

# Controlled environment agriculture:

**Controlled environment agriculture has the solutions to significant food production and environmental issues. Now it just needs the capital.**

*The* **NEW**  
**asset class**  
*on the block*

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<sup>1</sup> Center for Food Safety and Applied Nutrition, US Food and Drug Administration, FDA Strategy for the Safety of Imported Food, 2019.

<sup>2</sup> FAO, IFAD, UNICEF, WFP and WHO, The State of Food Security and Nutrition in the World 2020: Transforming Food Systems for Affordable Healthy Diets, 2020.

<sup>3</sup> GL Barbosa, FD Gadelha, N Kublik, et al., Comparison of Land, Water, and Energy Requirements of Lettuce Grown Using Hydroponic vs. Conventional Agricultural Methods, *International Journal of Environmental Research and Public Health*, 2015, 12(6), 6879-6891.



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“Like extracting bread from air.”  
In 1908, Fritz Haber’s invention of synthesized fertilizer revolutionized the agriculture industry. Through a process of extracting ammonia from the air for fertilizer use, annual global crop yields doubled overnight. His invention is credited with our ability today to feed billions of people. But new problems are catching up to us.

Here in the United States, we are currently extremely reliant on international imports to meet our produce needs. Coupled with the challenges of affordability and accessibility of labor, much of the country is also incapable of producing outside for the colder half of the year. As of 2020, 53% of all the fresh fruit and 32% of all the fresh vegetables consumed in this country are imported.<sup>1</sup> Increasingly

unpredictable weather patterns are only making the challenges of conventional domestic farming more difficult. Globally, we are still struggling to meet demand for produce. A 2015 World Health Organization study found that only 36% of the global population has adequate availability of fruits and vegetables to meet minimum nutrition targets.<sup>2</sup>

Fortunately, a new wave of technology categorized as controlled environment agriculture (CEA) has the potential to revolutionize America’s food production system once again and help alleviate the greater global deficit of high quality, affordable produce. CEA is proven to increase yields per acre by a magnitude of over 10 times that of conventional agriculture through curation of year-round, ideal conditions and symbiotic micro-ecosystems.<sup>3</sup> Conventionally, these facilities use

hydroponic, aeroponic and aquaponic systems to grow vegetables without soil. This technology allows growers to use exponentially less water and fertilizer than conventional field agriculture. With new innovations in digital monitoring, robotic harvesting, and automated sorting and packaging, the challenges of finding labor are also alleviated. Equally important, CEA avoids the externalities of environmental degradation, which is systemic in conventional agriculture.

Through CEA we are able to produce higher quality crops without damaging the ecosystem. The controlled environment facilitates the elimination of toxic chemicals in exchange for biological pesticides (predators for parasites). Additionally, as facilities move closer to market, breeding programs are able to pivot away from a focus on shelf life (for long-haul shipping) towards flavor, texture and nutritional value. Changes in consumer demand for healthier local food is creating growing demand for CEA and ultimately opportunities for investment in the asset class.

## Overview

Over the last century, conventional industrial farming has had catastrophic effects on the environment. Chemical pesticide use has decimated insect pollinator populations. Monoculture farming, erosion from tilling, herbicides and fungicides have polluted, depleted and sterilized our soils. Excessive fertilizing has polluted our water. It is not an exaggeration to say that the choices we make today will have cascading effects for centuries. The Food and Agriculture Organization (FAO) estimates that 33% of the world’s soil is moderately to highly degraded through erosion, salinization, compaction,

<sup>4</sup> FAO, Polluting Our Soils Is Polluting Our Future, May 2, 2018.

<sup>5</sup> Euan McKirdy, New Study Suggests Insect Populations Have Declined by 75% over 3 Decades, CNN, October 20, 2017.

<sup>6</sup> Maarten Elferink and Florian Schierhorn, Global Demand for Food Is Rising. Can We Meet It?, Harvard Business Review, April 26, 2019.

<sup>7</sup> S2G Ventures, Growing Beyond the Hype: Controlled Environment Agriculture, 2020.

acidification, chemical pollution and nutrient depletion. These degradations hamper the soils' ecological functionality, affecting its food production capabilities.<sup>4</sup> Insect populations have also declined by 75% over the past three decades, largely due to agricultural practices, hampering natural breeding and fruiting processes.<sup>5</sup> The cataclysmic loss of biodiversity is reaching a breaking point that will not be easy to reverse. Therefore, it is critical that we reinvent the way in which we produce our food. Controlled environmental agriculture addresses all of these environmental concerns by creating a closed loop system.

CEA can be classified into three main structures: high tunnels, greenhouses and plant factories. Each has its own benefits and limitations.

- **High tunnels** are the least expensive and most common solution in the market today. At as low as \$3 per square foot in construction cost, they require very little capital to get started. While they are a great improvement over conventional agriculture, they have a short life span, are very susceptible to environmental damages, are less light and heat efficient, and are uninsurable.
- **Greenhouses** average \$35 per square foot at commercial scale and are the most energy efficient form of CEA.
- **Indoor plant factories** — typically what people think of when they think of vertical farming — are highly variable in price (generally between \$100 and \$200 per square foot for new construction), but can essentially be established in any reclaimed building or container. They are very high in climate control efficiency and yields per acre possible (by growing vertically), but are more

### ESG considerations

CEA is a better impact solution than many other popular alternatives. It is often carbon negative. It requires limited use of rare earth metal materials whose mining undermines the true environmental values of many energy-oriented investors. It very poignantly addresses the problems of biodiversity and habitat loss. It decreases agricultural water usage by over 95%. It dramatically reduces shipping waste. And socially, it has the potential to solve global food crises.

limited in what crops they can grow efficiently. Plant factories also require extreme electricity consumption. For example, lettuce crops grown by CEA consume upwards of 350kWh per square foot per year compared to a typical greenhouse's 25kWh per square foot.

The costliest aspect of running any CEA facility is electricity consumption. Not accounting for transportation or increased quality's value proposition, electricity consumption is the biggest barrier today to achieving production cost parity with conventional agriculture. The key to understanding the efficiencies is to look at supplemental lighting efficiency, the cost of electricity and local conditions. Consider this: In New York state, at current electricity prices, even if LED technology was perfected to translate

100% of input energy to light, a greenhouse's use of the sun and supplemental light (instead of 100% artificial lighting) is still more efficient than the benefits of a plant factory's more insulative qualities.

For this reason, choosing the right asset type to invest in for a given location is critical. Are you near the Arctic Circle where natural sunlight is very limited for half the year and temperature lows are extreme? Then a plant factory is likely the correct option. Are you in a generally mild climate state with high electricity costs? Then a greenhouse may be right for you.

### Opportunity

As of today, investment in CEA has reached just over \$2 billion across North America and Europe. The compound annual growth rate for the North American vegetable greenhouse market since 2007 is greater than 20%. In a \$20 billion market, crops from CEA facilities only account for 1.3% of the annual produce consumed in the US. With total food demand expected to increase between 59% to 98% by 2050, CEA's growth potential is exponential.<sup>6</sup> This does not even account for the opportunity of increased produce demand facilitated by improved accessibility; research shows an increase of up to 32% in produce consumption for each additional supermarket in a census tract.<sup>7</sup>

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The barrier for some, and therefore the opportunity, is that these facilities require high upfront costs. In addition to the structures themselves, the intricate hydroponic irrigation systems, robotic equipment and sensory equipment can carry a large price tag. As a plethora of start-up companies race to compete and establish market dominance, they are hungry for capital. As such, many forego ownership of their facilities, instead focusing on their core expertise and leveraging capital towards opening more facilities.

Several developers and investors are capitalizing on this opportunity in a number of ways. The most common is a sale-leaseback. As examples: Equilibrium Capital acquired and leased two greenhouse facilities to indoor agriculture company Revel Green for \$11.3 million. It plans to finance at least three more greenhouse facilities. Another firm, Green Acreage provides sale-leaseback and construction financing to companies operating in the cannabis industry. Green Acreage invested \$77.3 million with Acreage Holdings that entered into long-term, triple-net lease agreements with Green Acreage for properties in California. Other players in the market executing similar strategies include Power REIT, which owns six CEA properties in southern Colorado and Maine with a total of approximately 131,000 square feet of greenhouse and processing space; and Innovative Industrial Properties that focuses on the acquisition, disposition, construction, development and management of CEA facilities across the country.

To better understand the lucrativeness of the opportunity, Innovative Industrial Properties states that their typical absolute net lease terms are 10 to 20 years with base rents at 10% to 16% of

total investment and 3% to 4.5% annual rent escalations. Typical deals range from \$5 million to \$30 million and carry security deposits and corporate guarantees. This compares quite favorably to conventional farmland sale-leasebacks that often have 5-year terms and net around 5% of the purchase price as base rent and escalate 7.5% to 12.5% every term.

Other growers have opted for mixed-use facilities where they can rent rooftop greenhouse space. This allows growers to be in deep urban locations and virtually eliminate shipping expenses. For example, Gotham Greens recently purchased and built a 15,000 square foot greenhouse on a vacant Brooklyn rooftop. Others have chosen to take the concept directly to the literal market. BrightFarms has, to date, signed up eight supermarket chains around the country — including three of the largest national chains — to build these rooftop farms for about \$2 million per acre. The facilities are expected generate \$1 million to \$1.5 million in annual revenue.

International investment continues to be an important funding source for controlled environment agriculture as countries like Saudi Arabia and the UAE look to establish sustainable domestic food systems through the furtherance of the technology. Many CEA growers have gotten their start through partnerships with sovereign wealth funds.

The opportunity is clear; how real estate investors choose to enter the space is up for debate. Funded by \$82 million from Equilibrium Capital, AppHarvest, a 3-year-old start-up, has purchased 366 acres in eastern Kentucky with the goal of leveraging economies of scale. With plans to develop a 2.76 million square foot greenhouse for

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\$97 million, AppHarvest will be one of the largest greenhouses in the world, supplying much of the Eastern seaboard within one day's drive.

## Conclusion

Although CEA has existed for the past decade, technological development and botanical research have greatly reduced the risk and challenges of the business. Digital monitoring and control technologies have simplified running a CEA facility. Concurrently, consumer demand for high quality organics has risen dramatically, creating a bigger market.

As we stand today, the climate crisis has reached boiling point and habitat degradation has pushed biodiversity to the brink. CEA stands as a profitable, sustainable, lower risk alternative to conventional agriculture; its biggest challenge is simply the upfront costs of developing the facilities. ♦

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