AGRICULTURAL FINANCE

Fad or Future: Controlled Environment Agriculture

November 22, 2021

Executive Summary

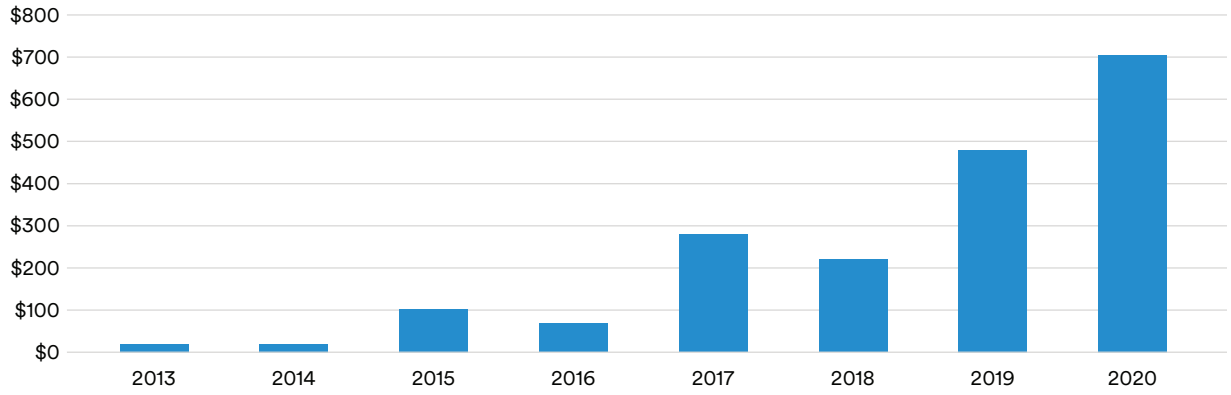
Controlled environment agriculture (CEA) has benefitted in recent years from consumer preferences that increasingly favor sustainability. While the origination of CEA dates back centuries, CEA did not flourish in the U.S. until recently, with output increasing 56% since 2009.[1] The industry is poised to grow further still, due to technological innovation and increased investment in the space. Challenges remain, though, as CEA operators face higher production costs and rising competition from imports. Regardless, we expect CEA to play an increasingly important role in the modern U.S. food system.

MetLife Investment Management

Introduction

Modern CEA combines engineering, plant science, and computer-managed greenhouse control technologies to optimize plant growing systems, quality, and overall production.[2] It encompasses everything from basic hoop houses, to greenhouses, to fully automated and climate-controlled vertical farms. In the past decade investors have taken notice of this innovation and the potential that it holds, infusing over $1.8 billion into CEA (Figure 1).[3] This investment has helped fuel the more than 50% expansion in CEA output in the U.S. since 2009.[4]

Figure 1 | Investment in CEA ($millions)



Source: S2G Ventures, MIM

CEA as Part of the Vision for the Future of Agriculture

CEA's expansion in recent years can be attributed to multiple advantages associated with the practice. Most notably, CEA provides the opportunity for production uniformity as plants grown indoors are not subject to the variability of the outside environment. This allows producers to experiment and optimize growing techniques to increase output, improve appearance, or even raise the nutritional content of the crops.[5,6] Furthermore, operators can locate production closer to consumers, which reduces transportation costs and allows for fresher produce year-round. Finally, water use requirements are generally significantly lower for CEA production, which can reduce irrigation costs in certain drought prone areas (Figure 2).[7]

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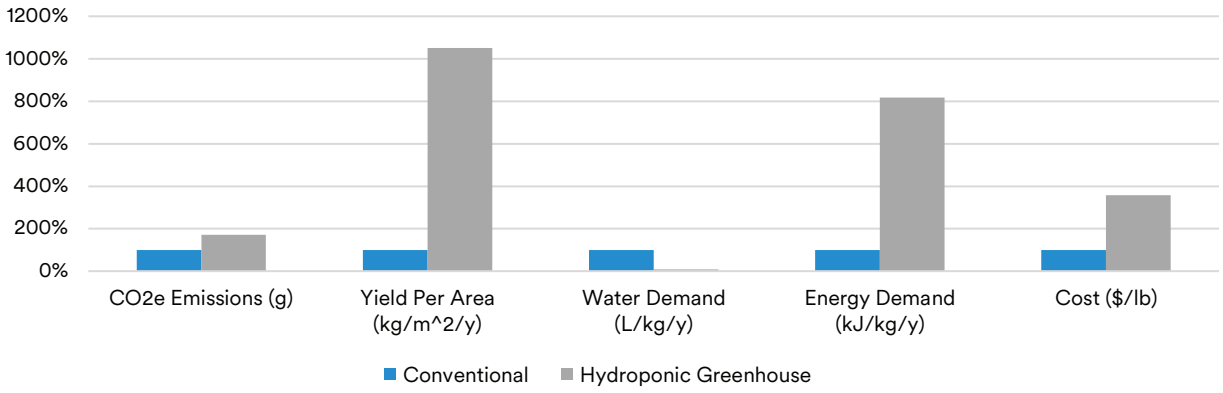
Figure 2 | Comparison of Conventional and Hyroponic Greenhouse Growing Methods



Source: International Journal of Environmental Research and Public Health, Agronomy for Sustainable Development, AgFunderNews, MIM

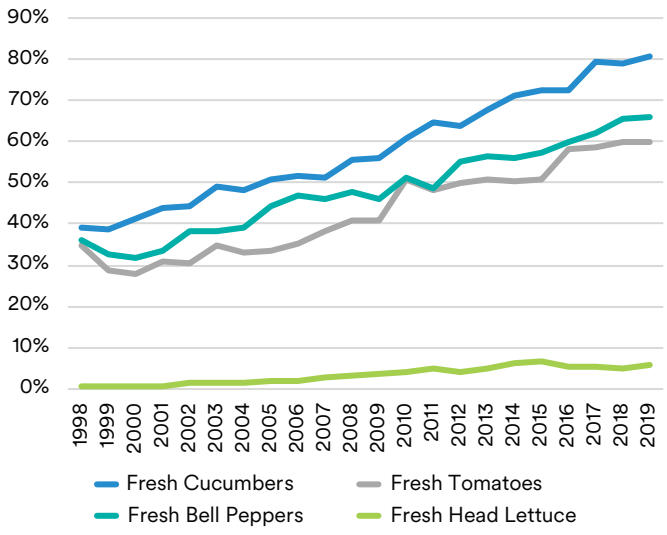
Despite praise surrounding the environmental benefits of CEA, significant hurdles still exist. Among these are higher energy use per unit of production and increased total costs of production.[8] CEA promises to reduce the carbon footprint associated with transportation distances and fertilizer requirements. However, increased energy use, primarily from controlling the climate in the growing environment, currently offsets this entire reduction and more.[9]

The greater energy usage also raises the cost of production above comparable non-CEA production. Cost estimates for growing leafy greens such as lettuce and kale in a hydroponic greenhouse or vertical farm are 358% and 427% higher, respectively, than a conventional outdoor farm.[10] Many experts believe that over time, CEA has the potential to be cost competitive with traditional field agriculture as operations scale and with technological advances.[11] As an example, heating costs in CEA floriculture have decreased 85% from 2006 to 2020.[12] This trend suggests heating costs in other CEA systems may have decreased similarly during that timeframe.[13, 14]

U.S. Vegetable Producers Look Abroad for New Opportunity

The United States Mexico Canada Agreement (USMCA), and the earlier NAFTA agreement, opened the door for competitively priced crops from Canada and Mexico in the domestic market. In 1998, 21% of the U.S. supply of crops grown in CEA (cucumbers, bell peppers, fresh herbs, lettuce, and tomatoes) were imported. Today, that figure has grown to 53% as Canada and Mexico have increased export volumes to the U.S.[15] With over 4,200 acres, Canada has more than doubled the CEA growing area as the U.S. and is now a world leader in the industry.[16] U.S. vegetable producers have noticed the success of their northern neighbors, and many have turned to CEA to compete with imports through differentiation of their product and to capture the associated price premium.

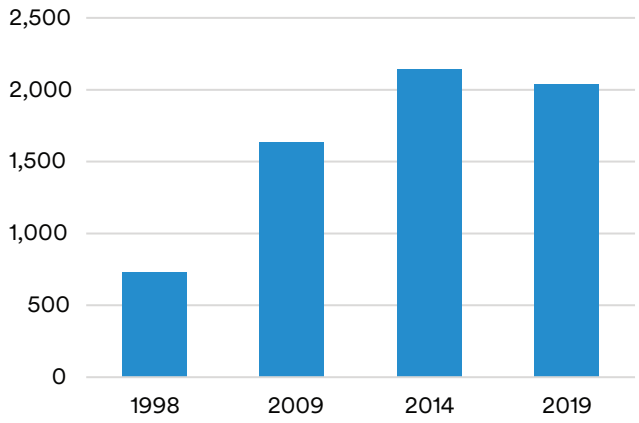
Figure 3 | U.S. Imports as a Percent of Total Supply



Source: USDA, MIM

CEA's domestic area under production for a number of vegetable crops expanded as well (Figure 4).[17] Crops that were historically produced in CEA such as tomatoes and fresh herbs have seen gradual increases in production over the past 20 years while emerging crops such as lettuce, peppers, and strawberries have seen excellent growth in CEA production (Figure 5).[18] This increase is primarily due to improved technology and growing methods that have more than doubled CEA yields for many crops since 2009.[19] Further improvements to CEA practices continue to attract more growers and investors to the space as it is recognized as a viable farming method.

Figure 4 | U.S. Area Under CEA Production (Acres)



Source: USDA, MIM

Figure 5 | U.S. CEA Production: Year-over-Year Growth (2009 - 2019)

Vegetable	
Tomatoes	1.49%
Cucumbers	4.62%
Peppers	25.39%
Strawberries	10.09%

Sources: USDA, MIM

CEA Grows into the Mainstream

U.S. CEA companies have combined knowledge from international production, burgeoning investment, and robust technological innovation to break into markets typically dominated by conventional, outdoor growers. NatureSweet is the largest greenhouse grower in the U.S. with over 1,600 acres of greenhouses in North America, primarily producing popular varieties of snack tomatoes.[20,21] NatureSweet has found a route to profitability through marketing a differentiated, higher quality product at a price premium (Figure 6). Similarly, Gotham Greens—a New York based greenhouse company that primarily produces leafy greens across the U.S.—has employed innovative renewable energy practices to mitigate increased energy requirements and costs to create a viable CEA model. Interestingly, the COVID-19 pandemic

Figure 6 | CEA Over Convential Premiums Paid (2021)

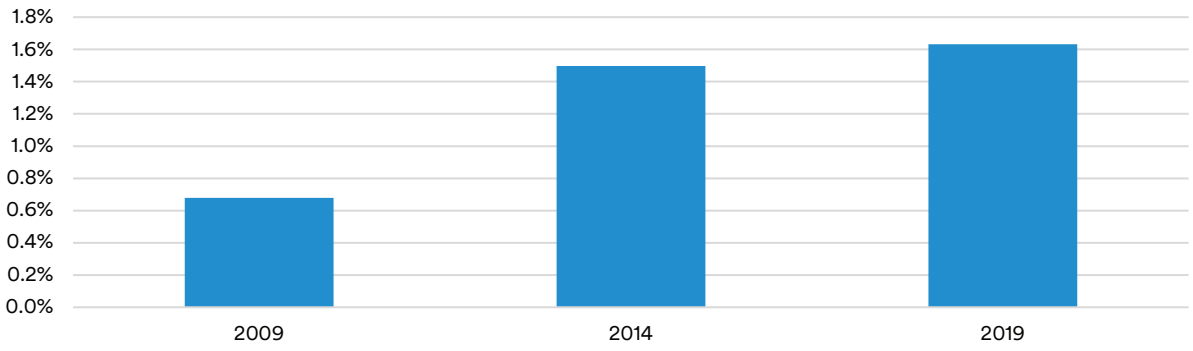
Grape Tomato	Arugula	Bell Pepper
$0.13 $/oz premium	$0.16 $/oz premium	$0.03 $/oz premium
52% % premium	26% % premium	4% % premium

Source: Walmart, Whole Foods, Kroger, Albertsons, Target, MIM

served as a boon for Gotham Greens as its greenhouse production model proved more flexible than that of open-field producers, allowing the company to adjust to fractured supply chains.

This level of investment will help improve technologies and scale economies as the CEA industry aims to get operational cost parity with conventional producers. Increasingly efficient greenhouse hardware will also advance the environmental sustainability of CEA, helping propel the industry toward being part of the future of modern agriculture. While CEA may never fully replace conventional field agriculture, it has developed into a viable and profitable production option for several crops.

Figure 7 | Percentage of U.S. Production in Greenhouses



Source: USDA, MIM

Endnotes

1 USDA NASS, Census of Horticulture, December 2020
2 NYSERDA, Controlled Environment Agriculture, 2020
3 S2G Ventures, Growing Beyond the Hype: Controlled Environment Agriculture, 2020
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6 Plant Physiology and Biochemistry, Plasticity of photosynthetic processes and the accumulation of secondary metabolites in response to monochromatic light environments: A review, September 2020
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10 AgFunderNews, The Economics of Local Vertical & Greenhouse Farming are Getting Competitive, April 2019
11 S2G Ventures, Growing Beyond the Hype: Controlled Environment Agriculture, 2020
12 Nominal Costs Adjusted for Inflation
13 Rutgers University, How much Does It Cost To Grow a Greenhouse Crop?, 2006
14 American Society for Horticultural Science, Production Costs and Profitability for Selected Greenhouse Grown Annual and Perennial Crops: Partial Enterprise Budgeting and Sensitivity Analysis, March 2020
15 USDA ERS, Food Availability (Per Capita) Data System, March 2021
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18 USDA NASS, Census of Horticulture, December 2020
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21 The Produce News, New Campaign to Highlight NatureSweet's Growing Standards, January 2017

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