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Vertical Farming

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This publication introduces commercial-scale vertical farming and discusses the recent growth of vertical farms in urban areas. It describes the major types of vertical farms and discusses environmental issues with vertical farms. The publication includes a list of the major vertical farms in the United States and lists further resources.

Contents

Interior view of Freight Farms' shipping-container vertical farm. Photo: Freight Farms, www.freightfarms.com

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Introduction: What is Vertical Farming?

Prime agricultural land can be scarce and expensive. With worldwide population growth, the demand for both more food and more land to grow food is ever increasing. But some entrepreneurs and farmers are beginning to look up, not out, for space to grow more food.

One solution to our need for more space might be found in the abandoned warehouses in our cities, new buildings built on environmentally damaged lands, and even in used shipping containers from ocean transports. This solution, called vertical farming, involves growing crops in controlled indoor environments, with precise light, nutrients, and temperatures. In vertical farming, growing plants are stacked in layers that may reach several stories tall.

Although small, residential vertical gardening (including window farms) has been around for decades, commercial-scale vertical farms have only been seriously examined in the United States for the past few years. As of early 2015, the United States had only a handful of commercial vertical farms under operation. But the interest in this new farming technology is growing rapidly, and

entrepreneurs in several American cities are taking a serious look at this innovative farming system.

Types of Vertical Farms

Vertical farms come in different shapes and sizes, from simple two-level or wall-mounted systems to large warehouses several stories tall. But all vertical farms use one of three soil-free systems for providing nutrients to plants—hydroponic, aeroponic, or aquaponic. The following information describes these three growing systems:

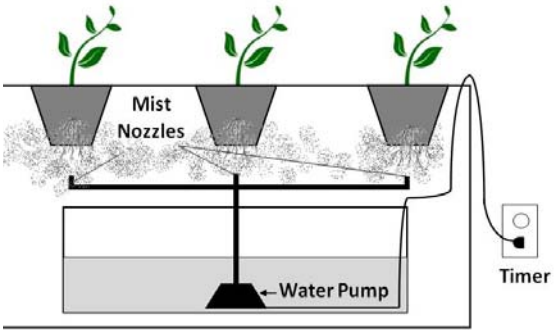
1. **Hydroponics**. The predominant growing system used in vertical farms, hydroponics involves growing plants in nutrient solutions that are free of soil. The plant roots are submerged in the nutrient solution, which is frequently monitored and circulated to ensure that the correct chemical composition is maintained.

2. **Aeroponics**. The National Aeronautical and Space Administration (NASA) is responsible for developing this innovative indoor growing technique. In the 1990s, NASA was interested in finding efficient ways to grow plants in space and coined the term "aeroponics," defined as "growing plants in an air/mist environment with no soil and very little water."

   Aeroponics systems are still an anomaly in the vertical farming world, but they are attracting significant interest. An aeroponic system is by far the most efficient plant-growing system for vertical farms, using up to 90% less water than even the most efficient hydroponic systems. Plants grown in these aeroponic systems have also been shown to uptake more minerals and vitamins, making the plants healthier and potentially more nutritious. AeroFarms, the leading aeroponics vertical farming company in the United States, is currently building the largest vertical farm in the nation in New Jersey (see Case Study 1, page 9).

3. **Aquaponics.** An aquaponic system takes the hydroponic system one step further, combining plants and fish in the same ecosystem. Fish are grown in indoor ponds, producing nutrient-rich waste that is used as a feed source for the plants in the vertical farm. The plants, in turn, filter and purify the wastewater, which is recycled to the fish ponds.

   Although aquaponics is used in smaller-scale vertical farming systems, most commercial vertical farm systems focus on producing only a few fast-growing vegetable crops and don't include an aquaponics component. This simplifies the economics and production issues and maximizes efficiency. However, new standardized aquaponic systems may help make this closed-cycle system more popular.



Aeroponic graphic. Illustration: NCAT

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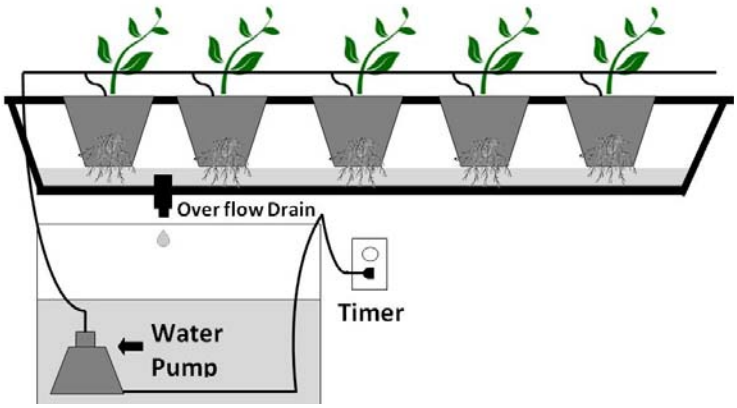
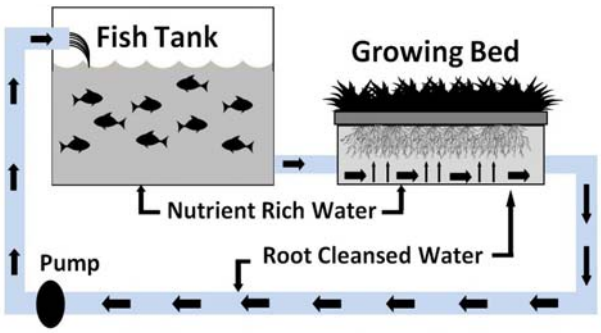


Hydroponic graphic. Illustration: NCAT



Aquaponic graphic. Illustration: NCAT

Vertical farming systems can be further classified by the type of structure that houses the system.

Building-based vertical farms are often housed in abandoned buildings in cities, such as Chicago's "The Plant" vertical farm that was constructed in an old pork-packing plant. New building construction is also used in vertical farms, such as the new multistory vertical farm being attached to an existing parking lot structure in downtown Jackson Hole, Wyoming (see Case Study 2, page 10).

Interior view of Chicago's "The Plant" vertical farm. Photo: Steve Becker, www.cclfchicago.org

Shipping-container vertical farms are an increasingly popular option. These vertical farms use 40-foot shipping containers, normally in service carrying goods around the world. Shipping containers are being refurbished by several companies into self-contained vertical farms, complete with LED lights, drip-irrigation systems, and vertically stacked shelves for starting and growing a variety of plants. These self-contained units have computer-controlled growth management systems that allow users to monitor all systems remotely from a smart phone or computer. Three of the leading companies producing shipping-container vertical farms are Freight Farms, CropBox, and Growtainers (See Case Study 3, page 11).

Interior view of Freight Farms' shipping-container vertical farm. Photo: Freight Farms, www.freightfarms.com

Chicago's "The Plant" vertical farm. Photo: Steve Becker, www.cclfchicago.org

Exterior view of Freight Farms' shipping-container vertical farm. Photo: Freight Farms, www.freightfarms.com

What Are the Pros and Cons of Vertical Farms?

Dickson Despommier, in his book *The Vertical Farm: Feeding the World in the 21st Century,* listed a number of environmental and social benefits of vertical farming. The following is an adaptation of Despommier's major points (Despommier, 2011):

- **Continuous Crop Production**—Vertical farming technology can ensure crop production year-round in non-tropical regions. And the production is much more efficient than land-based farming. According to Despommier, a single indoor acre of a vertical farm may produce yield equivalent to more than 30 acres of farmland, when the number of crops produced per season is taken into account.

The controlled growing conditions in a vertical farm allow a reduction or total abandonment of the use of chemical pesticides.

- **Elimination of Herbicides and Pesticides**—The controlled growing conditions in a vertical farm allow a reduction or total abandonment of the use of chemical pesticides. Some vertical farming operations use ladybugs and other biological controls when needed to deal with any infestations.

- **Protection from Weather-Related Variations in Crop Production**—Because crops in a vertical farm are grown under a controlled environment, they are safe from extreme weather occurrences such as droughts, hail, and floods.

- **Water Conservation and Recycling**—Hydroponic growing techniques used in vertical farms use about 70% less water than normal agriculture (and aeroponic techniques, which involve the misting of plant roots, use even less water).

- **Climate Friendly**—Growing crops indoors reduces or eliminates the use of tractors and other large farm equipment commonly used on outdoor farms, thus reducing the burning of fossil fuel. According to Despommier, deploying vertical farms on a large scale could result in a significant reduction in air pollution and in CO2 emissions. Furthermore, carbon emissions might be reduced because crops from a vertical farm are usually shipped just a few blocks from the production facility, instead of being trucked or shipped hundreds or thousands of miles from a conventional farm to a market. (To many sustainable-farming advocates, the jury may still be out on the climate-friendly claims of vertical farming. Large amounts of electricity are required to provide light and to heat and cool the enclosed growing systems, although new energy-efficient LEDs are being developed that could reduce lighting costs.)

- **People Friendly**—Conventional farming is one of the most hazardous occupations in the United States. Some common occupational hazards that are avoided in vertical farming are accidents in operating large and dangerous farming equipment and exposure to poisonous chemicals.

In spite of these perceived advantages of vertical farms, some agricultural experts are skeptical that the costs and benefits will pencil out. Some think that expensive urban real estate in many cities may rule out vertical farms (although using abandoned warehouses or environmentally contaminated sites may help the economics). And the high electricity usage to run lighting and heating/cooling in a vertical farm impacts the economics. Below is a summary of the perceived disadvantages of vertical farming:

- **Land and Building Costs**—Urban locations for vertical farms can be quite expensive. Some existing vertical farms are based in abandoned warehouses, derelict areas, or Superfund sites, which can be more economical for construction.

- **Energy Use**—Although transportation costs may be significantly less than in conventional agriculture, the energy consumption for artificial lighting and climate control in a vertical farm can add significantly to operations costs.

- **Controversy over USDA Organic Certification**—It is unclear if or when there will be agreement on whether crops produced in a vertical farm can be certified organic. Many agricultural specialists feel that a certified organic crop involves an entire soil ecosystem and natural system, not just the lack of pesticides and herbicides.

- **Limited Number of Crop Species**—The current model for crops grown in vertical farms focuses on high-value, rapid-growing, small-footprint, and quick-turnover crops, such as lettuce, basil, and other salad items. Slower-growing vegetables, as well as grains, aren't as profitable in a commercial vertical farming system.

- **Pollination Needs**—Crops requiring insect pollination are at a disadvantage in a vertical farm, since insects are usually excluded from the growing environment. Plants requiring pollination may need to be pollinated by hand, requiring staff time and labor.

Can Vertical Farms Be Certified Organic?

Farmers value the USDA Certified Organic label—and consumers are often willing to pay a premium price for products that are certified organic. But can crops grown in vertical farms qualify for this valuable certification? There's an ongoing debate about certification between the vertical farming community and organic regulators that set the organic certification standards.

The USDA National Organic Program (NOP) sets national standards for the production, handling, and processing of organic agricultural products. In addition, the NOP oversees mandatory certification of organic production. A National Organic Standards Board (NOSB) advises USDA in setting the standards upon which the NOP is based. Producers who are certified to have met standards set by the NOP may label their products "USDA Certified Organic," as allowed by regulation.

NOSB and USDA have defined organic agriculture as more than just a lack of the use of pesticides, herbicides, and artificial fertilizers. Certified organic crops must be grown in a holistic system. Here's a 2010 recommendation by NOSB for the definition of organic agriculture (NOSB, 2010):

"Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony."

Because soil isn't present in vertical farming production (which consists of hydroponic, aeroponic, or aquaponic systems), a vertical farm would have difficulty meeting this strict definition of organic agriculture, since there is no "soil biological activity." But NOP is now allowing some organic certification agencies to award organic certification to hydroponic operations if those operations can prove they use only organic inputs in their operation and meet other certification criteria.

Some national certification agencies (such as California Certified Organic Farmers) have already certified organic hydroponic operations, while other regional certification agencies are refusing to certify hydroponic and other growing systems that aren't soil-based. The debate over whether crops grown in vertical farms can be certified organic is likely to continue.

What about lighting costs?

Highly efficient Light-Emitting Diodes (LEDs) are used in most vertical farms, with special bulbs that use only the red and blue light spectra, the most beneficial for optimizing plant growth. Eliminating the production of other light waves helps reduce energy costs by as much as 15%.

But even with these reductions in lighting costs, the total electrical bill (and carbon footprint) of a self-contained vertical greenhouse can be substantial. Continued research and development of even more efficient LEDs will help reduce the costs and carbon pollution contribution of LED lighting in vertical farming operations.

Large banks of fluorescent lamps provide the spectrum of light that keeps the floating beds of plants alive year-round in The Plant Chicago, a vertical farming facility. Source: Peter Gray/Harvest Public Media

Funding for Vertical Farms

Obtaining startup funding for any farming venture is difficult. This is especially true for farmers and entrepreneurs establishing a commercial vertical farming operation. However, both public and private financing sources have funded vertical farms in the past few years and, as the technology matures, more investment in this sector is likely. A well-written business plan, including capital costs, marketing approaches, staffing, and customer base is essential to have on hand before seeking funding.

Both public and private financing sources have funded vertical farms in the past few years and, as the technology matures, more investment in this sector is likely.

Speaking at a webinar on vertical farming in May 2015 (Kluko, 2015), Milan Kluko of Green Spirit Farms in Detroit mapped out popular financing options. Kluko's own vertical farm received $250,000 in loans from a Michigan farm cooperative, which had previously funded only traditional agricultural operations. The superior credit risk of the vertical farming operation was key to receiving the loan, based on the concept that indoor farming can be much less risky than traditional farming that is dependent on the vagaries of weather. (Green Spirit Farms produces a consistent 17 harvests of greens per year.)

Other financing options described by Kluko include individual investors who believe in the vertical farming model, private equity sources, and crowdfunding.

Federal and state loan and grant programs, typically available to traditional and sustainable agriculture programs, can also be tapped for vertical farm projects. A recent white paper on indoor crop production summarized these government opportunities (Newbean Capital et al., 2015):

- **USDA Specialty Crop Grant Program**—Vertical farms that partner with a research organization may apply for funding on specialty crop research, as long as the results are shared with the public.

- **USDA Value-Added Producer Grant Program**—Funding is available to vertical farms that can add value to the raw products (such as preparing a basil salad dressing using fresh greens from a vertical farm).

- **USDA Rural Energy for America Program (REAP)** —Vertical farms in rural areas may be eligible for energy-efficiency funding for switching to LED lights. (Note that operations in some urban areas may be precluded from applying for REAP funds.)

- **State-Specific Technology and Workforce Development Programs**—FarmedHere, a container-farm company near Chicago, received a grant from the Illinois Department of Commerce for purchasing LED lights. FarmedHere pointed out in its grant application that LED lights would increase plant yield, which would necessitate the hiring of more employees for harvesting and packing the increased crop.

- **Local Utility Programs**—Incentive programs may also provide rebates for energy-efficiency improvements that could be used in a vertical farm, such as choosing energy-efficient LED lights instead of fluorescent lights.

Conclusion

Vertical farms in urban areas are a relatively new phenomenon, but interest in this approach is growing, and the number of vertical farms in the United States is expanding every year. There are several variations of vertical farms being tested throughout the world, and new innovations and technology will likely increase the energy efficiency and profit margins of these farms in the future.

In the near term, most vertical farms will focus on high-return and short-rotation crops such as salad greens, with nearby restaurants often buying all of the production. Whether vertical farms will become more widespread in America's cities is uncertain, but the innovative vertical farms currently under construction or already in production are being closely observed by urban planners and the sustainable agriculture community.

Vertical Farms in the United States

As of March 2015, there were over a dozen vertical farms operating or under construction in the United States. The number of vertical farms is expected to more than triple by the end of 2016. List adapted from *Indoor Crop Production—Feeding the Future.* (Newbean Capital et. al., 2015)

AeroFarms
Newark, New Jersey
http://aerofarms.com
Vertical farming system based on aeroponics. Developing world's largest vertical farm (69,000 square feet).

CropBox
Clinton, North Carolina
www.cropbox.co
Shipping-container vertical farming system. Offers turnkey subscription plan providing growing media, nutrients, seeds, and support.

Farmbox Greens
Seattle, Washington
www.farmboxgreens.com
Small, enclosed vertical farm in residential setting. Delivers microgreens to local market.

FarmedHere
Bedford Park, Illinois
www.farmedhere.com
Vertical farm growing arugula and basil for local restaurants and the value-added market.

Freight Farms
Boston, Massachusetts
www.freightfarms.com
Founded in 2010, this New England-based vertical farming company uses recycled shipping containers to provide an enclosed growing environment. Mobile apps on smartphones control all environmental factors in the growing space.

Green Spirit Farms
New Buffalo, Michigan
www.greenspiritfarms.com
Vertical farm growing radish, kale, and lettuce, with locations in Michigan and Detroit.

Greener Roots Farm
Nashville, Tennessee
http://greenerroots.com
Hydroponic vertical farm that sells all produce to restaurants within a 10-mile radius.

GrowTainers
Dallas, Texas
www.growtainers.com
Shipping container vertical farming system, complete with mobile apps for environmental control.

Local Garden
Vancouver British Columbia (Canada)
www.localgarden.com
Two-story, 6,000-square-foot building on the roof of a parking garage. Grows microgreens, spinach, and kale.

PodPonics
Forest Park, Georgia
http://podponics.com
Grows the equivalent of nearly an acre of produce in a single shipping container.

The Plant
Chicago, Illinois
www.plantchicago.com
Built in an abandoned pork-packing plant, this vertical farm also uses roof space for a conventional soil garden.

Urban Produce
Los Angeles, California
www.urbanproduce.com
Seeded trays on conveyor-belt system. Produces microgreens, including kale, radish, and cauliflower.

Uriah's Urban Farms
Tampa, Florida
www.uriahsurbanfarms.com
Grows microgreens, lettuce, and other vegetables on vertical walls, often within restaurant space.

Vertical Harvest
Jackson Hole, Wyoming
www.verticalharvestjackson.com
Three-story rotating carousel vertical farm attached to a parking garage.

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Newbean Capital, Local Roots, and Proteus Environmental Technologies. 2015. Indoor Crop Production—Feeding the Future. http://indoor.ag/whitepaper

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Further Resources

Books and Reports

Th e Organic Hydroponics Dichotomy: Can a Soil-less Growing System be "Organic"? 2015. Cornucopia Institute.
www.cornucopia.org/HydroponicsWhitePaper.pdf

This whitepaper from the nonprofit Cornucopia Institute discusses the recent rulings by the NOSB and NOP on whether the term organic can be applied to soil-less systems, such as hydroponic crop production.

Organization

Association for Vertical Farming
http://vertical-farming.net

An international nonprofit organization focusing on advancing vertical and urban farming technologies, designs and businesses. The Association publishes a quarterly newsletter, posts breaking news of vertical farming, hosts a design competition, and sponsors workshops and conferences.

Websites

Agritecture
www.agritecture.com

An excellent source for current information on vertical farming and urban agriculture design, news, business, and jobs.

Seedstock
www.seedstock.com

This social-venture organization fosters the development of robust and sustainable local food systems through consulting services, a news and information blog, and live events. Seedstock works with government agencies, municipalities, and all private-sector stakeholders to create a sustainable food ecosystem of innovation, entrepreneurship, and investment.

Videos

Challenges in Vertical Farming Video Series (19 videos)
www.youtube.com/playlist?list=PLVqaARCrz-m9n57wfUI_5zKsKwa3xci_X

The Robotics Institute
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
412-268-3818

Proceedings from a 2012 workshop that captured the state of the art of vertical farming, defined a research agenda, and established a working group at the nexus of biology, engineering, economics, and architecture. Sponsored by Carnegie Mellon University's Robotics Institute.

Webinars/Podcasts

How to Get Started in Vertical Farming and Urban Agriculture – the Next Big Th ing for Cities. Hosted by David Thorpe, Special Consultant to Sustainable Cities Collective.
http://sustainablecitiescollective.com/david-thorpe/1074146/webinar-roundup-how-get-started-vertical-farming-and-urban-agriculture-next-big

Sustainable Cities Collective
Social Media Today LLC
P.O. Box 1432
Charlottesville, VA 22902
347-674-0890

Urban Agriculture Audio/Podcasts. Hosted by Vincent and Dickson, Professors at Columbia University Medical Center.
www.urbanag.ws
Columbia University Mailman School of Public Health
Department of Environmental Health Sciences
722 West 168th Street
Rosenfi eld Building, 11th Floor
New York, NY 10032-0403

Urban Agriculture is a monthly podcast started in 2014. The podcast focuses on food production within the built environment, including vertical and container farming. The podcasts feature in-depth interviews with many of the world's leading experts in urban agriculture.

Conferences

Indoor Ag-Con
www.indoor.ag

This two-day annual event hosts an international audience of experts who share their knowledge of vertical farming. The annual event is held in Las Vegas (with a second event scheduled in New York City starting in fall 2015). The conference features keynotes from leaders in farming, supplier, technology, and customer sectors.

Case Study 1:

The World's Largest Indoor Vertical Farm Is Coming to New Jersey

By Lauren Rothman
March 24, 2015 / 11:00 am
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A century ago, Newark, New Jersey's Ironbound neighborhood was a bustling center of industry, home to factories that mixed up Benjamin Moore paint, brewed Ballantine beer, and, of course, manufactured the steel and other metals from which the district takes its name. Today, most of the area's industry has dried up, and many of the former factory sites have been converted into modern homes and apartments. But the neighborhood stands to regain some of its productive past with the arrival of AeroFarms, a ten-year-old aeroponics company that's moving into a huge former steel factory to grow level upon level of quick-to-mature, sustainable greens and herbs.

AeroFarms was started in 2004 by Ed Harwood, a former professor at Cornell's School of Agriculture who developed the company's low-waste, high-yield growing system. Aeroponics is both soilless and sunless, and can be thought of as next-level hydroponics: Instead of utilizing gallon upon gallon of water to grow plants, AeroFarms' system sprays plants with a nutrient-rich mist. Seeds are sown, germinated, and grown on reusable sheets of fabric, which are stretched out over trays that are stacked vertically and will fill 69,000 square feet of space in the Newark factory. LED lights stand in for the sun, and their strength is adjusted according to the plants' maturity.

Marc Oshima, AeroFarms' chief marketing officer, says these combined factors make the AeroFarms system much more efficient than traditional agriculture.

"We're 75 times more productive per square foot annually than the field, and even ten times more productive than a hydroponic greenhouse," he says. "We use over 95 percent less water than growing out in the field."

A mockup of a growing room at the new site. Photo: AeroFarms

A mockup of the new vertical farm in Newark. Photo: AeroFarms

"Even versus a hydroponic grower, we're able to use less water and less nutrients, and also have a much faster growing process," Oshima continues. "We can take that exact same seed that, out in the field, would take 30 to 45 days to grow, and we can grow it in 12 to 16 days. We're talking about between 22 and 30 crop turns a year; out in the field, you're lucky if you can get three crop turns."

Aeroponics can be used to grow any type of produce, Oshima says, but over the years AeroFarms has zeroed in on short-stemmed leafy greens, in order to maximize the amount of trays that can be stacked up inside the vertical farm. (Plants like tomatoes and peppers, for example, grow too tall to be efficiently stacked.) The Newark farm will grow hundreds of varieties, Oshima says, and even conventional growers have taken note.

"One of the things that we're excited about is how we can increase access to healthy foods," Oshima says. "And we're creating jobs. We're working closely with the Ironbound Community Center, in terms of sourcing people from the community to work in the farm."

But Oshima sees AeroFarms' highly productive form of farming—the Newark site will eventually produce 2 million pounds of greens annually—as capable of reaching far beyond New Jersey.

"What's exciting about what we're doing is that we're very much helping to address a global issue," he says. "We have increasing urbanization, population increases, food safety, and food security issues. We have a tremendous amount of interest in helping to solve these problems."

Case Study 2:

Vertical Harvest aims for year-round veggies in Jackson Hole & jobs, too

Greenhouse to provide work for developmentally disabled

http://mountaintownnews.net/2014/01/16/jackson-holes-vertical-harvest-greenhouse

Posted on January 16, 2014 by allen.best. Reprinted with permission.

JACKSON, Wyo. – The guaranteed frost-free season in Jackson Hole lasts barely a month, from July 15 to Aug. 16. The average frost-free season is little longer, just 72 days.

Tomatoes? Only with the greatest of luck.

But tomatoes will abound, some 44,000 pounds annually, according to projections for Vertical Harvest, a business that plans to build a three-story greenhouse adjacent to the municipal parking garage in downtown Jackson.

Separated by a two-foot space from the parking garage, the $2.35 million greenhouse will be located on a town-owned rectangle of land 30 feet wide by 150 feet long.

Penny McBride, the project administrator for Vertical Harvest, admits to encountering some skepticism when she broached the idea of a three-story greenhouse. "You gotta be kidding me," some said.

But through innovation and hard work, plus a willingness to sit down and listen to the hard words of skeptics, the idea has emerged as a winner. Construction is projected to begin this spring.

Among the key skeptics persuaded was Wyoming Gov. Matt Mead, whose great-grandparents were cattle-raising homesteaders in Jackson Hole.

In June, Mead voted to approve a $1.5 million state loan for the project. This is on top of $300,000 grant from the town of Jackson.

"The people involved in it had such a high level of commitment," said Mead during a recent tour in Jackson covered by the Jackson Hole News&Guide. "They convinced me."

Vegetables are to be grown year round in the 13,500-square-foot hydroponic greenhouse for sale to restaurants, local grocery stores and directly to consumers.

The project combines the passions of McBride: local sustainable agricultural, innovative buildings and then a social aspect: providing jobs for people with developmental disabilities, a segment of the community that struggles to find meaningful work.

Vertical Harvest projects that the greenhouse will be able to use one-tenth of an acre to produce an equivalent amount to 5 acres of traditional agriculture. Recirculating water will dramatically increase efficiency. Artificial light will be necessary during winter, with a total consumption of 312,000 kWh per year.

In addition to the tomatoes, the greenhouse is projected to deliver 20,000 pounds of lettuce, 44,00 pounds of herbs, 10,000 pounds of microgreens, 7,500 pounds of baby specialty greens, and 4,725 pounds of strawberries.

Of this production, 95 percent is already contracted for delivery to local restaurants and consumers.

Vertical Harvest, Jackson, Wyoming. Photo: Vertical Harvest

Case Study 3:

North Carolina entrepreneurs look to reinvent farming with the CropBox

www.newsobserver.com/news/business/article11316137.html

By David Bracken - dbracken@newsobserver.com

February 28, 2015

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For more than 30 years, Williamson Greenhouses has been a pioneer in using state-of-the-art greenhouse technology to revolutionize how tobacco is grown in the Southeastern U.S.

The company's founder, Burl Williamson, developed a hydroponic growing system that allowed farmers to start their tobacco plants in greenhouses before transplanting them to the field, an approach that greatly increased crop yields and is now standard in the industry.

But as the tobacco industry shrunk in recent years, Tripp Williamson, 31, who is Burl's son and now runs the company, realized that for Williamson Greenhouses to thrive for another 30 years it would need to use its expertise to expand into new markets.

Enter the CropBox. A shipping container equipped with a hydroponic growing system and software monitoring system, the CropBox is designed to give farmers and nonfarmers the ability to grow crops all year. All they need is enough room to place a shipping container on their property.

Coon Rock Farm became the first customer to lease a CropBox, where it hopes to grow lettuce and other crops that it can use for its home delivery service, Bella Bean Organics, as well as its restaurant and its CSA.

"It will grow lettuce in the exact same conditions in February as it will in July," Holcomb said. "From a financial perspective, I'm able to free up an entire greenhouse to do something else in the summer."

The CropBox's origins date to 2008, when Ben Greene developed the idea as part of his master's thesis while attending N.C. State University's industrial design program.

From the outside, the CropBox looks like any other shipping container. But inside it features rows and rows of oasis cubes with 2,800 planting spots. Overhead lighting is provided by high-end fluorescent lights while a 200-gallon reservoir and pump system allows water to circulate. A computer system enables you to remotely monitor the environmental conditions inside the shipping container – the temperature, lighting, water, pH, and CO_2 and humidity levels.

Greene and Williamson say the CropBox uses 90 percent less water and 80 percent less fertilizer than conventional farms, as well as requiring no pesticides. It removes many of the variables – extreme weather, insects – that can reduce a farmer's yields.

"You take the guess work out of it," Tripp Williamson said. "Our biggest thing is to lower the barrier of entry for anybody that wants to be a farmer."

Saudis interested

Greene and Williamson believe the potential market for the CropBox is vast because the world's food needs are growing while the land available for farming is shrinking. Investors from Saudi Arabia have already visited Clinton to check out the CropBox prototype.

Greene said Saudi Arabia, which has a scarcity of water, is eager to find more efficient ways to grow crops, particularly because a head of lettuce there can cost $4.

But the most immediate market for the CropBox looks to be local farmers seeking to make more efficient use of their land.

For Holcomb of Coon Rock Farm, the CropBox offers a solution to the variability of the local food supply throughout the year. Holcomb's Durham restaurant, Piedmont Restaurant, only serves locally-sourced food, but many of his customers want salad in the summer when lettuce doesn't grow very well in the North Carolina heat.

While Coon Rock will start out growing lettuce in its CropBox, Holcomb said he plans to experiment with as many crops as possible.

"This is very much a try something new and figure out how it's going to work," he said. "My gut is that this is going to work out extremely well."

Coon Rock Farm manager Lisbeth Rasmussen walks between racks of hydroponic trays containing bib lettuce in the farm's new Cropbox. Photo: hlynch@newsobserver.com

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