Journal of Academic Inquiry and Knowledge Volume 2023 (1) 150-158

ISBN 979-8-218-21662-7

THE PROMISE OF VERTICAL FARMING

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The environment is delicate and highly vulnerable to the harmful activities that humans have been engaging in for centuries. While most of these activities are beyond the average person's control, it is crucial to understand why they are causing specific effects. Agriculture is vital to society, but it is dominated by industrial farming, which has led to concerns about the future of agriculture. To ensure the sustainability of agriculture, farmers must consider alternative practices such as vertical farming, which shows great promise. If we continue with the detriments of industrial agriculture, we will soon be left with depleted soil. Future generations will resent us for leaving them with a barren wasteland. The fear of an impending apocalypse, characterized by the frantic efforts of scientists to save the world from our actions, can be traced back to both Agricultural Revolutions. However, despite the bleak outlook, vertical farming offers a promising alternative to industrial agriculture that should be fully used to move away from harmful farming practices altogether.

What is Vertical Farming?

Vertical farming offers a viable solution to the problems created by industrial agriculture. This farming technique uses existing technology in modern cities to cultivate and monitor crops, plants, and animals in controlled urban environments. With this approach, farming no longer has to be confined to vast plots of land in remote areas but can occur right in the city's heart. By adopting vertical farming, cities can become self-sufficient in producing food instead of relying solely on imports. These farms are often referred to as "farms of the future," as they leverage cutting-edge technologies and build on the resources that are already present within society.

Vertical farming is not just a theoretical concept for a dystopian future but a practical solution pursued by scientists, engineers, architects, and others worldwide. There are currently three types of vertical farms that come to mind when thinking about the subject. The first type is located within large, tall buildings in urban areas. The second type is found on the rooftops of various buildings and apartments, while the third type is a large-scale development of the first type (Al-Kodmany, 2018). These vertical farms are designed to be located within urban environments to enable local food redistribution. With the United Nations projecting that by 2050, 80% of the world's population will live in cities, accessibility to fresh produce becomes a critical concern (Al-Kodmany, 2018).

Additionally, mega-cities already occupy around 2% of the Earth's land surface and are home to millions of people (Banerjee, 2013). Vertical farming takes advantage of urban spaces and utilizes high-story buildings as an alternative to sprawling acres of land. Such buildings can produce whatever type of fruit or vegetable is in demand or is necessary to grow, regardless of the season (Banerjee, 2013).

Vertical farming conserves as many nutrients as possible throughout the agricultural process, regardless of its form. The environment where produce, plants, and animals grow is

strictly controlled and monitored, with factors such as light and water intake precisely calculated. In this controlled environment, LED technologies provide light, and they have a limited environmental impact due to their low levels of thermal radiation. The buildings themselves are designed to maximize space, with an indoor acre equivalent to 4-6 outdoor acres or more (Banerjee et al., 2013). These farms are equipped to grow and sustain large quantities of food in a minimal amount of space and with little harm to the surrounding world.

Current Industrial Agricultural Practices

Currently, the industrial agriculture sector dominates the farming industry worldwide. This industry prioritizes efficiency and cost-effective processes to meet the demand for food, allowing people to consume what they want when they want. The roots of this industry can be traced back to the agricultural revolutions, which brought institutional changes and modernized farming methods, leading to a long timeline of change and impact (Floud & McCloskey, 1994). However, while industrial farming methods were once necessary to sustain life centuries ago, the case is different today.

Industrial farming methods require finite resources such as land, labor, production quotas, environmental space, and market access, which have always been beyond human control (van der Ploeg, 2010). However, the limited availability of arable land is a particular challenge. Repeated use of specific plots of land damages and depletes the soil, making it difficult for farms to reuse the same land. The availability of suitable land for farming, or arable land, is critical to agriculture, and its relationship with food security deserves serious consideration (Tsiattalos, 2013). Unfortunately, every minute of every day, more than an acre of arable land is lost to development in the United States, with over 23 million acres of agricultural land lost to development from 1982-2007, an area equivalent to the size of Indiana. Over a million acres of

farmland are lost annually (Tsiattalos, 2013). Globally, projections show that agricultural land can only increase by another 2% by 2040, with a current low of 11% worldwide.

Furthermore, as people move to cities, urbanization has resulted in high-density areas, further shrinking agricultural land (Banerjee, 2013). This lack of stability is concerning, particularly as the world population is projected to exceed 9 billion people by 2050 (Al-Kodmany, 2018). Population growth and urbanization will halve the available land base by 2050, while 80% of the world's population is expected to reside in cities (Tsiattalos, 2013; Al-Kodmany, 2018). In addition, the transportation of produce from farms to cities will become more complex and expensive, exacerbating the challenges of feeding the world's population.

The world is facing a decline in essential resources like water, soil, and land due to the detrimental effects of industrial farming. Agricultural irrigation alone accounts for over 70% or about two-thirds of annual water use, much of which is unnecessary or wasted (Water and Agriculture - OECD, n.d.), leaving little water for other vital purposes. Soil, another essential resource, is also in danger due to industrial agriculture's history of destroying arable soil. Heavy machinery and other farming techniques focused on efficiency instead of longevity result in soil degradation and erosion (Horrigan et al., 2002). This is alarming since soil forms slowly over time, taking anywhere from 20 to 1,000 years to form just one centimeter, with 1% of the world's topsoil eroded annually (Horrigan et al., 2002). It is vital to conserve these precious resources, given their scarcity. Therefore, taking necessary measures to prevent industrial farming practices from further damaging and depleting them is crucial.

Considering all these factors, it is more suitable to seek alternative technology to compensate for the damages done/continue to be done by the industrial agriculture sector. Technology continues to advance every day, and innovation is expected from the minds of

individuals seeking solutions to problems that could harm the entire world. Therefore, an alternative solution must be presented to minimize the harmful effects of industrial farming.

Vertical Farming is a Better Solution Than Industrial Agriculture

Taking the logistical factors regarding realism into account, vertical farming promises to feed the world. It becomes clear that vertical farming aligns more with the future we need. Climate change has been a hot topic for a while now, with multitudes of conservation-type campaigns becoming the norm amongst all the fear and desperation consuming everybody. Vertical farming considers all the factors contributing to climate change and environmental degradation and aims to eliminate that through sustainability methods before anything.

One of the most attractive aspects of vertical farming is the increased human intervention in the agricultural process, which can help assuage skepticism about the idea. Natural land is finite and unpredictable, which makes growing food in controlled environments run entirely by humans more reliable. Factors such as excess rain, drought, and natural disasters can be eliminated in these controlled environments. Additionally, almost all of the energy used in the process is supplied through renewable resources like geothermal or solar arrays rather than fossil fuels, which are harmful to the environment and are primarily used in industrial agriculture (Banerjee, 2013). The building process is also cheaper than residential high-rise buildings, as these high-rise buildings in the cities would not require residential amenities.

Vertical Farming's Impact on People's Current and Future Lives

A future of vertical farms holds immense potential, particularly for those residing in urban areas. Cities are projected to grow in population density over the next 25 years, making food accessibility an increasingly pressing concern that vertical farms are uniquely poised to address. Mega-cities, such as Tokyo, New York City, Shanghai, and Los Angeles, require

efficient food supply chains to meet the needs of their inhabitants. In many cities, food deserts are prevalent, affecting low-income families who lack access to grocery stores within a reasonable distance. With the establishment of more vertical farms worldwide, transporting produce from farms to stores will become easier and cheaper, making fresh and healthy food more accessible to urban residents. While the costs of produce from vertical farms might be high initially due to the technology and resources required, food prices will likely rise in the long term as natural resources become scarcer.

In addition, there would be a significant increase in employment opportunities for people in the neighboring areas. Vertical farms require human intervention to function optimally. Apart from internal operations, there would be job openings in engineering for the technologies employed and architectural guidance to build and design the farms to fit into their unique environment. These opportunities are all equally essential job sectors in the vertical farming industry.

Conclusion

Continuous innovation and care should be given to the future of agriculture and be of utmost priority. Industrial agriculture has harmed and continues to harm the environment in several ways, and its negative impact will increase as time goes on. Vertical farming is a solution that aims to limit the practice of industrial agriculture by utilizing large high-rise buildings to create an environment that allows for the growth of all kinds of produce all year round. This "curated" and "artificial" method aims to protect the longevity of food rather than taking away from its natural essence. Agriculture is not environmentally conscious, which is still the case with industrial agriculture. While it may continue to be used for its efficiency and cost, it is not a sustainable option. Once the Earth is depleted of its nutrient-rich soil and clean water for

agriculture, it could lead to an insurmountable crisis. However, vertical farming will delay this reality as much as possible. With further integration of the farms into cities, we can create an ecosystem full of thriving organisms and enriched natural resources. The gradual shift towards vertical farming will also increase employment opportunities, including internal farm work, engineering for the technologies used, and architectural guidance to help build and design these vertical farms to suit their unique environments. With the utilization of different ideas in this ever-developing process, we can create a future of agriculture that is sustainable, efficient, and environmentally conscious.

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