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The Rise of Vertical Farming

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The sky is the limit: In 1999, Columbia professor Dickson Despommier used the term “vertical farming” to describe a

system of agriculture in which crops are grown indoors on vertically stacked platforms. His students imagined skyscrapers with lush greens, bursting from the sides of city buildings and providing hyper-local produce to dense urban centers.



In the two decades since then, vertical farming has grown up in unexpected—yet promising—ways. In fact, according to the most recent P&S Intelligence report, the total vertical farming market size in 2021 was \$3.98 billion and this number is expected to grow 25.2% annually to reach \$30.2 billion by 2030.

Although each vertical farm is uniquely built to overcome local challenges and to meet specific goals, the advantages of farming vertically are universally evident: space efficiency, hyper-locality to consumers and water conservation stand out among a plethora of benefits. Energy-efficient LEDs have made controlled environment agriculture (CEA) a viable option for commercial growers around the world. Vertical farming—in many ways—is the obvious next step up.

Pictured: The industry-leading efficiency of the RAZR Modular System ensures a competitive edge in both cost savings and high-intensity performance.

Earth is the limit

Roughly 12,000 years ago, agriculture birthed the oldest cities and the most powerful empires on Earth. The domestication of wild crops, and the storing of cereals and grains allowed population centers to develop, grow and specialize beyond hunting, gathering and herding. However, for much of human history, farmers have been at the mercy of their location, environment and pests.

In ancient Egypt, farming was limited to the short stretch of fertile black sand on each side of the Nile River. In Mesopotamia, flat floodplains forced the growing cities to build irrigation ditches, canals and high circular walls. Indeed, in every part of the world, humans have learned to adapt to their environmental conditions by innovating new ways of agriculture. This fact is evidenced by a great diversity of agricultural forms, from rice

paddies cut into mountain slopes to flat fields of wheat.

Soil is the limit

Our ancients understood that arable soil requires nutrients. By rotating crops that take different elements from the soil, growing near volcanoes and river deposits, or fertilizing with organic matter and nitrogen-giving trees, our ancients preserved their farmlands and yielded greater harvests to feed their growing cities. But ancient cities were small by today's comparison. Even Rome—by far the largest city in the ancient world—contained a population of perhaps 1 million people, which is equivalent to modern-day San Jose, Austin or Jacksonville.

To feed a world population of 8 billion, modern agriculture has been made possible by innovations in chemical engineering, particularly the synthesis and infusion of nitrogen in soil. One example is Nitrate, which is a common inorganic ion found in plants that's required for proper growth and development, and absorbed through roots from the soil and water around them. Its primary role in plants is to make proteins, which have many functions, such as producing proper foliage, chlorophyll and flowers.



Pictured: Despite economic uncertainties and an ever-changing agricultural landscape, consumer demand is putting even greater pressures on leading growers to go vertical.

Despite such innovations, soil remains a limiting resource for many parts of the world. Arable land scarcity is the result of a range of human and climatic factors, including degradation, climate change, soil constraints, urban encroachment and unequal land distribution. According to the Global Land Assessment of Degradation, nearly 2 billion

hectares worldwide have been degraded since the 1950s (representing 22% of cropland, pastures, forests and woodlands). Climate change promises further loss of arable land.

Imagination is the limit

Vertical farming offers solutions in places where good soil is limited, where sunlight is rare or where the weather is harsh. In addition to innovations such as nitrogen-enriched soil, agriculturists have formulated entirely new mediums and systems that allow plants to grow without soil altogether.

Hydroponics is the method of growing food in mineral-rich water, which eliminates exposure to soilborne diseases and pests. In the same vein, aquaponics combines the knowledge of aquaculture (fish farming) with hydroponics to utilize the symbiotic relationship between fish and plants. Such methods of growing food in water are thousands of years old, but new facilities are being built within cities to provide the advantages of water-based agriculture.

Aeroponics is a relatively new method that was devised by NASA in the 1990s to grow food in space. Aeroponics uses neither soil nor water as a medium. Instead, nutrient-rich solutions are misted or sprayed onto the roots of plants, which remain suspended in the air or affixed to columns or trellises. This method was developed to conserve hyper-limited water, weight and—ironically—space in space stations.

Still, these resource-conserving methods of agriculture are proving more useful for the growing cities on our home planet.

Space is the limit

Vertical farming is a viable solution to the rising global population and the diminishing of arable land. By growing upwards and utilizing the full dimensions of available space within city limits, vertical farms are providing fresh produce in places where commercial agriculture was—at one point—impossible.

The overwhelming majority of vertical farms are indoor facilities with LED lighting that utilize either two-tier or three-tier racking systems. Conversions from single to multi-tier operations exist, but remain atypical. More often, new facilities are built to optimize vertical farming and utilize the full benefits of prime location, limited space and resource efficiency.



Pictured: By growing crops within large population centers, Bowery Farming allows communities to access produce within days of harvesting, rather than weeks.

A popular trend among growers is to use vertical racks during propagation before transplanting the crops into a more traditional greenhouse format. This method is prudent because it enables full environmental control during the most delicate and formative stages of plant growth, while utilizing already-existing greenhouse structures during the

later stages.

Unique innovations in vertical farming have far exceeded the original dreams of agriculture students. From “vertical vending machines” to Local Bounti’s “Stack-and-Flow” hybrid model, which combines vertical and hydroponic farming, growers are pushing the limits of what’s possible with access to new technologies and an ever-larger web of information and resources.

Bowery Farming is not only realizing the early dreams of urbanized vertical farming, but also revolutionizing what it means to deliver fresh food to the table. By controlling every step of the growing process and tailoring technologies to specific crops, their operations are reimagining farming from the ground up. By growing crops within large population centers, communities can access produce within days of harvesting—rather than weeks. This new kind of agriculture has been commended by experts for growing tasty, sustainable and safe produce indoors.

Light is the limit

To succeed in a competitive market, a business must gain many small advantages that add up to a big difference. This is especially true in commercial agriculture, where competition is fierce and the margin for error is leaf-thin. [Fluence](#) understands how to make every step count. Whether reducing cost and waste, or maximizing yield and quality, success is balanced on a razor’s edge.

Lighting accounts for 25% to 30% of the total cost of vertical farming (CAPEX and OPEX), which is why Fluence’s lighting designers and horticultural specialists work with a grower to realize the potential advantages of their grow. It’s critical that cultivators employ the correct strategy and deploy the best equipment from the outset to ensure optimal plant quality and yield. The industry-leading efficiency of Fluence’s RAZR Modular lighting system for vertical farms ensures a competitive edge in both cost savings

and high-intensity performance. This is the area within vertical farming where it's critical to choose the right partner.

The horizon of agriculture is vertical farming

Industry experts and recent studies agree that vertical farming looms large on the horizon. Despite economic uncertainties and an ever-changing agricultural landscape, there remains an even greater pressure that's leading growers to go vertical: consumer demand.

As global population and urban density continue their steep and synonymous climb, vertical farms are sure to follow. Current predictions that the vertical farming market will triple to \$30 billion could very well be underestimated if consumer demand for hyper-local produce increases with accessibility and affordability.

There's no such thing as a fool-proof plan, but when we prepare for everything, we're fully proofed. Your success is our success.

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