and growth goals.

Soil

Growing in soil is common amongst home growers and greenhouse growers. Soil growing with small amounts of fertilizer can provide microgreens with naturally occurring nutrients. However, growing in soil makes microgreens susceptible to soil-born bacterial infections. Moreover, soil residue on microgreens is unappealing to customers. Using soil to grow microgreens may require additional labor to wash the microgreens (Mir et al.).

Soilless – Hydroponics and Aquaponics

Hydroponic microgreen growing is popular amongst farmers growing in small urban spaces as well as greenhouses. Many home hydroponic farmers use grow mats housed within plastic trays, and hand-water trays daily. More advanced models use ebb and flow systems that do not use a constant flow of nutrient solution, rather they alternate between a watering followed by a draining period (Reddy). Aquaponics growing does not appear to be commonly practiced amongst microgreen producers. The benefits of aquaponics systems in microgreen production are similar to those of hydroponics.



Figure 3. Hydroponic microgreens with ebb and flow system. Image via Bootstrap Farmer.

Vertical Stacking

Vertically stacking trays is a method that many microgreen farmers use to increase space productivity. Microgreen trays are usually stacked on 4-6 shelf metal or plastic racks, with lighting strips attached to the underside of each shelf. These racks range in price depending on material and size- a 7 ft. wire metal rack can cost around \$100, while heavy duty steel shelving can cost up to \$600. Vertical stacking can be used in soil or soilless growing and maximizes space use. It is important to consider the growing environment, and whether it is feasible and safe for growers to reach high areas multiple times during the day.

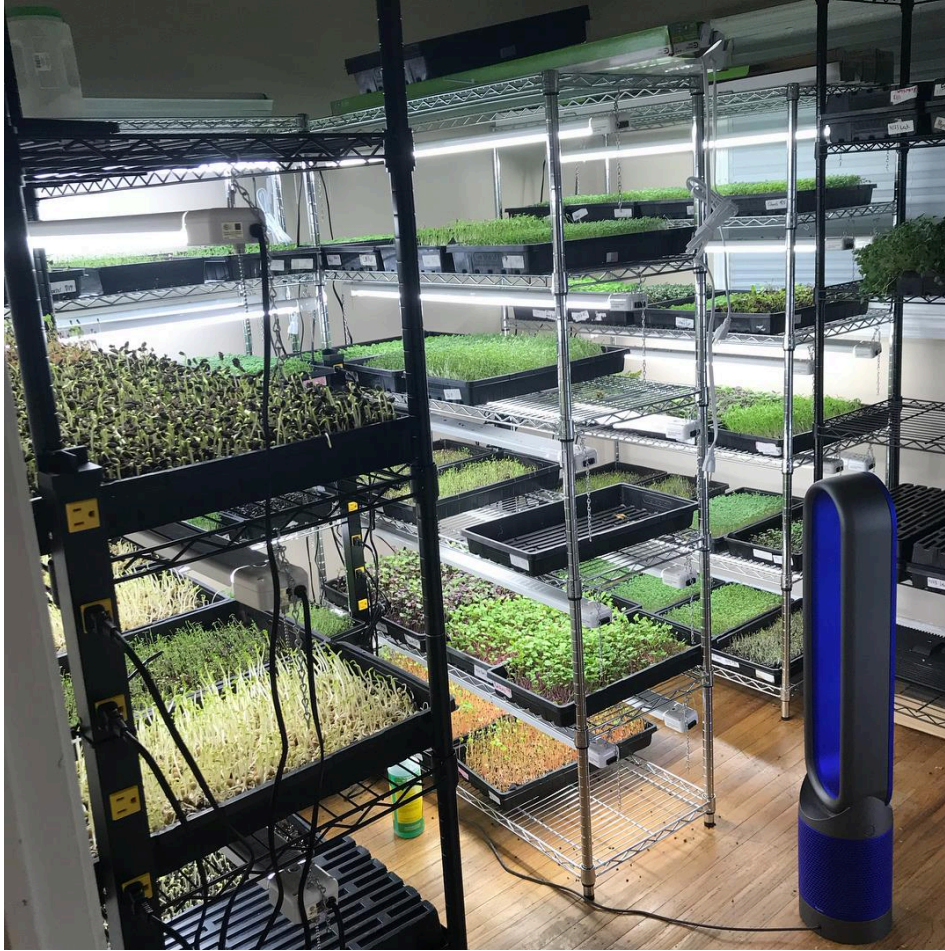


Figure 4. Vertical stacking in home-grown farm Indogrow Farms. Image courtesy of Indogrow Farms.

Deep Water Culture

An alternative to vertical stacking is the deep water culture method, which can be used in hydroponic or aquaponic systems. Small net pots or trays holding growing material and seeds are placed directly into a large tank, allowing plants direct access to a water source (Brooke). This method usually leads to minimized costs due to its simplicity- it requires less maintenance once set up and involves few components. The drawbacks of this method are that it is difficult to regulate water temperature and pH level, which can impact plant growth (Brooke).



Figure 5. Deep water culture microgreens growing using floating raft method. Image courtesy of Grass and Garden TV.

Growing Environments

Microgreens can be grown in almost any indoor space. Individuals can grow microgreens at home using supplies found around the house, and farmers worldwide are actively exploring new methods for maximizing grow space.

Home Growing

Home growing of microgreens is becoming increasingly common as microgreens can be grown on an indoor windowsill or on a larger scale in a garage or basement. According to TERI's website and to an interview with the *San Diego Union Tribune*, TERI operates many of its microgreens are grown in greenhouses located at its residential locations (Krager). Quantum Microgreens home grows microgreens in a greenhouse structure that has no humidity, cooling, or heating control and used natural sunlight (SD Voyager). Many microgreens farms encourage home growing by their consumers, as a means of promoting food security in the community.

Shipping Container

Urban farmers continue to experiment with growing in small repurposed spaces like shipping containers. These are especially useful in large urban environments with little access to natural light or large open spaces. However, growing in shipping containers is not ideal as it is often challenging to regulate humidity, temperature, and lighting without incurring high costs. Some start-up companies like Growtainer and CropBox produce shipping container farms that come equipped with water and lighting systems, insulation, and shelving. They also include sensors that allow farmers to monitor and log data points that allow them to analyze ideal growing conditions for crops. Such businesses represent areas of innovation for urban farming and precision farming but remain pricey at \$60,000-\$75,000 (Produce Grower).

Greenhouse

Microgreens can be grown in a greenhouse with natural or artificial lighting. Greenhouses that have ample space can grow a single level spread of microgreen trays across long tables or use vertical stacking. Greenhouses protect microgreens from environmental harms. Air circulation will also be important in enclosed greenhouse spaces.



Figure 6. Urban greenhouse growing space at Urban Micro in Vancouver, Canada. Image via Urban Micro.

Harvesting and Packaging

Microgreens should be harvested at the first true-leaf stage of plant growth, when seedlings are around 2 inches tall. Harvesting is usually the most time-consuming portion of microgreen production, as it requires growers to carefully trim sometimes hundreds to thousands of microgreens every week. An electric knife or trimmer can help expedite the harvesting process, but kitchen scissors are also a useful tool for harvesting small amounts of microgreens. Microgreens are highly perishable, so they should be handled with utmost care immediately after harvesting.

Microgreens should be washed and dried after harvest and placed in a cool dark area for storage. Exposure to light or warmth post-harvest can subject microgreens to wilting and discoloration. Harvested microgreens are best stored in plastic containers that protect greens from being damaged. Six-inch clamshells, which are the appropriate size to hold the market standard 4-5 oz of harvested microgreens, cost as little as \$17 for a pack of 125 containers. Packaging can also be time consuming as it requires microgreens to be weighed and carefully handled to prevent waste (Mir et al.). Microgreens can also be packaged in plastic bags, but they offer less protection for the product.

Microgreens are very perishable. If refrigerated and kept away from direct light, microgreens typically last from 5-7 days after harvest (Fresh Origins). It is therefore important to plan production accordingly. The short grow time for microgreens is helpful to manage production on a weekly or bi-weekly cadence.



Figure 7. Microgreens packaged in both plastic clamshells and bags. Image courtesy of Black Hills Farmers Market.

Part III: Go-to-Market Recommendations

Microgreen growing is a worthy pursuit for Solutions Farms because it is profitable, replicable, cost effective, and aligns with Solutions for Change's values and organizational goals. San Diego is a populous county, and citizens show a preference toward purchasing local organic food. That said, there are several existing competitors in the local market, and due to the timing of this research many market participants were not operating or were unable to be reached. The market share of local competitors like TERI remains unclear and will need to be explored through further research. Below is a compilation of recommendations for a Solutions Farms microgreen operation, along with recommendations for future research.

Target Market

Solutions Farms should target end consumers that seek local, sustainable, and healthy food sources. According to a study by UC Davis, fresh produce consumption is positively correlated with income and education. Vegetable consumption is often done at home in homemade meals (Cook). Gallup

reports that over half of Americans aged 18-29 seek organic foods, and organic food consumers are likely to have an annual household income over \$75,000 (Riffkin). Organic produce purchasers are also more likely to have a child under the age of 18 living in the house (Dettmann and Dimitri). Solutions Farms target end consumer is likely a young adult or an adult parent with a college degree and mid- to high income. Solutions Farms can reach these consumers through various sales channels.

Market Message

Solutions Farms primary competitive advantage is that its social mission and environmentally sustainable growing methods differentiate it from competitors. Solutions Farms can leverage its brand in the market by informing consumers of the farm's contribution to the Solutions for Change program, as well as the environmental benefits of aquaponics and hydroponics. By purchasing from Solutions Farms, customers are satisfying their desire for healthy, sustainable food and in addition their purchase is contributing to an organization that sustainably solves homelessness.

Distribution Channels

Solutions Farms should explore both wholesale and direct-to-consumer sales channels. Solutions Farms is actively growing its CSA operation during the time of this report. One strategy is to first pursue direct-to-consumer sales from Solutions' existing customer base. This approach is relatively low risk and will allow Solutions Farms to gather information about consumer preferences from an immediate source. Current trends indicate a shift in consumer purchasing of local foods, and many research firms believe this shift toward local will remain in the post-COVID environment. Outdoor farmer's markets like the Vista Farmer's Market are a strong channel match for Solutions Farms, as farmer's markets are a channel that gives Solutions Farms access to its target demographic of customers who prefer local, sustainable, and healthy products. Finally, Solutions Farms should target local restaurants and brewpubs. Farmer's markets could potentially expose Solutions Farms to local chefs or business owners. Chefs prefer to purchase from local producers that can offer fresher product in less time than large distributors. Brewpubs and hospital cafeterias should be targeted in a similar manner.

Production Method

Solutions Farms should consider utilizing the unused space it has available in its current greenhouse for a microgreens operation. This area can house growing tables exposed to natural light. Solutions Farms should also consider vertical stacking paired with LED lighting, as this maximizes space productivity and allows for better control of light strength. Solutions Farms can adopt its current watering methods to provide bottom watering to microgreen trays. Solutions Farms should consider using coconut coir or a growing mat made of a mixture of natural materials. If labor becomes a challenge for the farm, it should consider purchasing a broadcast spreader or electric trimmer to help in production. Solutions Farms should designate a table for the harvesting, packaging, and storage of microgreens. Microgreens can be harvested using scissors, weighed, packaged, and stored. It is recommended that Solutions Farms document growing methods, inputs, and resulting yield in an Excel spreadsheet. Collecting this data will help Solutions Farms to determine optimal growing conditions and seed density. Solutions Farms can set weekly pars for microgreen production and add trays to its production as demand increases.

Product and Packaging

Solutions Farms should begin growing some of the more commonly grown microgreens, including spring mixes, radishes, and arugula. After gaining feedback from consumers and through discussions with local chefs, Solutions Farms can choose to add or remove varieties from its product offerings. The benefit of growing microgreens is it is easy to adapt to demand due to short grow time and minimal associated costs. Seeds are the greatest cost, which can be prevented by buying in bulk, although overbuying should be avoided because seed quality will deteriorate with age. Solutions Farms should package its microgreens in the market standard of plastic clamshells. They protect the microgreens from being damaged, and from unwanted moisture. They also allow customers to view the product, which is important because aesthetic appeal is a selling point of microgreens. Microgreens can be priced using a cost markup method in addition to competitor price matching. If Solutions Farms sells its microgreens for \$35 per lb., a fair market price, it will need to sell about 200 lbs. of microgreens per month, or 50 lbs. per week, to reach its \$7,000 monthly revenue target. However, Solutions Farms can likely charge a premium for its microgreens due to the additional perceived value of locally and sustainably produced farm products tied to a local social mission. Assuming a chef purchases 0.5-1 lb. of microgreens a week for \$35 per lb., a farmer can gain \$70-140 from each chef per month. Solutions can sell 2-3 ounces of microgreens in a plastic clamshell directly to consumers for a market standard price of \$6. A weekly microgreen salad subscription can sell for \$25-\$30 for five days of product, or Solutions can offer a monthly subscription for one box of microgreens weekly for \$25-\$30 per month.

Sales Methods

Solutions Farms should attempt to cross sell to current customers by offering samples of its microgreen product. This can also help the Farm receive feedback from consumers regarding preferences for different microgreen varieties. Because microgreens are a niche product, many consumers are unaware of microgreens, their benefits, and their uses. Product knowledge and educating consumers will be important in stimulating sales. Solutions Farms can offer recipe ideas on a small printout included with samples or purchases, or on the Solutions Farms blog. Fresh Origins dedicates a section of its website to recipes containing its microgreens. The recipes are provided by Fresh Origins as well as chefs that purchase Fresh Origins microgreens (Fresh Origins). Dutch microgreen producer Koppert Cress has a search bar on its website that recommends microgreen varieties based on the user's selected criteria for taste, cuisine, and dish ingredients (Koppert Cress). Most online microgreen businesses list microgreen varieties along with a description of the microgreen's texture, flavor, nutritional benefits, and a clear image. These efforts improve consumer knowledge of the product and informs them of how the product solves for one of their needs. Solutions can partner with local chefs to determine ideal microgreen varieties and pairings for their menus.

Farmer's market environments will allow the farm to educate potential customers on the benefits and uses of microgreens, as well as the social mission and sustainable practices of Solutions Farms. Along with in person selling, the farm can include in its packages a printed card that informs the customer of the farm's growing methods, and its role in Solutions for Change. On the other side of the card can be a printed recipe or a list of ideas for how the customer can use their microgreens.

Potential Social Impacts

Learning and Creativity

Along with providing revenue for Solutions for Change, Solutions Farms serves as an important educational environment for Solutions for Change residents to develop workplace skills and learn about nutrition and healthy eating. Microgreens are nutrient dense and convenient to grow and eat. Solutions Farms residents could practice growing a small tray of microgreens in their homes, and experiment with using microgreens in homecooked dishes. Home growing a small tray of microgreens could be a fun and educational project for children. Chefs sometimes call microgreens the “vegetable confetti” because of how they are often used to decorate or add an interesting flavor to dishes.

Self-sufficiency and food security

Growing microgreens can provide communities with increased food security and encourage self-sufficiency in homes. Microgreens are excellent crops for urban farming in small spaces, as they can be grown in almost any environment with minimal supplies. Urban farming of microgreens provides economic opportunity to home growers that can generate profit from a small area in their homes with minimal upfront costs. Microgreens can be produced quickly and are currently experiencing growing demand from consumers that now more than ever are seeking local, sustainable sources for food.

Nutrition and health

Microgreens are nutrient dense. They are a convenient way to consume healthy vitamins and phytonutrients, and each variety of microgreen will provide consumers with different benefits. The nutritional advantages of microgreens align with Solutions for Change’s focus on improving physical health and nutrition education for its residents and within the community. Microgreens are also convenient because of their small size, and because they can be paired with many dishes. They do not require preparation aside from being trimmed and rinsed.

Areas for future research

The research used to compile these recommendations was performed during the COVID period. Many restaurants and farmer’s markets were partially or completely closed and attempts to reach market participants were often met without response. Furthermore, the long-term magnitude and severity of the pandemic impact on the food supply chain and consumer habits is unclear. It is therefore recommended that Solutions Farms perform additional primary research to develop concrete sales leads when the current impact of the virus has subsided.

Another further area of research is whether there is opportunity for Solutions Farms to pursue a strategic partnership with TERI. A representative of TERI was contacted with no response, but according to its website the organization is expanding its agricultural operations to a large San Marcos campus. The plan includes discussion of a farmer’s market at the campus, which could be a potential sales outlet for Solutions.

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