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Vertical Farms Must Trim Costs, Hone Business Models to Achieve Profitability

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Inside…

Key Points:

- In recent years, investors have put billions of dollars into indoor vertical farming, a subsector of controlled environment agriculture (CEA), to produce and distribute food closer to urban consumers.
- However, cash flow has been impaired by high upfront investment and operational costs, namely labor and huge energy expenses, coupled with the inability to capture premium pricing. Weak cash flow has been a significant impediment in attracting traditional types of financing to vertical farms, thus forcing them to rely on venture and private capital funding.
- Successful vertical farms have invested outside the grow house in technologies to not only increase productivity and quality of produce, but to also increase efficiencies in warehouse management and distribution.
- Industry consolidation appears to be the ultimate outcome. Survivors will have sufficient funding to outlast competitors through extended periods of negative cash flow and will be able to acquire the liquidated assets of competitors exiting the industry.

Introduction

Although the concept of growing food indoors is not new *(Exhibit 1)*, investment in growing crops indoors in vertically stacked layers has ballooned in recent years. The idea of growing food closer to consumers in urban markets and under precisely controlled conditions (which minimize inputs such as water, nutrients, and chemicals, while also reducing the potential for food borne pathogens) has gained momentum over the past six years as part of the effort to raise the sustainability and reduce the carbon footprint of agriculture. The labor, health, and supply chain issues created by the COVID-19 pandemic has driven even more new consumer and investor interest.

According to the financial data and research firm PitchBook, startups in this fast-growing segment of controlled environment agriculture (CEAs) raised more than $1.6 billion globally across 70 deals in 2021, up 86% more than the total capital

raised in 2020. Numerous research firms project the industry will expand globally at an estimated compound annual growth rate (CAGR) of nearly 10%-20% or higher by 2030 *(Exhibit 2).*

Vertical farms are often touted as the solution to numerous challenges facing production agriculture. The high-yielding form of crop production via climate-controlled facilities is often seen as the answer to labor tightness in production agriculture, bringing more reliability to food production in a world with rising population and increased weather variability tied to climate change. Increased traceability, lower risk of food recalls, and the year-round production of food with higher consistency and quality and a longer shelf life are also cited as powerful incentives to relocate produce production away from remote farm fields to vertical farms in population centers.

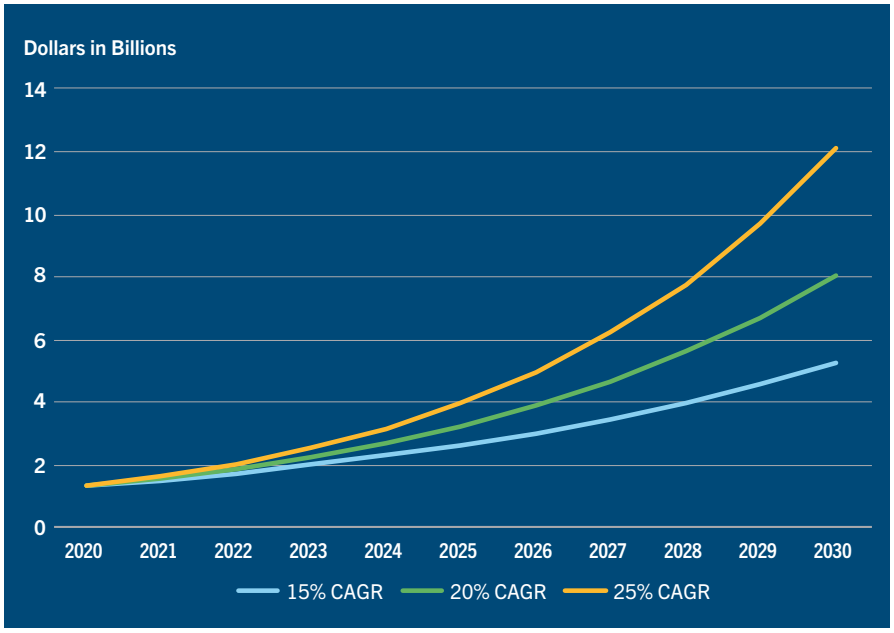
However, vertical farming operations have high capital requirements. Costly technologies hamper their cash flows, and vertical farms still require manual labor and produce crops at a smaller scale, putting them at a cost disadvantage to traditional outdoor farms. Internal analysis by CoBank along with other published research show that most vertical farming operations have yet to demonstrate profitability. This raises questions about not only the viability of the many new entrants, but also how future vertical farms

EXHIBIT 1: Vertical Farming Companies Operating in the U.S. Today

Company	Year Founded
Hydrofarm Holdings (California)	1977
Village Farms (Canada)	1989
AeroFarms (New Jersey)	2004
Gotham Greens (New York)	2009
Bright Farms (New York)	2011
Freight Farms (Massachusetts)	2011
Plenty (California)	2013
Bowery Farming (New York)	2015
80 Acres Farms (Ohio)	2015
AppHarvest (Kentucky)	2017

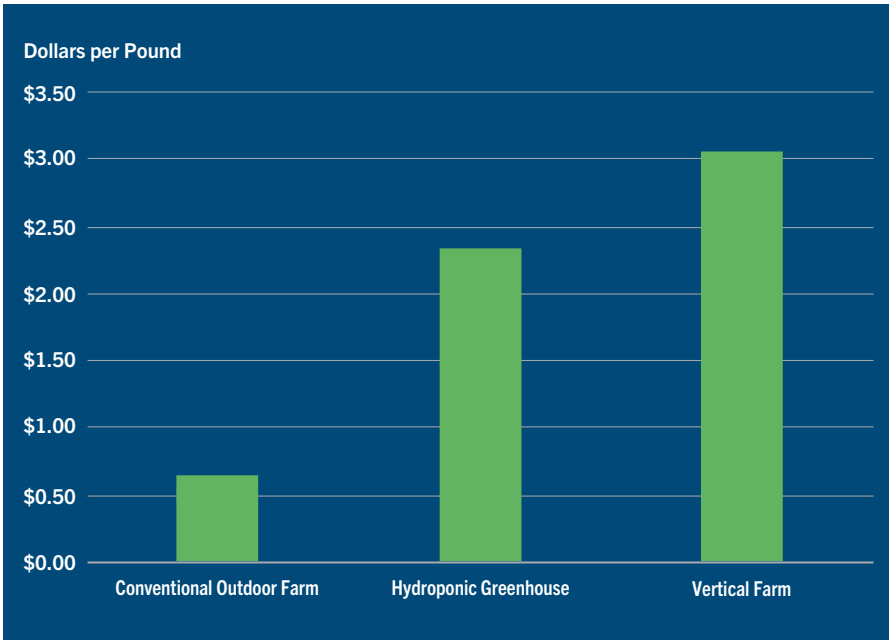
Sources: Company websites and Crunchbase

EXHIBIT 2: Estimated Growth Scenarios for U.S. Vertical Farming Revenues



Sources: Statista; CoBank ACB

EXHIBIT 3: Breakeven Cost of Production to Grow and Deliver Greens



Source: AgFunder

must evolve to achieve financial sustainability. Survival in the industry will require strong financial backing, lower technology and energy costs, efficient distribution, and potentially reimagined business models.

Technology and Cost

High investment and operating costs are the albatross of vertical farms. Real estate property located closer to urban centers also raises initial investment costs. A single large-scale vertical farming facility may cost more than $100 million in construction costs alone, according to industry estimates. It should be noted that technology costs tend to fall long term, and farms can locate to urban regions with distressed property values or local government financial incentives.

By its very nature, optimizing plant growth in vertical farming requires immense investment in technology and energy to control growing conditions including temperature, light, humidity, oxygen, and CO2 levels. Capital expenses include LED lights and robotics, and technology for monitoring crop health and growing conditions, such as AI, computer systems, and cameras. Nascent technologies such as hydroponics that allow plants to grow in solutions of nutrients rather than soil, and aeroponics that grow plants in a mist environment with no soil and very little water, are currently very high-cost growing methods.

And, all of this technology spells heavy reliance on electricity for lighting and natural gas for climate control – costs that will likely be markedly higher moving forward due to the rapid growth of the U.S. natural gas export sector.

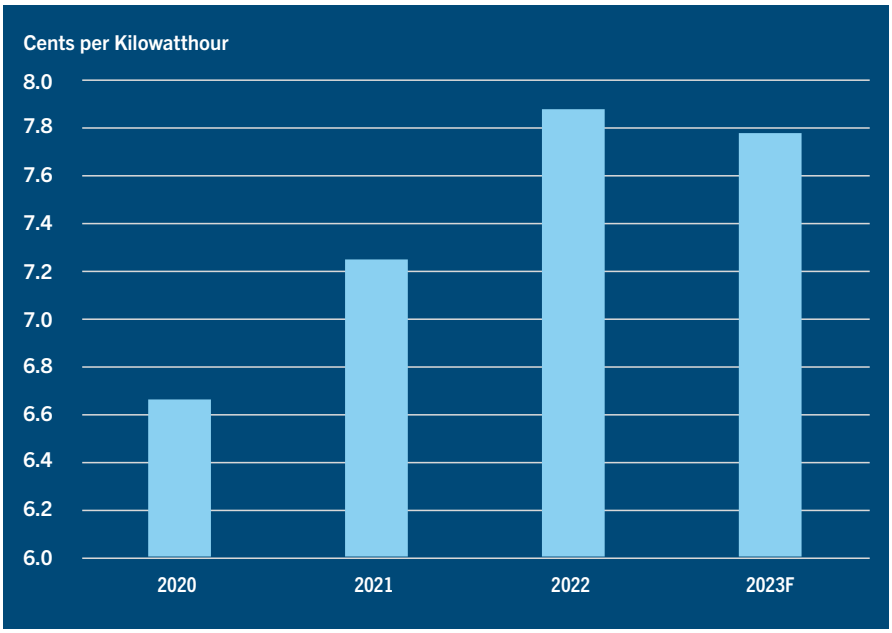
To cover the high costs, vertical farms maximize throughput by focusing on crops like leafy greens and herbs that have short growing periods from seed germination to harvest. However, recouping the high investment and operating costs through high volume production of commodity crops appears elusive for most vertical farms.

Sector Realignment

The high upfront costs and high energy needs of vertical farms often means the payback period for an investment may take many years. According to AgFunder, vertical agriculture's breakeven cost of production per pound of leafy greens is $3.07/lb, compared to only $2.33/lb for greenhouses and $0.65/lb for conventional outdoor farming *(Exhibit 3).*

To date, few vertical operations have shown positive cash flow despite the shorter transportation distances, higher volume of throughput when compared to outdoor crop production, and lower fertilizer, pesticide, and water usage. Prices for produce grown in vertical farms are not always competitive at retail compared to produce from traditional outdoor farms, and distribution methods may be cost prohibitive. In a sign of financial stress in the sector, indoor farming saw seven exits in 2021 with an estimated value of $737.1 million, according to PitchBook.

EXHIBIT 4: Electricity Prices Paid by Industrial Sector



Source: EIA Short-term Energy Outlook

Amidst the current rapid cost escalation in energy, labor, and capital goods, existing vertical farms face an uphill battle to constrain costs while scaling up production and jostling for market share while consumers are focused on food prices. Vertical farms are also competing against farmers in traditional produce growing regions in the U.S. and Mexico where land and labor costs are lower, and advanced technology is reducing labor and other inputs. And unlike "center of the store" grocery items, cost-plus pricing or guaranteed annual pricing is uncommon in the retail produce space.

The Heavy Cost of Energy

Energy comprises about 50%-70% of the cost of goods sold for vertical farms, according Barclay's. Total energy use for a vertical farm averages 38.8 kWh per kg of produce (roughly 2.2 lbs.), based on surveys gathered by the 2021 Global Controlled Environment Agriculture (CEA) Census. That is about seven times the average of traditional greenhouse operations, which is 5.4 kWh per kg of produce.

Complicating the outlook for vertical farms, electricity prices are not expected to drop in the foreseeable future *(Exhibit 4).* Even as fuel prices begin to moderate, an aging power grid in the U.S. will require upgrades and repairs in the years ahead, assuring a future of elevated power costs. Further raising alarm over the future of the vertical farming space, 41% of CEA firms surveyed for the Census do not track data on energy usage – a red flag signaling the industry may not be prepared for higher energy costs that most analysts are projecting in the years to come.

Renewable energy sources like solar power, which continue to fall in cost, are often cited as a solution for vertical farms to lower power costs while simultaneously improving environmental sustainability. However, renewable energy comes with resource demands and environmental costs. Roughly 3-4 acres of solar panels are needed to produce one megawatt/month of electricity, according to IEEE Journal of Photovoltaics. For the sake of comparison, a vertical farm producing 25,000 pounds of produce per month would need about 1.5 acres of solar panels to source all of its power needs.

Pathway to Profitability

Given the high risks, vertical farms that do not demonstrate positive cash flow will have to rely on venture capital financing rather than debt financing to survive extended periods of negative cash flow. Can currently unprofitable vertical farms become cash flow positive, let alone generate positive returns to equity in time of escalating costs of capital?

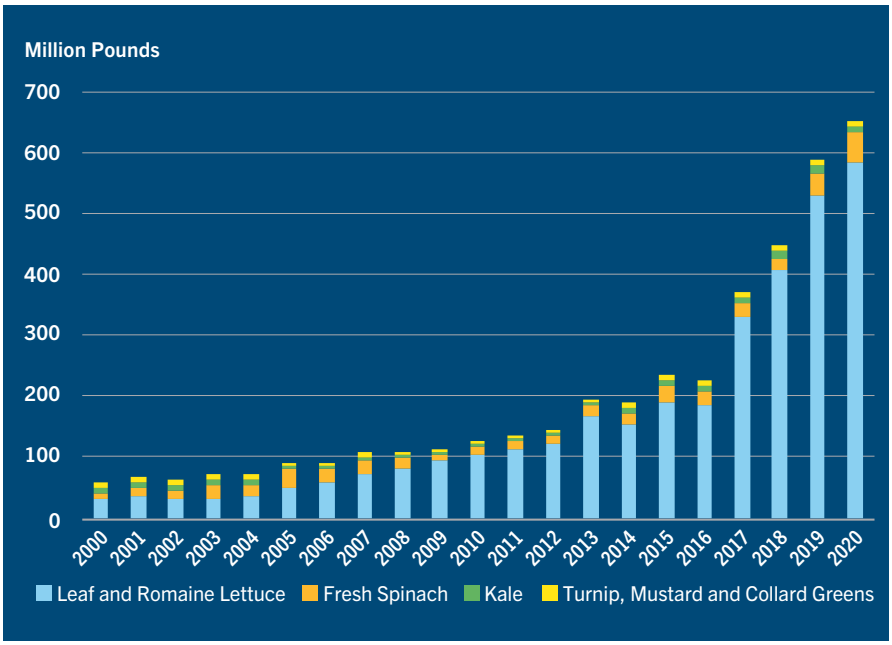
While few vertical farms have yet to show it, there are viable paths to profitability. Survivors that have sufficient and reliable financing will be able to acquire the low-cost liquidated assets. Successful vertical farms will also need to have a strong marketing pitch and brand-name recognition to command a premium price, all while being cost efficient in production and distribution. While researching this report, it became clear that firms that

did turn a profit not only invested in the right technologies to grow food, but also invested in technologies that enhance the efficiency of distribution and inventory management. These factors are critical given considerable price competition in the fresh produce space and the inability for most vertical farming brands to extract a premium price. Vertical farms producing leafy greens also face rising import competition. From 2015 to 2020, leafy green imports into the U.S. rose 177%, with imports coming primarily from Mexico and Canada *(Exhibit 5).*

Vertical farms could potentially achieve greater revenue via higher-value fruiting crops like tomatoes and berries. However, diversifying from leafy greens and herbs to fruiting crops will require much more energy and also result in less production throughput volume, as these crops have longer growing periods. Genetic engineering could increase quality and productivity, though that seems to run counter to the desires of the generally more affluent customers that purchase these items.

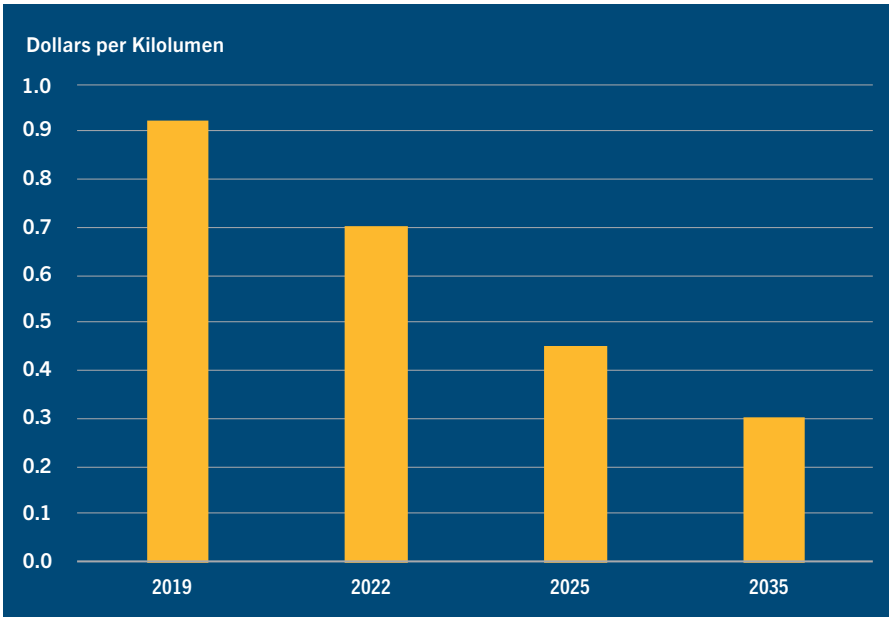
Energy demands could be partially offset by renewable energy sources like solar and wind which are expected to keep declining in cost. However, vertical farms usually lack the square footage needed to host a solar array or wind farm that would meet all energy needs.

EXHIBIT 5: U.S. Leafy Green Imports



Source: USDA-ERS

EXHIBIT 6: Price Forecast for Warm White LED Lamps in the U.S.



Source: Statista

Other technology costs like LED lighting systems are expected to decline in the years ahead, but moving forward, the reduction in LED costs will be incremental rather than revolutionary. According to Statista Research Department, by 2025, warm white LED lamps are projected to cost approximately $0.45 per kilolumen and by 2035 cost $0.30 per kilolumen *(Exhibit 6),* lowering the fixed costs of LED lights by one-third.

Jumping the energy hurdle will take creativity and innovation. One example is co-locating the growing operations within the grocery store to take advantage of a constantly controlled temperature environment that is already a fixed cost for the food retailers.

Outlook

Rather than seeing growth in the vertical farming space, consolidation appears to be imminent for inefficient vertical farms lacking debt financing options. Investment from venture capital is more suitable at this stage as most companies could fail to deliver returns above their cost of capital.

To survive, vertical farms will need strength in scalability, distribution, branding, and strong financial backing, all while being innovators of new business models and finding higher-value crops. They will need to invest in technologies both inside and outside of the grow house, focusing on lower energy usage, faster throughput and lower distribution costs. With many technologies still early in development, perhaps advances will eventually allow vertical farms to achieve true sustainability, both environmentally and financially.

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