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Lufa Farms

The planet is going from 7 billion to 9 billion people. We have to feed people using less land, less water, fewer pesticides. At the same time, conventional farming is facing challenges – the cost of a shipping container from Mexico to the U.S. just rose, for example. All of that is an opportunity for Lufa Farms. We are going towards the finish line, but the finish line is also coming towards us.

- Mohamed Hage, Founder & CEO of Lufa Farms

Mohamed Hage walked slowly through his farm, inspecting a row of tomato plants on his left and another of baby eggplant on the right. He looked out at the horizon. Instead of barns and silos, the 32-year-old entrepreneur peered out at an unlikely view – parking lots, brick buildings, and a sushi restaurant. The farm, called Lufa Farms (Lufa), was a 31,000 square foot (2,880 square meters) greenhouse located on the roof of an industrial building in the Ahuntsic-Cartierville neighborhood of Montréal, a Canadian city of 1.65 million people¹ in the province of Québec.

Lufa's greenhouse operated year-round, a feat in a city known for its long winters, while a landbased farm in the region had an annual growing season of 24 to 28 weeks.² The Lufa team cultivated crops in its greenhouse using hydroponic (soilless) techniques. They also had developed software to control greenhouse conditions from climate to lighting. Hage and his team were committed to responsible agriculture, which they defined as involving no new farmland, limiting water use, avoiding synthetic pest and disease controls, and farming a wide variety of crops.³

After several years of business development, the Lufa team began selling produce directly to consumers in April 2011. Lufa's customers were individuals and families who paid for subscriptions to receive weekly produce boxes that came in small, medium, and large sizes. Historically, the company had offered the baskets at \$22, \$32, and \$42.^a In July 2013, the farm instituted a new pricing model where all new subscribers received a "standard" basket and the older subscribers' basket prices were grandfathered in. The standard basket cost \$30 a week and contained approximately enough produce for two people to eat during a week. Lufa's prices were competitive with those of high-end Canadian grocers, and the company generally set prices for the goods it produced by placing a small premium on top of the products' organic counterpart. However, prices were also

^a All currencies are in U.S. Dollars, converted from Canadian Dollars at a one-to-one ratio in August 2013.

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affected by the under- or over-supply of an item. The team made decisions on what to grow based on market demand, but also based on experimentation and crop yields. As an example, Lauren Rathmell, the greenhouse director explained, "We tested strawberries last winter and found they don't yield enough to justify the crop area they occupy, though they were delicious."

A major part of Lufa's appeal to its customers was the freshness of its food. Every week, subscribers picked up their boxes, which contained produce picked from the greenhouse that morning as well as other specialty foods and other products that came from local farms for which Lufa acted as a distribution agent, at set locations ranging from coffee shops to public libraries spread throughout the area (see **Exhibits 1** and **2** for pickup locations and a map of Montréal neighborhoods). In the spring of 2013, Lufa began allowing subscribers to customize their orders, rather than sending them a pre-set assortment of goods, and found that the change boosted subscriptions. Hage noted that Lufa's seven-fold increase in subscribers – from the initial 400 in 2011 to 3,000 in 2013 – had had been achieved without any formal advertising budget; instead, the company relied on its online presence, social networking, word of mouth, promotional events, and the open houses it had hosted to publicize itself.

Hage's goal was to bring local food, grown according to the tenets of responsible agriculture, to large numbers of people. "We have to feed more people as resources become scarcer," he said. As his business achieved scale and as his team reduced greenhouse building costs, Hage thought that Lufa's costs for growing food would also drop. "In five years, we will be able to say, 'Local food is better for you and it is also less expensive'" than food bought at the grocery store.

As 2013 drew to a close, Lufa was poised to expand. Though Hage knew that funding and permitting would continue to be hurdles to overcome for the young company (and industry as a whole), Lufa's recent trajectory gave him hope. The company was projected to break even that fall. A second greenhouse had just opened in the Montréal suburb of Laval, Québec, and Lufa was working on three additional prospective greenhouses in 2014, two in Boston and another in Montréal. (For a business timeline, see **Exhibit 3**.) For the long term, Hage wondered if he should continue to focus on replicating the entire business model each time Lufa added a new city. He was also weighing other options for future expansion – franchising the intellectual property he had created in his business and letting partners with local expertise in other cities establish new rooftop farms, for example. From a marketing and brand perspective, might the best new partnerships come from restaurants and other institutions that would buy fresh food, rather than individual consumers?

The Lufa brand was well recognized in Québec and had strong positive consumer connotations. Growing and protecting that brand would be crucial to the future growth of the company. Given that the freshness of Lufa's food depended on its direct-to-consumer sales model, would it ever make sense for Lufa to sell produce to retailers, as other competing rooftop farms did?

Mohamed Hage

Hage had spent his early years in the village of Werdanieh, a municipality just south of Beirut, the capital city of Lebanon. During his childhood in the early 1980s, there were only about 200 homes in the village, and the primary industry was farming. The members of his extended family had all worked as farmers, with the exception of his father, who had become a lawyer. Hage had been inspired by his grandmother, who had put nine children through university, he said, by farming a wide variety of crops and raising chickens, selling to about 20 local families. Later generations of his

Lufa Farms

family, however, began to farm "according to an interpretation of Green Revolution^b principles. That meant monoculture, pesticides, selling to food terminals and so on," he said. "All of my cousins are still farming that way – monoculture hoophouses cover the landscape around the village now – and it has been less successful than my grandmother's business."

Hage and his immediate family moved to Canada when he was in his early teens. He attended Carlton University in Ottawa in 1999 and 2000, and took courses in 2001 at Concordia University in Montréal, but did not earn a degree from either school. He then joined Cypra Media, his family's business, working with his siblings. Cypra focused on software development and software housing, social media management, website development, and email marketing campaigns. While serving as CEO of Cypra several years later, he began to think about ideas for a new entrepreneurial venture.

With his extended family's agricultural successes and failures in the back of his mind, Hage began to study agriculture to see if he could come up with a business idea. He toured commercial farms, interested in potentially exporting their technology to Lebanon. In particular, he began to study hydroponics, defined as the cultivation of plants without the use of soil. (In general, plants were grown in an inert medium such as gravel, sand, pumice or sawdust, to which the farmer added a solution with all the nutrients needed by the plant.⁴) Hage thought hydroponic methods had a major advantage in that they produced high yields in relatively small spaces. (For hydroponic yields versus soiled yields per acre, see **Exhibit 4**. For more information about hydroponics at Lufa, see **Appendix**.)

"Every Canadian farmer I talked to said, 'Forget about it, it's too cold here; we have one good year, and four bad years,'" Hage recalled. "But I knew that in Holland they were producing without pesticides. I knew that in California they were working on rainwater recapture. I knew that at McGill they worked in rooftop greenhouses. It was like the iPhone moment, when all these separate technologies and practices came together."

Hage thought that a business based on greenhouses in urban settings that used environmentally responsible, hydroponic growing techniques to produce top-quality food had potential. Putting the greenhouses on rooftops would allow them to draw energy and heat from the buildings below. He named the business Lufa Farms, after the luffa plant, a resilient, abundant plant in Lebanon that grew on rooftops, and began to put together his team.

Lufa's Early Years

Hage founded Lufa Farms in 2009 and received support from several of its founding members, including Kurt Lynn, who started ListenUP! Canada, a chain of hearing aid centers, and had served as a consultant to Cypra Media for three years. Hage saw him as a mentor. Lynn helped write the business plan, frame the project, and later focused on Lufa's marketing and communications. "He and I complement each other; he is very grounded and I have a lot of energy," Hage said. "We still

^b The Green Revolution referred to a 1960s shift in farming practices in the developing world to help solve problems of food scarcity. It focused on the breeding of improved varieties of crops for areas of the world where demand for food far outstripped supply. For example, the development of high-yielding varieties of rice and wheat, coupled with greater fertilizer use and adjustments to irrigation and pest controls, led to much larger harvests of these grains in places such as Asia and Latin America. The Green Revolution initially focused on rice and wheat, but the term eventually became acceptable to describe the development of high-yielding varieties of other crops in developing economies as well. Source: Peter B.R. Hazell, "The Asian Green Revolution," International Food Policy Research Institute (IFPRI), c. 2009, page 1. Available at http://books.google.com/ books?id=frNfVx-KZOcC&pg=PA1#v=onepage&q&f=false, accessed August 2013.

have weekly calls to discuss Lufa, though his involvement is not as great as it was before, as he is closer to retirement."

The founding team also included Rathmell, a recent graduate from McGill University; Howard Resh, a well-known agronomist who had written extensively about hydroponics; and Yahya Badran, their construction manager, who had grown up in the same Lebanese town as Hage. (For bios of Lufa's management team and select board members, see **Exhibit 5**.) The team began to develop their business plan, refine their growing techniques and look into the necessary permitting. "We worked in order," Hage said. "First, the engineering, then the farming, and then, figuring out distribution." Initial funding for the business came entirely from private sources – Hage's family and friends.

Rathmell, who would become greenhouse director, put forth four tenets she considered essential to responsible agriculture as the team developed its business plan. First, they would use no new land for farming, which was consistent with the idea of farming on a roof. They would use water in a responsible way; Lufa Farms captured rainwater and recirculated irrigation water to feed its crops in a closed-loop system. They would not use synthetic pesticides, herbicides and fungicides; instead, they used biocontrols—ladybugs and other insects used to control populations of damaging insects, for example. Finally, they would focus on growing a wide variety of flavorful produce high in vitamin and mineral content.⁵

Although their agricultural, technological and engineering innovations were at the forefront of their plans, Hage thought the most important decision they made early on, "more important even than putting farms on rooftops, was choosing to market directly to the consumer," which allowed for food to be harvested and delivered on the same day to subscribers. As a result, Lufa's food had a level of freshness others could not match. One subscriber described the difference: "You can always find tomatoes in grocery stores, but they're not real tomatoes. A Lufa tomato has a wonderful tomato fragrance, a taste that is wonderful. I can get them year-round. A lot of the produce from the big stores just tastes sterile; it's been shipped here from Latin America or elsewhere. It would be very hard to go back to grocery store produce now."

Lufa's approach also capitalized on the popular local food movement. Followers opted to eat food grown nearby and in season; the push to eat locally had emerged in response to concerns about the quality and environmental effects of food from commercial farms, the perceived increase in product freshness, as well as a desire to support the local farming community. There was no consensus on the distance between producer and consumer for food to be considered "local," but many definitions – from state-based programs, regional programs, farmers selling food to consumers at farmers' markets or through community supported agriculture (CSA) systems^c – were accepted.⁶ Advocates of local food believed that product grown locally was fresher, tasted better, and was richer in nutrients.

By contrast, many commercial farms harvested unripe produce, then gassed it for ripening or processed it after the food traveled long distances, to ready it for sale.⁷ By the time food reached consumers, it had "lost its nutrients, taste, texture and smells,"⁸ Hage believed.

^c In a CSA model, interested consumers purchased a share or subscription from a local farmer, and in return received regular deliveries (usually weekly) of seasonal produce throughout the farming season. Source: http://www.localharvest.org/csa, accessed October 2013.

The First Greenhouse

Rathmell, had graduated in 2010 with a degree in biochemistry. (Rathmell's grandmother, Nina Fedoroff, was a geneticist known for her research on transposable genetic elements in maize, as well as the author of a book whose purpose it was to debunk myths about genetically modified foods. Fedoroff had also served as the Science and Technology Advisor to the Secretary of State and to the Administrator for the U.S. Agency for International Development (USAID) from 2007 to 2010.)⁹ Rathmell had known Hage since her first year at McGill. Together they had rented greenhouse space at McGill for two years prior to Lufa's launch, using the space to practice hydroponic farming techniques and experiment with prospective crops for the business.

Building Lufa's own rooftop greenhouse began with the challenge of finding the right location. Lufa needed a building with a large, flat roof that could support the greenhouse's weight, which was about 75 pounds per square foot. The Lufa team found a three-story industrial building with a 31,000-square-foot roof and massive support posts throughout, which would enable the building to carry a large load. (For an image of Lufa's first greenhouse on the roof of the building, see **Exhibit 6**.)

The landlord had wanted Lufa to pay \$5 per square foot per year to rent his roof space. "We could only pay \$1 per square foot. So we wrote him a long letter, and the guy finally called me and said we love what you are doing, we think you have a great story—we're taking a risk going with Lufa, but think it's a risk worth taking. He has been an amazing partner ever since," Hage recalled.

The Lufa team reviewed numerous "off-the-shelf" designs for greenhouses located on the ground that complied with agriculture codes, but since the farm would be located on a rooftop, the team saw room to innovate where agriculture codes met building codes. Lufa contracted an architect and a structural engineer to work with Badran (an engineer by trade) to create the specifications for a rooftop greenhouse that would not only meet agriculture codes, but building codes such as seismic bracing, fire protection, snow load requirements, ingress and egress requirements, and other national building codes that would apply to an urban rooftop greenhouse. Lufa hired Westbrook, a Canadian greenhouse-building and design company, to build their first greenhouse.

Although the first greenhouse achieved positive cash flow quite quickly (approximately six months after opening), Lufa went to KUBO, a world-renowned Dutch greenhouse building and design company to create an improved version of the rooftop greenhouse with new technology. Together, Lufa and KUBO designed a fine-tuned system for which Lufa had exclusive use in North America. Lufa was also able to secure the exclusive use of KUBO's Ultra-Clima system on rooftops, a system of overpressure facilities (meaning forced ventilation through side vents) that allowed for better climate control, more energy efficiency, increased crop area, and a lower chance of pest entry. The system also incorporated recirculation technology to reuse water and nutrients at a greater potential. (See **Exhibit 7** for a schematic of the Ultra-Clima system.)

Lufa's greenhouse used two growing systems: drip irrigation and nutrient film technique, both of which allowed nutrient solutions to be applied to every plant. In the drip irrigation system, solution dripped down to plant roots, which sat in blocks of coconut fiber (ground coconut husks), through a network of tubing. In the nutrient film technique system, roots grew directly in the nutrient solution. Channels housed the rows of crops in both cases. (For an image of crop rows, see **Exhibit 8**.)

The greenhouse was divided into a warm zone (about 26°C) and a cool zone (about 22°C), though temperatures could vary throughout the year. Temperature control was automated. Roof vents assisted with temperature control; the cool zone also had a cooling pad (an evaporative cooling mechanism) and exhaust fans. The greenhouse used high-pressure sodium (HPS) lighting to extend the length of the growing day, particularly when days grew shorter in winter, or on cloudy days. The goal was to approximate a 16-hour day length. Lights went on in winter as early as 1 a.m. Lights went on and off automatically based on a weather sensor and allowed Lufa to cut back on heating costs to a certain extent, since they gave off heat.

In the cool zone, the greenhouse team mainly grew greens – Boston lettuce, Swiss chard, and even stacked trays of microgreens, or immature edible greens, such as pea shoots. Greens were harvested and replanted every four weeks. The warm zone housed cucumbers, tomatoes, eggplant, peppers, and other produce, including an experimental row of crops, where the greenhouse team tried to grow everything from heirloom beans to mouse melons (tiny cucumbers that looked like miniature watermelons). (For images of cool- and warm-zone crops, see **Exhibits 9a** and **b**.) "There are standard crop cultivation guides for each crop but we have to compromise," Rathmell noted. "Cucumbers prefer one climate, tomatoes another, but we keep the temperature in the middle. Some rows are split between two crops, but each row usually hosts only one crop."

When Lufa's second greenhouse opened in Laval, Québec, in July 2013, tomatoes and eggplants moved there, while peppers, cucumbers, and cool zone crops remained at the first greenhouse. With the added capacity, Lufa would be able to grow as many as 23 different tomato varieties.

All of the water in the greenhouse was recirculated. Any water collected in the metal growing channels was recycled and reused. Each week, a sample of the water in the greenhouse was sent to an outside lab for an assessment of its nutrient mix. "You need a careful balance of nutrients," Rathmell explained. "Calcium usually accumulates in the solution, while iron and manganese deplete quickly. Based on water readings, we adjust – we add some iron, perhaps, or slowly work on lowering longer-term nutrient accumulations. It's something we've had to really experiment a lot with."

Pest management was a major concern. Lufa Farms used only biological pest controls (biocontrols), essentially consistent with organic farming methods. "But things in a greenhouse get out of hand really fast," Rathmell said. "We have to stay on top of it." In 2013, a commercial farm in Maine, for example, had suffered an infestation of whiteflies in its greenhouses that had forced the farm to remove 500,000 tomato plants and ruined the farm's entire tomato crop for up to 10 weeks.¹⁰ (To read an article on the incident, see **Exhibit 10**.)

Plant pollination was done with bumblebees; ladybugs and parasitic wasps were deployed to feed on aphids. Predatory mites were introduced at the start of a crop; these prevented infestation by thrips and other insects.

Each agricultural or engineering problem the business faced often led to technological innovation. Hage's team developed water circulation systems, water cultures, and software with which to manage conditions in the greenhouse. Energy curtains made of nylon and polyester enveloped the greenhouse at night and facilitated growth by keeping temperatures steady. These helped reduce heating needs by about 40%.

In summary, Hage said, "We have taken farming to an extreme." He added: "We use no pesticides, no herbicides, we capture and recirculate 100% of rainwater, we compost, we control all the climates by computer, we have microclimates within systems, and we even developed an iPad application to manage pest control." Hage believed a significant amount of intellectual property had been developed by Lufa, which had the potential to be franchised to others in new markets. He estimated that any new market entrants would need three to four years to function at Lufa's level. (See **Exhibit 11** for a table of Lufa's developed cultivation methods.)

Sales and Distribution

Lufa offered its customers approximately 200 different products at any given time, each identified with a unique stock-keeping unit (SKU) number. Of the products available on any given week, around 35 SKUs came from Lufa's own greenhouse, and top-selling items included tomatoes and cucumbers. Lufa contracted with other farms and specialty food producers to sell their products, such as jam, honey, coffee, and maple syrup, in Lufa baskets. Lufa operated as a food hub^d or a distribution system that moved many local foods into mainstream markets.

Establishing a network of farms was a way for Lufa to manage competition, said James Rathmell,^e Lufa's corporate development manager. "It's about discovering and offering local treasures. We've never thought of ourselves as being in competition with local farmers." Averaged across all SKUs, Lufa's margins were approximately 50%. "People [get] really excited about the farm, but our core business is actually as an aggregator of goods. That's how we make our money," James remarked.

Lufa's website allowed customers to see listings and photographs of what was available each week (to see Lufa's offerings as seen online by a subscriber, see **Exhibit 12**.) The site also featured a blog with detailed descriptions of new products. Customers selected items and quantities online and could modify their orders until midnight before the day they were scheduled to pick up their baskets. Customers' weekly subscription price reflected the minimum amount they could buy; they could also add and pay for additional items. Subscriptions were indefinite and were for all 52 weeks of the year. Lufa delivered baskets Monday through Friday of each week, with the exception of a handful of holidays. Beginning in July 2013, new subscribers started with a standard, \$30 weekly basket, and they could "pause" subscriptions while on vacation or cancel at any time.

Hage noted that customer attrition or the churn rate had dropped dramatically when Lufa changed its policies to allow subscribers to customize their baskets and to cancel subscriptions at any time. Prior to the switch, the churn rate had averaged about 50%. Subscriptions had lasted 12 weeks under the old policy; if subscribers did not renew subscriptions within four weeks of the subscription end date, they were considered "churned" by Lufa. If they did renew within four weeks, they were not considered part of the customer churn.

When Lufa changed its policies, however, "churn rate practically disappeared," Hage noted. He said that about 30 subscribers canceled every week, representing less than 1% of all Lufa subscribers, but that those who canceled usually did so after one week, because the product did not meet their needs in some fundamental way. "If they don't churn on the spot, they won't churn at all," he remarked. Lufa's 12-week customer retention rate moved from 60% to as high as 90%, extrapolating from the lowest and highest weekly retention rates, following the introduction of customizable baskets and switching all new customers to pay-as-you-go subscriptions, according to James.

Every night at midnight, after customers finished customizing their baskets, software created podcasts for each SKU; these were loaded directly to iPods. The staff that came in at 7 a.m. to pack

^d A food hub was defined as "a business or organization that actively manage[d] the aggregation, distribution, and marketing of source-identified food products, primarily from local and regional producers, to strengthen their ability to satisfy wholesale, retail and institutional demand." Source: James Barham, Debra Tropp, Kathleen Enterline, Jeff Farbman, John Fisk, and Stacia Kiraly, *Regional Food Hub Resource Guide*, April 2012. U.S. Department of Agriculture, Agricultural Marketing Service. Washington, D.C.

^e James was Lauren Rathmell's brother. He joined Lufa in 2012 after graduating from Columbia University and working with a series of technology start-ups. Throughout the case he will be referred to by his first name, his sister by her last name.

boxes would listen to the podcasts, which would tell them exactly how much of each SKU belonged in each box. Lufa produced almost zero food waste. "We harvest exactly what we need in a day, no more," Hage said. "In farming you have about 30% that is never sold – harvested, but not sold. That doesn't exist here. From a carbon footprint perspective, it is a huge deal,"^f he added. Rathmell elaborated, "We try to manage inventory on a daily basis down to the unit. Surplus items^g are often added to the inventory for the rest of the week, discounted, or we'll use extra produce for samples or gifts to subscribers or for promotional events. We also have a weekly donation pick-up: anything that is grade B or surplus is picked up once a week for a local food bank."

Systems for ensuring that boxes were packed correctly remained rudimentary—after packing, the same staff went back and checked random boxes to see if the right items were in each one. (For images of Lufa's warehouse and packaging, see **Exhibits 13a** and **b**.) "Now we are getting [more complex], and we do make mistakes," Hage admitted. "We are selling a lot of things before they're even picked. There are always logistical challenges that need to be solved."

Distribution at first was "not our strongest suit, to put it bluntly," James remarked. "We frontloaded the development of food-growing systems and new technology for farming and didn't focus enough on the logistics of actually getting food to the customer" when developing the business. Dave Furneaux, chair of Lufa's board of directors and one of the company's principal investors, put it another way: "The things that should be easy are hard for us, and the hard parts are where we are strong." Furneaux had urged the team to hire an operations manager to take over distribution. But that would require paying a large salary to someone to manage a small warehouse.

Lufa's warehouse was on the bottom floor of the building with the first greenhouse on it, and could support a maximum of about 5,000 subscribers. Staff packed boxes there daily; the warehouse also was used to store shelf-stable items. "We don't have the capacity to store a lot, and we don't want to," said James. "Right now, we call suppliers on a weekly basis and ask people, 'What can you get me next Monday?' But we're already automating that process, because we have such a quick turnaround of fresh produce." Lufa had three trucks that delivered boxes to 140 customer pickup locations around Montréal. After packing was complete, trucks left Lufa's warehouse at 11:30 a.m. and returned at about 3:30 p.m.

Lufa's pickup points included coffee shops, gyms, bike shops, pharmacies, bakeries, yoga studios, corporate locations and others around Montréal. Lufa contracted with each pickup point individually; they did not provide staff to handle Lufa's boxes or pay pickup points. Some vendors, however, said that traffic from Lufa subscribers also led to an uptick in sales of their own products. One pickup point, a cheese shop, had told Hage that they averaged \$15 in sales per Lufa pickup.

Pickup points were unmanned, and Lufa did not advertise at pickup points beyond a sticker on the door and brochures about the service, which were available at the locations. Each week, subscribers could choose the pickup point they wanted to use online, and could select a weekday when they would pick up their box. Boxes were labeled with subscribers' names and stacked in a

^f The mainstream food supply system encouraged waste in many ways; food was often mishandled during lengthy transport routes. Large portions, enormous menus, and poor training contributed to waste in restaurants. Supermarkets' aesthetic standards meant ugly but otherwise usable produce was sometimes left unharvested. Source: "Saving Leftovers Saves Money and Resources," Natural Resources Defense Council, available at http://www.nrdc.org/living/eatingwell/saving-leftovers-saves-money-resources.asp, accessed June 2013.

^g Surplus items were items for which there was no current demand but were ripe and ready for harvest.

designated location at the pickup point; subscribers would simply find their boxes and take them home. Lufa used cardboard boxes, but planned to switch to reusable plastic boxes.

The system was not perfect. A handful of thefts had occurred at pickup points. In another incident, just after a leap in subscriber growth of 5% in one day, a distribution problem had occurred because of a truck that left late – the result of a late arrival by a third-party vendor. "We had one drop point that said if that happened again, they were pulling out," James noted. "It was a private drop point, and their employees had to stay late to pick up their boxes. It would have been a blow to our subscriber base. We sent an apology e-mail; a lot of people asked for refunds."

There were also risks involved in selling goods from outside suppliers, from late food deliveries holding up Lufa's trucks to potentially major problems such as food safety issues. The Lufa team made a major effort to get to know all of their suppliers well, to invite suppliers to meet consumers at Lufa's open houses and other community events, even to blog about suppliers on the Lufa website so that people knew more about the products on sale and the methods used to grow or create them.

One Lufa subscriber felt that the business still had some glitches. On a visit to the Lufa website, she found that a product she wanted to order – spinach – that appeared to be available could not be added to her basket. She also found it difficult to translate weights and measurements online to an actual number of items she would receive – an order for a pint of tomatoes, for example, had yielded just three tomatoes in her basket. "Their customer service is great, though, and will take the time to solve your problem," she said. "And the taste of their fruit and vegetables is exceptional. I still think it would be hard to go back to shopping another way."

Marketing and Advertising

Lufa's target market consisted of 30- to 50-year-olds either with families or just starting families. The customer base skewed heavily to female customers (approximately 80%). Most subscribers lived in high-income or densely populated, urban areas, where there was a range of pickup location options. When thinking about where to put pickup locations to cater to the target market, Hage admitted the team had realized it was a good idea to "follow the Starbucks."

The business had relied on word of mouth, social media and other online advertising platforms to acquire customers. "We're great at search engine optimization," Hage said. Internet users, particularly in the Montréal area, who plugged related keywords into Google—"fresh vegetables Montréal" or "CSA Montréal," for example—would see Lufa near the top of the list of offerings.

Lufa also produced a great deal of online content on its website, including a regularly updated blog on which a Lufa team member described all new products and provided detail on their food suppliers. Hage noted that articles about urban farming in the mainstream media and television appearances had never seemed to lead directly to a jump in Lufa subscriptions, although the press had "generated a great deal of buzz and was amazing from a branding perspective. But we'd have a half an hour on a popular show, and then wouldn't see a huge spike in terms of subscriptions."

Instead, customer acquisition had occurred through events or online efforts. "We use more content marketing," Hage noted. Lufa used open houses – to which it invited subscribers and guests to the Lufa greenhouses or offices, with free tasting sessions and presentations by artisanal food producers – to bring in new subscribers. In 2012, at Christmas, Lufa hosted a Marché Nöel, or Christmas market, to which it invited its suppliers to come and sell their products to the public. After one 2013 open house, hosted at Lufa's headquarters, a 5% increase in subscriptions had occurred.

Also in 2013, a celebrity chef filmed a television commercial^h for a Toyota Prius automobile, Hage added. In the ad, the chef took someone to his favorite place in Montréal—a farm—but the farm turned out not to be a traditional, land-based farm, but rather Lufa's rooftop greenhouse. Lufa had paid nothing to be part of the spot; in fact, Lufa was paid \$400 for participating.

The best marketing, Hage said, came from the quirky Lufa story itself and the idea of bringing a community together through healthy food. "You have an amazing, captivating story that effectively replaces a marketing budget. When you build a socially conscious business, there are such upsides."

The Cost of a Rooftop Farm

Recurring costs associated with the rooftop in Ahuntsic-Cartierville included heat, electricity, taxes, and rent. "Essentially we are paying a triple-net [lease]ⁱ per square foot," said Hage. They also paid for insurance, a standard agricultural private policy that protected against crop loss and other damages.^j

Capital expenses (capex) for the first greenhouse were roughly \$80 per square foot; the initial investment in the building totaled roughly \$2.3 million. By comparison, Hage estimated that capex for a greenhouse built on the ground was \$30 per square foot. Their eventual goal for future greenhouses was capex of \$40 to \$50 per square foot. But a rooftop greenhouse would always cost more than one on the ground, Hage reasoned, because it would have to be built according to building codes and merged with an existing structure.

Despite high capex, operating expenses (opex) tended to be low. A rooftop greenhouse structure, built of aluminum, glass and galvanized steel, was built to last for more than 40 years. Traditional greenhouses were made of plastic and polycarbonates and replaced every decade. Heating costs were halved, because the rooftop greenhouse took advantage of radiant heat from the building below.

For labor, Lufa relied on recent graduates and college students, who were able to work early hours. "We believe that in any city, we can continue to utilize student labor or fresh grads," Hage said. "We recently had 3,000 CVs for three positions that start work at 5 a.m. Now we just use referrals." College students also tended to be versatile in a startup environment, often taking the initiative on new projects. Some might leave employment to travel or participate in other activities, but they would often return to Lufa afterward, which lowered training costs for the company as well.

Transportation costs also contributed to lower opex, as food traveled less than it usually did when grown on a commercial farm, and the network of drop off points was dense. Lufa had three trucks, each of which could fit around 1,500 boxes and was being used at about half capacity. Fuel for each truck cost \$30 a day. Each truck had a team of two people, each one earned about \$11 an hour and all of them worked in the warehouse, packed the trucks, and then delivered the boxes on the trucks to

^h To view the advertisement, see the Lufa Farms Twitter page post titled "Vincent Graton et Marc-André Royal se rendent aux Fermes Lufa à bord de la Prius!" (https://twitter.com/LufaFarms/status/351154837213298689), posted June 29, 2013 at 6:46 PM via YouTube.

ⁱ A net-net-net (NNN) or triple-net lease required that the lessee pay some or all of the costs associated with a property, costs which would normally be paid by the landlord. These could include taxes, utilities, maintenance and other items that would be determined before the lease was signed.

^JSuch private insurance policies also existed in the U.S.

customer pickup locations. Transporting boxes (not including packing) took four hours each day. Including fuel and labor, transportation and delivery costs were about \$300 a day.

The Laval greenhouse, at 43,000 square feet, was significantly larger than the Montréal greenhouse. The second greenhouse's scale, as well as certain modifications to its construction after seeing what had worked well at the first location (some as simple as reducing the number of exits from three to two, for example), meant that capex had already dropped to about \$70 per square foot. The Lufa team considered Laval their second-generation rooftop greenhouse.

Even as Laval was being built, the Lufa team had filed for a patent on their third-generation greenhouse, which used several technologies to lighten greenhouse loads dramatically. "With those adjustments, many more buildings become suitable," Hage said. "It is \$6 per square foot cheaper because we don't require as much support from the building below. Each iteration of the farm has certain improvements. But there is still a long way to go."

"Each time you open a large-scale greenhouse, the company's valuation jumps," because of the amount they could grow, added James. "You get increasing efficiencies and returns to scale per square foot. Future revenue growth will come from finding projects and executing on them well." Furneaux estimated seven to ten greenhouses would decrease capex to a point that was sustainable.

Expansion Plans

Furneaux had identified and structured a deal for a third greenhouse, with construction beginning in 2014 and expected to last until early- to mid-2015, on a single-story, 250,000-square-foot building in the Saint Laurent neighborhood of Montréal. Other expansion plans included two sites in Boston. Unlike Montréal, Boston had an established CSA network and a number of farmers markets already, noted James. "We'll see how we grapple with those," he said.

All of those sites would use the patented, third-generation farm. "With these two Boston projects, and the three in Montréal, you start to achieve scale," Furneaux said. "You can feed maybe 20,000 to 40,000 people in each city. Then you start to think about licensing the technology or franchising."

Zoning and Permitting

Zoning and permitting involved a great deal of coordination at each new site. Getting permits for the first greenhouse in Ahuntsic-Cartierville involved time-consuming negotiations with the local government. Nine kilometers away, in Laval, "we had to do it all over again," Hage said. In each case, existing zoning did not allow for the operation of commercial agriculture. Lufa instead went through lengthy processes to obtain permission to operate as a special project, with an architect presenting the idea for the greenhouse to the city and soliciting comments from the public. After a favorable reception, Lufa received a zoning adjustment that allowed them to submit their greenhouse design for a construction permit. They submitted structural and engineering plans, obtained construction permits, and things moved forward. Obtaining the zoning adjustment in each location took six months; the entire permitting process took about a year. "The big goal is to ensure that [in the future] we do not have to go through the special projects process each time," said Hage.

Before settling on Boston as a third location, they had explored establishing a Toronto location, but, Hage said, "we couldn't get the support we needed. In Boston, we are getting so much help. The Boston Redevelopment Authority calls us on a monthly basis to check up on us." Authorities in Boston helped the Lufa team find potential locations and manage local contacts, as well as deal with permitting. Even with the warm reception, however, a Boston site had been in the works for two years, in part because a previous Boston building had pulled out of a deal at the last minute.

One possible longer-term approach was to obtain permitting for rooftop greenhouses as equipment, not as buildings, Hage thought. He likened this approach to the one used by the solar industry. When solar panels first came on the market, they were challenging to put on roofs; very few people knew how to install them, or whether they were permanent or movable, and consequently obtaining permits for them had been onerous. Eventually, however, solar panels became modular and getting a permit for solar panels in Ontario took no longer than a week. "If we can get the greenhouse to be treated as equipment, like a solar panel, it could simplify the permitting process. This has to be something that everyone knows how to add to a building, like an HVAC unit."

Along with navigating zoning and planning issues with local government officials, Hage also had to convince real estate developers that putting an urban rooftop farm on one of their buildings was a reasonable idea. Because rooftop farming was a new industry and Lufa Farms had experience only in Montréal, the opportunity had not been built out to a level that made investors comfortable. In fact, Hage was trying to assuage potential development partners' doubts by inviting them from Boston to Lufa's operations in Montréal to familiarize investors with commercial urban rooftop agriculture.

Funding

Hage, Furneaux and the Rathmell family were all early investors. Furneaux ran Kodiak Ventures, a venture capital firm based in Wellesley, Mass. Lufa's Series A round of financing of \$5 million was led by Cycle Capital Management, a clean technology fund based in Montréal. This money had been used to build the Laval site and to help explore expansion possibilities in Boston. The early investors owned a substantial majority of the company's shares, and Hage wanted to avoid dilution by relying on capital equipment loans, landlord-financed construction, and debt, if possible.

Hage thought the company would apply for another round of venture capital financing in 2014. He hoped to raise another \$10 million, and did not think it would be hard to find investors. "Three years ago, investors said, 'This is silly.' Two years ago, they said, 'Well—maybe.' A year ago, they said, 'Good idea.' And now they all want to get involved," Furneaux added.

Lufa's other investors included Ray Stata, founder of Analog Devices and the venture capital firm Stata Ventures, also a friend of Furneaux's and Andrew Ferrier, a Canadian who had been CEO of the world's largest dairy processor, Fonterra, from 2002 to 2011. There were a few others, in real estate, software and information technology, Hage said.

"We look for investors who share our vision. We do a lot to evaluate the fit from that perspective before embarking on a new partnership with an investor," Hage said. "We're looking for visionaries who can also do a lot to support the team; everyone has to roll up their sleeves and play." Hage was interested in investors that could buy into a sustainability model; in fact, Hage believed that his target investor base was clean technology investors rather than agribusiness investors.

Although the company had applied for agricultural innovation grants in its early years, it had not received a single one, Furneaux noted. Hage thought subsidies might begin to appear down the line, as they had for the solar energy industry. But he did not want to rely on them, or even count on their appearance. "The first rule of sustainability is financial independence. You need to be profitable; otherwise, it's not sustainable." He noted that several Lufa competitors used subsidies and free land. Without the use of subsidies, Lufa as a whole was projected to hit profitability in November 2013. (See **Exhibit 14** for Lufa Farms' pro forma financials.)

In addition, on each of the three new deals (Boston and the third Montréal site), the real estate developer had been receptive to fund half or more of the project. Essentially, the developer, as owner and landlord, would pay to build the greenhouse, and Lufa would take a long-term lease and pay rent. This would keep Lufa from needing new capital, since the landlord provided it. In Montréal, the developer was willing to include more than half of the costs in his overall development financing and build in a return over the life of the lease, Furneaux noted. "Essentially we are now seeing developers and building owners wanting to underwrite our build-out and charge us back over the course of 20 years," he said. "We are now in the process of analyzing the tradeoffs between the various forms of equity, debt, vendor financing and project financing that are available to the company."

Expanding the Business Model

There were other models for expansion that the Lufa team had explored, although they had not yet made any formal commitments. Lufa had been approached by one or two captive communities – remote areas that depended almost entirely on food imports, and often had problems with extreme weather. One remote community of 2,000 people, centered around an aluminum factory, had expressed interest in a rooftop greenhouse. "They have lots of buildings, lots of heat, they pay good salaries," Hage said. "But obtaining fresh food is one of their biggest problems."

James noted that Lufa had spoken to several universities in the U.S. and Canada about working together through a managed services model where the greenhouses would supply food to university operations (e.g. cafeterias). In this model the universities would put up the capex for the farm and the Lufa team would deal with building a greenhouse, managing it and doing the actual farming. Some greenhouse management could be done remotely. With Lufa's proprietary software, they could potentially monitor everything from greenhouse yields to biocontrols. James pointed out, "Doing this allows us to operate all of our greenhouses with about one person per 10,000 square feet. If we didn't have a centralized team, we would have to hire a full-time plant science team of about three people for each new greenhouse we build, regardless of its size. Centralizing with remote management helps us scale by reducing opex going forward." He added, "Such an arrangement would allow us to focus on what we do best."

Lufa had been approached by a number of potential licensees interested in the business model, most of whom were entrepreneurs looking for a shortcut into the urban agriculture space. James explained, "But we are looking for someone who wants at least a 10-year relationship. We develop a strong partnership where we don't step on their toes and vice versa. The issue is trying to find someone to develop a long-term relationship with; they typically just want one project, a one-off, and that isn't what we have been looking for."

The Lufa team was increasingly interested in building greenhouses on new buildings, as they had done in Laval. "The greenhouse becomes part of an existing project that is moving ahead; we don't have to find the building, or figure out its structural integrity," James said. Two conversations with owners of older buildings had recently ended, he added, because the owner saw himself parting with the building within the next five years. "Revenue from the greenhouse lease wasn't enough to cover the cost of selling prime real estate in the downtown core area." In addition, if they continued to partner with real estate developers on financing at new locations, they would not have to raise debt and equity financing each time. "It would mean extra capex at the outset to reinforce the building, but it could work. From a growth perspective, it would allow us to stamp these things out as quickly as possible as opposed to raising a huge amount of capital upfront for every project."

Competition

Lufa Farms was not alone in the urban farming space, though the concept remained unusual and none of the companies in operation had yet emerged as an industry leader. Techniques were still being tested and perfected, and new vertical farming^k ideas were emerging globally. TerraSphere, a company with offices in Surrey, British Columbia, Canada and Boston, installed vertical farms and sold produce through Choices Markets, a Canadian organic grocery chain.¹¹ Alterrus Systems Inc., a Vancouver-based company, had built a greenhouse farm atop a Vancouver parking garage and grew herbs and salad greens in water using a series of moving trays on a conveyor belt.¹² Plantagon, a Swedish company, proposed a 12-floor mixed-use development (including office space) where plants moved on vertical tracks along different floors to facilitate harvesting and exposure to sunlight.¹³

Other companies were in more mature stages of implementation. Gotham Greens, a New York City-based company, had built a commercial hydroponic greenhouse on a rooftop in Brooklyn in 2011. The company signed a deal to build another greenhouse atop an industrial building in Queens' Jamaica neighborhood, which was expected to be operational in 2014. Gotham Greens had also built a greenhouse atop a Whole Foods in Brooklyn, slated to open in late 2013.¹⁴

BrightFarms, also based in New York City, had one commercial-scale greenhouse farm in Bucks County, PA and another seven in different stages of development: five in the Midwestern U.S., one in Washington D.C., and one in Brooklyn. Its goal was to "improve the environmental impact of the food supply chain and increase the relative consumption of whole and fresh foods."¹⁵ With a business-to-business model, BrightFarms built at or near supermarkets and had partnered with six supermarket chains since 2011, including the A&P brands Super Fresh, The Food Emporium, A&P, and Pathmark. Stores signed agreements to purchase produce over a 10-year term at a fixed price.¹⁶

A Whole Foods Market in Lynnfield, MA, which opened in 2013, had a rooftop planter in which to grow tomatoes, kale, basil, tarragon and other produce. The crops were grown in soil; the planter was some 17,000 square feet. Whole Foods harvested and sold the produce in the supermarket below.¹⁷ Another Massachusetts company, Higher Ground Farm, had plans to build rooftop farms.¹⁸ Higher Ground Farm had built a soil-based farm atop the Boston Design Center, which spread across 55,000 square feet. The growing season would run from May until November, and crops would be delivered to local restaurants by bicycle. A CSA program would open in 2014.¹⁹

Most rooftop greenhouse farming had so far occurred in colder climates, though Hage thought that a market did exist outside cold-climate cities. But colder areas were the entry point, given shorter natural growing seasons and therefore greater demand for greenhouse produce year-round.

Conclusion

Hage pondered what to do next as he tasted one of the crunchy radishes from his farm. Even as he enjoyed Lufa's early successes, he realized the business had to keep moving forward and expanding to fulfill its mission. For now, the presumed plan was to take on the challenge of expansion to Boston and other cold-climate cities where the company's proprietary techniques were most suited, even though this involved managing zoning problems, fundraising, and dealing with local governments.

^k Growing food in skyscrapers with artificial light and organic materials was referred to as vertical farming.

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At what point would it make sense for his business model to change? What sort of partners made the most sense? Hage worried that moving too quickly would inhibit adherence to the high standards he had set. If so, food quality would suffer. On the other hand, if Lufa moved too slowly, the business might lose momentum and fail to achieve scale. There was also the question of the Lufa brand. Hage and his colleagues had built the Lufa brand into a recognizable entity in Montréal, without having to spend much money. How should he think about the brand going forward? If he franchised his technology, would he increase the risk of the brand being diluted or damaged?

Hage had to decide on a longer-term, sustainable strategy. Where should he focus his efforts?

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Exhibit 1 Lufa Farms' P	ickup Points and Lufa L	ogo (watermark)	
	Pickup Point by Mor	ntréal Neighborhood	
Ahuntsic-Cartierville	Lachine	Quartier Latin	Not Set (continued)
Éco-Quartier-Fleury East	Éco-Quartier Lachine	The Commensal St-Denis	Fraser Milner Casgrain
Éco-Quartier-Lajeunesse	<u>Laval</u>	Rosemont	Restaurant Divino
Éco-Quartier-Salaberry	Dépot de l'Importateur	Dépanneur Le Pick-Up	THQ
La bête à pain	Java U-Laval	Famillprix	Privé
Lufa Farms	Rurbain	Olives et café noir	Académie St. Thérèse
Beaconsfield (Kirkland)	Vêtements Hotte au Travail	SODER	Association de la Construction de Québec
Éco et Éco/Buygreenonline.ca	Pharmacie Brunet PLUS	Touristour	Association de la Construction de Québec Region Métropolitaine
Centre-Sud	Le Capotte	Via Capitale du Mont Royale	CGI (Crémazle)
Éco-Quartier St-Jacques	Frenco	Saint-Anne-de-Bellevue	Cirque du Soleil-Maine
Marché St-Jacques	Le Plateau	Moins 40	Cité du commerce électronique
OOM Ethlkwear	Crémy Pâtisserie	Fleuriste St-Anne	City of Cote-St-Luc
Pourquoi Pas Espresso Bar	Greenpeace Canada	St. Laurent	Coop Fédérée
Centre-Ville	La mise en place	Antabil	CSST
Castel Durocher	Le Fromentier	Eco-Quartier St-Laurent	Deloitte
environnement	Le Placard	Franc	Dentons Canada
Java U-Stanley	Noblessence	Saint-Laurent Eco-quartier	DentsuBos
Le Commensal-Downtown	Spafax	<u>Sud-Ouest</u>	Domtar Pulp & Paper
Mansfield Athletic Club-Downtown	Via Capitale du Mont Royale	Galerie Point Rouge	Éco-Quartier St-Michel François Perreault
Société des Arts Technologiques	Mile-End	Itsi Bitsi	Eldos & Square-Enix Montréal
YMCA-Stanley	Café Falco	Magasin General Saint-Henri	Group Montoni
Côte St-Luc	Café Résonance	Marché Bleuet	НАТСН
English Montréal School Board	Chez Boris	<u>Verdun</u>	Industrielle Alliance
<u>Côte-des-Neiges</u>	Lola Rosa (Parc avenue)	Café La Tazza	INSPQ
Borough of Nôtre-Dame-de-Grace	Starbucks (Park Avenue)	Fromagerie Copette et cle.	IRCM
IDOLEM Le Carle-Hot Yoga Studio	<u>NDG</u>	Lefebvre et Filles Bouchées de Bonheur	Jewish General Hospital
Java U-Côte-des-Neiges	Café 92 and Mama Sophia	Vieux-Port	LinkByNet (employees only)
Java U-Jean-Talon West	Café Juicy Lotus	Café des Arts	МАХХАМ
Siscoe Gym	Outremont	La Concession-Boutique et comptoir alimentaire	Megabrands (employees only)
<u>Côte-St-Luc</u>	Thermomix/Nobelhaus Importations	Ville Mont-Royal	Midtown Athletic Club
Public Library-Côte-St-Luc	University of Montréal	McKenna Fleuriste	Montréal Schoolboard (CSDM)
Dollard-des-Orneaux	Parc Extension	Villeray	Norton Rose (Ogilvy Renault)
Moksha Yoga West Island	Bric à Vrac	Centre du loisirs communautaires Lajeunesse	Pfizer Kirkland
Dorval	Marché Soupson	Veux-tu une bière?	Price Waterhouse Coopers
West Island CrossFit	Point-Claire	Westmount	Sacré-Coeur Hospital
Hochelaga-Maisonneuve	Holistic Center Om West	Centre Greene-Community Centre	Sid Lee
Essentiellement sol	Ça va Java Café	L'Autre Choix Mini Marché	SNC-Lavalin
Famillprix-Hochelaga	Café Marmelade	Lole Women	Stikeman Elliott
<u>lle-des-Soeurs</u>	Fraser Source du Sports	Westmount Wellness Center	Technoparc Montréal
Chez Carl Restaurant	Librairie Cillo	Not Set	Technopole Angus
Via Capitale-Nuns' Island	Mansfield Athletic Club-Pointe Claire	7275 St Urbain	Ville de Montréal
	Svnerav Cvcle	CSMB-siège social	Wapikoni Mobile

Source: Company documents.





Date	Milestone
2006	Mohamed Hage has idea for Lufa Farms; starts to put together a team
June 2009	Hage and his team officially found Lufa Farms and develop business plan
August 2009	Hage and team begin to experiment with hydroponic growing techniques, start to look for
	building on which to build first greenhouse, start to explore permitting for greenhouse
August 2010	Permit obtained for first greenhouse in Ahuntsic-Cartierville neighborhood
January 2011	Construction of first greenhouse completed; crops begin to grow
April 2011	Lufa opens sales to the public with 400 subscribers
August 2012	Lufa receives Series A financing of \$5 million
July 2013	Lufa reaches 2,500 subscribers
July 2013	Construction of Laval greenhouse is complete and growing of crops begins
November 2013	Lufa projected to break even
2014	Lufa projected to break ground on three new greenhouses, one in Montréal and two in Boston

Exhibit 3 Lufa Farms: A Business Timeline

Source: Company documents.

Exhibit 4 Soiled and Hydroponic Yields per Acre per year

Crop	Soiled	Hydroponic
Soya	600 lbs.	1,550 lbs.
Beans	5 tons	21 tons
Peas	1 ton	9 tons
Beets	4 tons	12 tons
Potatoes	8 tons	70 tons
Cabbage	13,000 lbs.	18,000 lbs.
Lettuce	9,000 lbs.	21,000 lbs.
Tomatoes	5 to 10 tons	60 to 300 tons
Cucumbers	7,000 lbs.	28,000 lbs.

Source: Casewriter from L. Biggs and D. Giles, "Current and future agricultural practices and technologies which affect fuel efficiency," Intelligent Energy Europe, http://efficient20.eu/files/2011/02/D3.1-Current-and-future-agricultural-practices-and-technologies-which-affect-fuel-efficiency_v2.pdf, accessed September 2013.

Exhibit 5 Lufa Farms' Management and Board

Mohamed Hage (Founder, CEO) Lufa Farms is the second venture Hage has founded since 2002. His previous company was Cypra Media. He has a talent for inspiring passion in his employees and for establishing ties with experts from a range of specialties. Hage conceived of Lufa in the early 2000s based on his experiences with fresh produce while growing up in a village near Beirut.

Kurt D. Lynn (Vice President, Founding Member) Lynn, a Toronto-based entrepreneur best known for the ListenUP! Canada hearing-healthcare chain. He was founder or senior executive of a half dozen North American enterprises including Kolvox Communications, NEBS Computer Products Division, OpenComputing, VisiCorp Personal Software, and Digital Equipment Corporation. Lynn joined Lufa in 2009 as a founding member, and contributes his expertise in sales and marketing.

Yahya Badran (Director of Engineering, Founding Member) Badran joined Lufa during the initial studying phase for the prototype greenhouse. He is a graduate of the Universite Technique de la Construction de Bucarest, and previously worked on projects in Romania and Lebanon before settling in Montréal and founding FDA Construction. Always in search of new challenges, Badran

has headed a number of residential and commercial projects for different clients. At Lufa, he oversees all planning and construction stages for new rooftop greenhouses.

Lauren Rathmell (Greenhouse Director, Founding Member) Rathmell, a trained biochemist, started working with Lufa Farms as a researcher at McGill's MacDonald campus. She played a large role in the development of the plant science and growing science that Lufa eventually implemented, including the NFT and drip irrigation systems, the use of biological pest controls, the microclimate and crop rotation systems, and the selection of crop varieties. Rathmell currently supervises all greenhouse operations as well as research and development.

Dave Furneaux (Board Chairman) Furneaux has more than 20 years' experience with the financing and capitalization of companies operating in an array of sectors, including clean tech. He has been involved with more than 100 businesses and founded two different investment firms, Furneaux Capital and Kodiak Venture Partners. Over the course of his career, he has procured more than \$700 million in capital. Several of his companies have emerged as industry leaders. Furneaux plays an integral role in Lufa Farms, working in partnership with Hage to determine the strategic direction of the company. He also assists with the development of growth plans and with finding the necessary financing for the company to achieve its objectives.

Howard Resh (Master Horticulturalist) Resh provides operational oversight and horticultural supervision to Lufa's prototype greenhouses. A native of British Columbia, he is a pioneering hydroponics researcher, author and practitioner. In addition to his position with Lufa, Resh is director of a hydroponic farm and organic garden in the British West Indies. He previously held science and management positions with Hoppmann Corporation and California Watercress Inc.

Jean-Michel Vanier (Director of Finance and Human Resources) Vanier joined Lufa in 2012. He is responsible for optimizing the company's financial operations. This includes the implementation of financial and administrative processes designed to support the company's aggressive growth plans. As head of human resources, he also has the task of attracting, developing and retaining talented individuals. Before coming to Lufa, Vanier was assistant controller at SNC-Lavalin. He is a graduate of HEC Montréal and a member of the Canadian Institute of Chartered Accountants.

Andrew Ferrier (Board Member) Ferrier has run companies in the U.S., New Zealand and Canada. From 2003 through 2011, he ran Fonterra Co-operative Group, the world's largest dairy processor. Before heading Fonterra, Ferrier was CEO of GSW Inc., based in Toronto, Canada, and for 16 years through 1999, Ferrier worked in the sugar industry. He now runs his own investment business, Canz Capital Ltd., with investments in New Zealand and Canada.

Andrée-Lise Méthot (Board Member) Methot has more than 15 years' experience in corporate financing, management and engineering. The founder of Cycle Capital Management, Methot created the first Québec-based venture capital fund focusing on the cleantech sector. She also launched a fund focusing on sustainable development. Methot serves on portfolio companies' boards and also co-founded and chairs Ecotech Québec.

Rémy Kosseim (Board Member) Kosseim is a 1980 commerce graduate of McGill University. A professional accountant by trade, he has worked closely with entrepreneurs in many sectors, providing management consulting, financial, taxation and related services.

Sources: Lufa Farms, http://www.nzte.govt.nz/en/about-us/our-people/board-members/andrew-ferrier/, http://www.cyclecapital.com/andree-lise-methot/,

http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=618957, the stocks/private/snapshot.asp?privcapId=618957, the s



Exhibit 6 Lufa's First Greenhouse (Montréal)

Source: Company documents.

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Exhibit 8 Crop Rows at Lufa's First Greenhouse

Source: Company documents.

Exhibit 9a Cold Zone Crops



Source: Casewriters.

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Exhibit 9b Warm Zone Crops



Source: Company documents.

Exhibit 10 "Whiteflies Force Major Maine Farm to Destroy Crop," The Portland Press Herald

MADISON – Backyard Farms, which produces more than 27 million pounds of tomatoes a year, says an infestation of whiteflies in its greenhouses will force the company to destroy its entire crop of half-a-million plants and start over.

The clean-out will disrupt its tomato-growing operation and deliveries for as long as 10 weeks.

Backyard Farms, which ships tomatoes across the Northeast to about 50 retailers ranging from Hannaford to Whole Foods to Walmart, decided to clean out both of its greenhouses, which cover 42 acres, in an effort to fully eliminate any problems, said President and CEO Chuck Green. The company will destroy all of its plants, sanitize the greenhouses and grow a new crop, Green said.

"The decision was made that if we can't deliver the best-quality product, we would do a total clean-out and sanitation effort," he said. "It's like scrubbing a surgical room. . . You won't see fruit with our name on it in stores until mid- to late October."

Backyard Farms opened a 24-acre operation in 2007, growing tomatoes year-round, and has expanded since then, supplying tomatoes to restaurants and retailers. The company grows tomatoes year-round.

In glass-enclosed greenhouses, it grows plants hydroponically, in a nutrient solution rather than in soil. Workers wear sanitized "clean suits" when they tend plants to prevent the spread of disease, Green said. "We have extreme biocontrols in place," he said.

Whiteflies, which look like tiny white moths, suck away plant juices and cause leaves to yellow or die. The insects also excrete a sticky honeydew that often causes a black, sooty mold on the leaves. The mold

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can be washed away easily and is not harmful to humans, said Jim Dill, pest management specialist for the University of Maine's Cooperative Extension.

"It's a very common problem for greenhouses. It usually doesn't get out of control, but if it does, there are biocontrol organisms that can help," said Dill. "It's not harmful to people at all. The real damage is sucking the juices out of the fruit."

Greenhouse plants are more susceptible to whiteflies than outdoor farms, Dill said.

Backyard Farms began notifying customers about two weeks ago that deliveries would be disrupted. It will remove all of its signs from stores so there will be no confusion about what produce is for sale, Green said.

"We've been very lucky. Our customers have been very supportive and warm. I think they almost feel worse for us than we feel," he said. Backyard Farms also notified state and local officials, which it was not required to do, Green said.

Hannaford, which was Backyard Farms' first major customer, said it remains supportive of the company and will restock the produce once it is available again.

"Our merchandising team was notified. In agriculture, problems can happen," said Hannaford spokesman Michael Norton. "We're feeling we'll be back with Backyard Farms at the earliest possible date. We've been with them from the beginning. If we have to find an alternative vendor, we will do what we need to do, but we'll be back with Backyard Farms as soon as possible."

Green said Backyard Farms plans to keep its 200 employees on the payroll throughout the clean-out and replanting process.

"We're not laying anyone off. The rationale is that in good times and bad times, you have to walk the walk and talk the talk of taking care of people," he said. "It's a risk you take in agriculture."

Green would not say how much money Backyard Farms will lose by destroying its plants, or how much the clean-out will cost.

"It's a tremendous hit to our business," he said.

The company has hired plant specialists and plant pathogen specialists to make sure the whitefly problem doesn't occur again. Green declined to name the specialists.

When the company resumes production, it will test all of the seeds and plants to make sure there's no disease, Green said. It will also use bugs that will be predators to any whiteflies.

The whitefly problem has not been widespread in Maine, other farmers said.

Sean Hagan of Left Field Farm in Bowdoinham said he hasn't seen whiteflies in his greenhouses. His tomatoes and peppers are grown in open-sided greenhouses, rather than the type of glass-enclosed greenhouses that Backyard Farms uses.

"That's more of an indoor problem," Hagan said. "I haven't seen any issues."

CORRECTION: Because of a reporter error, a story on Page 1 Wednesday about tomato grower Backyard Farms gave an incorrect description of the company. It is not an organic farm.

Source: Jessica Hall, "Whiteflies Force Major Maine Farm to Destroy Crop," *The Portland Press Herald*, July 10, 2013, www.pressherald.com/news/whiteflies-force-backyard-farms-to-destroy-crop_2013-07-10.html, accessed July 2013.

Exhibit 11 Overview of Lufa Farms cultivation technologies

Energy management The design and location of the greenhouses allow for reduced energy consumption (roughly 30%-50% less than a standard ground-level greenhouse in a rural area). The primary advantage is the insulation gained from the rooftop and building below. The greenhouse also helps reduce the heating/cooling demands of the building by insulating from temperature extremes. Energy curtains help further reduce heating requirements, as they're deployed at night to trap heat gained during the day and reduce heat loss at night (about 40% and 60% reduction in heating needs for Lufa's first and second sites, respectively) High-efficiency natural gas boilers installed at both sites offer 20%-30% greater efficiency than standard equipment.

Pest and disease management Lufa used only biological controls for pest and disease management (no synthetic pesticides, herbicides, fungicides) and developed tools for scouting crops and combatting issues. A custom iPad application and methodology was used for scouting, with plants inspected weekly for pests and diseases. Data was used to map pest and disease pressures in the greenhouse crop area, identify hot spots, determine application/introduction needs, and predict population trends over time. Lufa designed strategies around maintaining mini 'ecosystems' in the crops, with harmful and beneficial insects in balance.

Recirculation Lufa recirculated all irrigation water and developed strategies for ensuring the proper balance of nutrients in the hydroponic solutions. The system also captured rainwater from the roof surface of both greenhouses and condensation from interior glass surfaces at the new site. This water was stored in fresh water tanks to supplement water used for irrigation. The Lufa team also developed a custom program and calculator to make short- and long-term adjustments to recirculating solutions.

Composting Composting took place on-site at the first greenhouse, with an in-vessel unit from AGF Brome. Green waste and carbon inputs were loaded and the drum rotated at set intervals, with finished compost exiting from the end of the drum. Lufa's green waste inputs were relatively unique for an in-vessel composter, so the team devised their own calculator and formulation to ensure the proper composting process is achieved.

Remotely-managed cultivation Now with two farms in operation, the team began to focus on centralizing growing methods and developing strategies to remotely manage the farms. Lufa had a network operations center at the main office, from which the team could view and operate the two greenhouses, as well as communicate with the operations teams at each site.

KUBO Ultra-Clima greenhouse Refer to Exhibit 7.

Source: Company documents.



Exhibit 12 Product Selection Options for Lufa Subscribers



Exhibit 13a Packing Boxes at Lufa's Montréal Warehouse

Source: Casewriters.

Exhibit 13b Packed Boxes at Pickup Location



Source: Company documents.

514-008

Revenue	
Effective Gross Income	\$8,404,485
Total Revenue	\$8,404,485
Operating Expenses	
Labor	\$460,000
Plant Science	\$262,740
Rent	\$643,839
Property Tax	\$99,000
Insurance	\$43,000
Security	\$50,000
Supplies	\$126,000
Distribution	\$4,695,955
Marketing	\$732,563
Total Operating Expenses	\$7,113,097
Startup Costs	
Equipment and Construction	¢5 500 000
Total Startun Construction	\$5,500,000
Total Startup Costs	<i>φσ</i> , <i>σ0000000000000</i>

Exhibit 14 Lufa Farms' Pro Forma Financial Statement

Source: Company documents.

Note (1): Facility Sizes - Ahuntsic greenhouse was 31,000 square feet; Laval was 42,000 square feet.

Note (2): This pro forma has been disguised but closely approximates the underlying realities of Lufa's operations.

Appendix An Introduction to Hydroponics

Hydroponics was an ancient gardening technique, dating back to the hanging gardens of Babylon circa 600 B.C.E. The technique was a cultivation method that eliminated the need for soil, and instead used solutions and inert substrates to provide plants with the nutrients required to sustain themselves. Different substrates (the bases on which a plant grows) were used in hydroponics, composed of materials such as coconut fiber (which consisted of ground coconut husks); rockwool (heated, spun rock formed into blocks); peat moss mixed with perlite (which consisted of volcanic glass); limestone; or other substrates.

To provide nutrients for the plant, chemical solutions could be crafted with different formulations for each crop group. The solutions consisted of nutritious elements for the plants, such as nitrogen, phosphorous, potassium, calcium, magnesium, iron, manganese, boron, zinc, and copper in their available ionic forms.

At Lufa Farms, the uptake of the plants' roots was monitored by electroconductivity. PH balances were also closely monitored, which affected nutrient availability. To adjust the pH balance, nitric acid was introduced to the crafted solutions. To distribute the solutions, three independent irrigation systems were used, each with two stock solutions, a batch tank, and a return tank. The batch tank distributed solution to the greenhouse, the solution subsequently flowed to the return tank, and then started again at the batch tank to complete the cycle.

Source: Company documents, Lufa Farms "Greenhouse Production" PowerPoint presentation.

Endnotes

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