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Brazilian agribusiness: Investment in vertical farming as a competitive advantage

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ABSTRACT
Agriculture is one of the main economic activities in the world, it has been growing strongly with its strategy of ensuring the availability of food, guaranteeing an important source of income. Faced with the global challenge of growing food for a growing world population, the world's largest agricultural producers have secured a significant increase with different technological investments over time, diversifying field production in recent decades. Vertical farming, used mainly in large urban centers, has been seen as the technology of the agronomic future to meet consumer demands. During the development of the article, some research methods were used, such as documentary, field research and economic-financial information, as they present advantages such as: standardization of the crop and root environment, drastic reduction in the use of water, better control of vegetative growth, greater production, quality and precocity, in addition to greater possibilities of mechanization and automation of the crop. Thus obtaining high rates of return. It can be concluded, then, that these technologies come in the sense of positioning themselves as a solution to the main problems that arise in agriculture, lack of land for planting, for example, soil in inadequate conditions, population growth, global warming, pollution, and food waste. From this, the purpose of this work is to address the main innovations brought by technological innovation to agriculture.

Keywords: Agriculture, Technology, Mechanization, Business

1 INTRODUCTION

With the advancement of scientific knowledge and techniques of studies on the natural environment, the alarms about the impacts generated by human activities on its industrial development have increased. The elaboration of studies related to ecology and its diffusion as an area of knowledge contributed to increase the number of scientists who pointed out the harmful effects of the evolution of societies and their savage capitalism.

With the arrival of new technologies in the field, the world's agricultural activity has entered a new phase: modern agriculture! This began with the First Industrial Revolution, at the end of the nineteenth century, and was marked by the evolution of agricultural production systems and the change in rural production patterns. Currently, technology in agriculture is multidirectional, acting in several

areas of agribusiness, aiming to develop more productivity in the fields, using modern and intelligent agricultural management. This agricultural technology helps producers to have more income, in parallel to this they can keep the field productive through more efficient agricultural practices.

One of the techniques that can increase the productivity of the field, using the minimum of chemical fertilizers (so historically used through traditional methods such as crop rotation), aligning it with more modern methods, such as monitoring the yield of the field using agricultural technology and satellite images (its use occurs in spatial applicability, as it uses software to track agricultural performance remotely and even offline) as well as the advent of new Technologies, agriculture can only gain, and new energy technologies, finally, are a great ally of the rural sector, bringing growth and economy.

This production model, based on the constant incorporation of technology, in addition to continuous scientific research, tends to evolve at an increasing speed, as different innovations are incorporated by the farmer. When analyzing the evolution of the human species, in 1960 there were three billion people, in 2021 there were approximately 8 billion (WORLD BANK, 2022). By 2050, eight out of ten inhabitants of planet Earth will live in cities, by then, the UN indicates, the world population is expected to increase and reach 10 billion (PASTROE 2019). To ensure that so many people have access to food from crops around the world, without further compromising the planet's scarce resource capacity, modern agriculture is committed to sustainability, which involves its entire food production chain.

To feed them, maintaining current practices, it will be necessary to have 1 billion hectares of new land, equivalent to 20% of the Brazilian territory, in 2018 80% of the soil suitable for agriculture was compromised, a curious point is that 15% of it is spoiled, devastated by improper use (PASTROE 2019). To overcome this problem, one of the solutions lies precisely in the growth of cities, with the increasing use of cultivation technologies, practices have been developed that, until recently, were uncommon: such as vertical cultivation inside buildings, containers, and sheds.

The main objective of this study is: is it feasible to implement more companies in the vertical farming circuit? Aligning the answer to this central question, it will seek to make an analysis of the segment (in the Brazil-World axis), as well as to identify the main companies already existing, to understand their importance and contribution to the segment, in addition to the technologies used, also presenting data from vertical agriculture to support the study. Given the importance of agriculture for the global population, this article has a central importance and justification for the debate on whether or not to invest more in Brazilian agribusiness in the coming years.

From this this work it is necessary, to understand more comprehensively its importance, this work is divided into five parts, namely: the first is this introduction on the theme and the main points analyzed in this perspective; in the second part, agriculture in Brazil and its importance for the

Brazilian economy and for supply in the world will be contextualized, in the third part, the reader will be presented with the world of vertical agriculture and its main companies and businesses; In the fourth point, the data of the segment that supported this research and, finally, the fifth and last topic, the final considerations about the study will be presented.

2 AGRICULTURE IN BRAZIL

It is known that agricultural activity is one of the most important in the Brazilian economy, because, even though it contributes only 5% of the Brazilian GDP (Gross Domestic Product) today, it holds almost R$100 billion in export volume (together with livestock), according to data from the Secretariat of International Relations of the Ministry of Agriculture. Livestock and Supply (SRI/Mapa, *apud* COSTA E SENA, 2021). Agricultural production in Brazil, therefore, is one of the main factors responsible for the values of the country's trade balance, and this can be seen throughout history, the agriculture sector in Brazil, and its various cycles and transformations.

From the sugarcane economy in the sixteenth century, based mainly on the production of sugarcane during the colonial period, to the recent transformations and expansion of coffee and soybeans in Brazilian agriculture, Brazil has become one of the main agricultural producers in the world, today following such technical transformations, mainly with the use of technology, from the twentieth century onwards, how the mechanization of production and the modernization of activities made the country stand out around the world.

In recent years, Brazilian agricultural production has developed in such a way that Brazil will be the great supplier of food in the future, and not so far away, because today there is an agriculture adapted to tropical regions and a legion of rural producers aware of their responsibilities with the environment combined with food production. Due to the growing production in the Canary Islands, the prices of Brazilian products have drastically reduced the prices of global food, improving the health and quality of life of the urban population, freeing up their purchasing power for goods produced by industry and the service sector.

Such modernization of Brazilian agriculture is directly associated with the industrialization process that took place in the country during the first 20 years of the 21st century, a factor that was responsible for a reconfiguration of the geographic space and territorial division of Brazil. In this new panorama, the advance of these industries, the growth of the tertiary sector and the acceleration of the urbanization process have placed the countryside economically subordinated to the city, making it dependent on industrial techniques and productions (machinery, equipment, pesticides, etc.) that are increasingly verticalized.

Therefore, in these times of scarcity of fertile land and climatic limitations, part of the solution to the depletion of the countryside, the fight against hunger (which still reigns in a large part of Africa,

for example, according to the UN (2022)) and the search for a more sustainable world necessarily passes through urban farms, especially the so-called vertical farms, whose concept was developed, at the end of the twentieth century, by Dickson Despommier (DUARTE, 2022). He says that vertical planting can be allocated anywhere in the world and allows the cultivation of the most consumed edible plants, which are essential for a balanced diet, still following the premise that in a short time there will be no arable land to feed everyone.

3 THE VERTICAL BUSINESS

With the help of scientific research and new technologies, from 1970 onwards there was a leap in production in agriculture. As a result, there was an intense process of modernization of production chains, which generated an expansion of Brazilian agribusiness. Today, the eyes are on the future: new policies and solutions have been allies to cultivate an agriculture that feeds the world in a sustainable way, in Brazil, one of the great agricultural producers on the planet, urban vertical farms are also emerging. This planting model combines the advantages of traditional agriculture with the sustainability of organic farming (DUARTE, 2022).

According to Forbes (2022), vertical farms are expected to triple their market in five years, jumping from $3.31 billion in 2021 to $9.7 billion in 2026, according to the report. Brazil is beginning to understand the potential of this new agriculture, even if it is still a start, with small actions, given the size of the market, but vertical agriculture is already gaining its market in the country, according to Pastore (2019) there is already a greater demand than the supply, however more space is needed for production, so there is a need for new investments in this field, Because it is still new, it needs to invest in technology.

This technology in agriculture is also a multidirectional vector of work in modern agribusiness, which, in addition to seeking to increase the productivity of fields and using an intelligent management approach, also seeks to help farmers increase their income while keeping the field productive through efficient and intelligent agricultural practices. This approach increases field productivity with minimal use of chemical fertilizers through traditional methods such as crop rotation and more modern methods such as field yield monitoring using agricultural technology and satellite imagery, special applications or software to track agricultural performance remotely and even *offline* (SERGIEIEVA, 2022).

The concept of vertical farming itself comes from a common method of producing vegetables indoors, but in climatic conditions, as well as light, and conscious use of water (and other scarce natural resources) for the planting process, carefully controlled. The idea behind the concept is to use automated installations that, with the help of technologies, aim to cause the least possible environmental impact and considerably increase the production of agricultural products. The great advantage of this type of agricultural activity is that it does not depend on large horizontal and flat

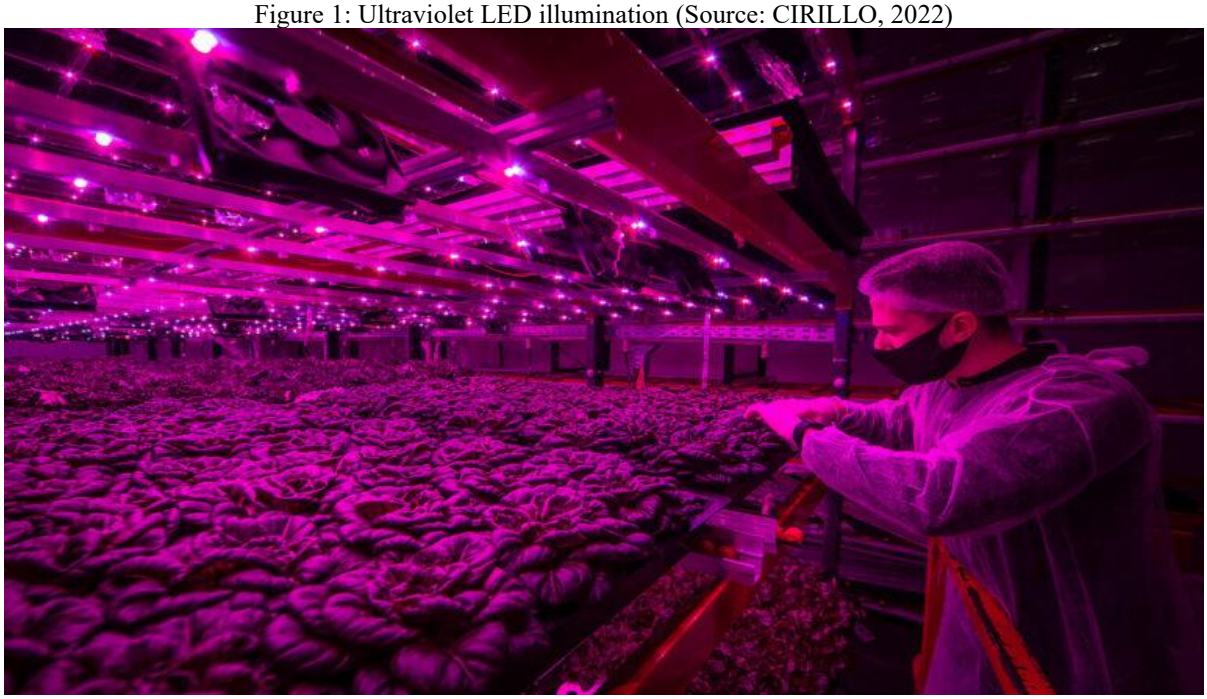
spaces. The term "vertical" is used due to the fact that this production can be done on floors, that is, on several planes (OKAMURA, 2019).

Still in the digital technologies used in vertical farm complexes, as they are usually located in urban centers, the probability of having connectivity to the network and with higher speeds is much higher than in traditionally agricultural regions, this is another point in favor of its development, because with *Iot* (English term for the Internet of Things) data can be integrated into the farm management system, facilitating managers' decision-making on a day-to-day basis, opening new doors to the market (OKAMURA, 2019). It is also possible to obtain a large amount of digital information about the planting crop, data such as temperature, humidity, pH of the water used, concentration of nutrients used in the water, all can be obtained and used in an easier way than in traditional agriculture. Because it is done in a controlled environment, as previously mentioned, in addition to not having so much influence from climatic and external factors that can hinder data extraction.

Another point to highlight in its cultivation is the use of robotics, which deals directly with the manufacture and use of robots, obtaining precision in results, faster production, increased operational yield, efficiency and low labor costs. There are still a number of resources that can be used in vertical planting, which still lack more studies and data, but have their growing debates among researchers, such as the NFT System (*Nutrient Film Technique*), which is a form of hydroponic cultivation, where plants are tilled having their root system inside a channel (or hydroponic profile): in it, its roots are in contact with the nutrient solution composed of water and nutrients, that is, there is a constant flow of this nutrient solution (SERGIEIEVA, 2022).

Last but not least, solar panels and LED lights complement the technologies used for vertical production. The solar panel is the essential equipment to generate photovoltaic energy, this in agriculture is an option that encompasses several advantages such as: reduction of operating costs in the sector, which can be high, in addition to optimizing the processes that are carried out by producers, regardless of the size of their farms. Finally, LED light, which has the role of artificial lighting, acting to increase the exposure of plants to light, with the aim of ensuring that they do more photosynthesis and, consequently, develop better and faster (EDUARDA, 2018). Therefore, these LED lights have the advantage that they do not heat up and, therefore, do not burn the plant, they can even help, because they produce a specific photosynthetic light, which imitates the sun, and allows the plants to produce the necessary sugars. Its use in commercial buildings is expected to grow at an annual rate of 6.9% until 2028 - a rate that could reach 32% among food producers (DUARTE, 2022).

Figure 1: Ultraviolet LED illumination (Source: CIRILLO, 2022)



4 THE NUMBERS THEMSELVES

From the previous explanations, it is easier to understand how important this sector has become for the development of modern agriculture, with a sustainable and ecologically correct focus. According to data from Forbes (2022), vertical farming has enabled an entirely new food supply chain, from farm to fork and from order to delivery and invoice. This global vertical farming market was valued at $3.47 billion in 2021, reached $4.16 billion in 2022, and is expected to grow to $20.9 billion in revenue by 2029 (Forbes, 2022).

Thanks to the improvement of tools, already explained above, vertical cultivation allows gains along the entire production chain. According to Pastore *apud* Epóca (2019), by 2025, the vertical farming sector is expected to move US$ 9.6 billion, growing at a compound annual rate of 21.3%, according to an April 2019 report by the American consulting firm Grand View Research (PASTORES, 2019). New technologies are at the base of this movement, so they are numbers that delight investors, and even with the reduction in 2020, due to the Covid-19 Pandemic, which affected several initiatives with logistical interruptions and a decrease in demand, the sector began to recover at the end of 2021 (DUARTE, 2022). Another point that favors this industry is the growing awareness of hygiene and safety, with the concept of the *low touch economy*, which also increases the demand for vertical farming and its products, says the cited report.

Among the production systems in vertical farms, some stand out, such as hydroponics, as well as the types of installation/structure that can be containers or even buildings. Although less common, cattle ranching also has examples of vertical farm production. Such is the case with the world's tallest

vertical farm for pigs, which opened in China last year. The building has 26 floors, is located in Hubei province and started production in September (DUARTE, 2022).

To assess the growing importance of the segment, in July 2018 there was a contribution from the Japanese group SoftBank, investing US$ 200 million in Plenty, an American company founded in 2014 by Matt Barnard, the *startup* grew vegetables and fruits in six-meter-high towers, forming huge walls of mustard, lettuce and tomatoes (PASTORE, 2019), being the first major investment in the segment.

The five largest agricultural producers in the world are China, the United States, Brazil, India and Russia, such agronomic nations have invested in different technologies, which has ensured a significant increase and diversification of field production in recent decades, in first place is the United States. Due to its continental territorial extension, the country is also one of the largest agricultural producers in the world and, added to the fact that it is one of the largest economies, the reason for its positioning as first on the list is justified. Brazil has been standing out in the commodity export market, in 2020 alone, agribusiness accounted for more than 20% of GDP, accounting for half of Brazil's exports (FAO, 2022).

The vertical farming market is growing, attracting investors, and is expected to reach nearly $10 billion by 2025. Thanks to the digital transformation, urban farms are an important part in the search for sustainability in the countryside, this enthusiasm around vertical farming is understandable. Indoor farms have so far proven to be more profitable than horizontal, open-field farms. Starting with space savings and productivity gains.

Especially in Brazil, in 2017, a group of engineers founded *Pink Farms*, in the capital of São Paulo, being the first and largest vertical urban farm in Latin America, it is installed in a shed next to Marginal Tietê. As the crops are protected from bad weather and pest attacks, food grown *indoors* does not require the use of pesticides. In these urban farms, business is no longer guided by the rhythm of the seasons, but by the technologies available, and the strength of agriculture 4.0 can be seen, which can be seen in the most appropriate planting for each species, it is high-tech photosynthesis in food production, with a higher concentration of vitamins and minerals compared to products grown outdoors (EXAME, 2022).

Compared to open-field farms, the productivity of verticals, square meter per square meter of land, is undoubtedly higher, but they still require space. According to Professor Dickson (DUARTE, 2022), to feed 50 thousand people, the farm should have a height equivalent to 30 floors and a base the size of half a block, for the city of São Paulo, for example, 244 buildings would be needed. For the consumer, products from vertical farms are still expensive, about 10% to 15% more than their open-field counterparts. Compared to organic, however, they tend to be 15% to 20% cheaper. "Cost can be a limit today," agrees Dickson. "But the time will soon come when they will be subsidized by

governments, so as to ensure healthy and sustainable food for all citizens, in all countries" (DUARTE, 2022).

For now, theoretically, everything that grows on the land could be grown in a vertical farm, but this is where the financial point of view comes in, which currently, can be an obstacle to building a vertical plantation, because chronologically speaking the technologies to plant in vertical farms have just been invented. But according to enthusiasts of the vertical cultivation model, it is only a matter of time, it may be a few years, according to Duarte (2022), five years ago, experts said, vertical farms as they are known today would have been unthinkable, but something has changed.

5 THE BUSINESS CHAIN AROUND THE WORLD (AND ITS ADVANTAGES!)

In Miyagi, Japan, lettuce plants grow at a fast rate, up to 40 times faster than in traditional fields, due to the use of LED lamps, in a partnership with biologist Shigeharu Shimamura, the 17,500 lamps used in the plantation were manufactured to the exact length to speed up the growth of the plants, this *high-tech* plantation Miyagi was built in a factory abandoned during the 2011 tsunami, and 10,000 lettuce plants are produced every day in its more than two thousand square meters (PASTORE, 2019). At this point it is curious to imagine a crop without land, but when visiting a vertical farm, everything is more sanitized.

In the configuration of agribusiness 4.0, vertical farms play an important role, but they are far from being the panacea for all the ills of the countryside. With the technology available today, for example, crops are still restricted to vegetables and some vegetables and fruits. Because in it the cultivation is done by hydroponics - a technique where the nutrition of the plants comes from a mixture of water and essential salts. However, with recent studies, new technologies are able to accurately determine the necessary amounts of each of these ingredients (DUARTE, 2022).

For the same reason, as they do not require the use of land, in vertical farms, water expenditure represents only 5% to 1% of consumption in conventional plantations (PASTORE, 2019). Another point is that they are in the cities, getting closer to consumers and the costs of logistics and transportation decrease – and the emission of pollutants as well. But not only that. By burning steps, the wastage rate of the products greatly reduces. According to Geraldo, from *Pink Farms,* in the traditional model of agriculture, 40% of the production of hardwoods spoils on the way between the field and the distribution and sales points, mainly due to poor packaging and/or lack of adequate packaging (DUARTE, 2022).

According to Pastore (2019), in the Svalbard archipelago, Norway, very close to the North Pole, concerned about the emission of CO2, emitted by ships and planes that deliver goods to the city, in addition to the excessive use of plastic, the American Benjamin Vidmar founded the *Polar Permaculture*, a sustainable farm on ice, producing vegetables, growing *microgreens*, vegetables in a

young state, with a high nutrient content and intense flavor. Elsewhere on the planet, north of Seoul (North Korea) there is the *NextOn* With an area of 2,300 square meters, under the command of Choi Jae-bin, a vertical farm produces vegetables (there only 16% of the total area is used for agriculture and, in the last four decades, the rural population has been reduced by half, bringing population growth to 40%) (PASTORE, 2019).

In Asia-Pacific, companies involved in vertical farming are investing and expanding their operations, the cited report mentions the company *Sustenir Agriculture* (in Singapore), which launched a 30,000-square-meter hydroponic vertical farming facility in *Tuen Mun*, Hong Kong, in November 2019. Even there, because it is a densely populated country, with limited availability of land for cultivation, the production of conventional agriculture is not enough to meet local demand and, therefore, the country depends heavily on imported products. To reduce such dependence and reduce food waste in the transportation process, vertical farming is the solution offered, resulting in the expansion of farms by companies in the region (PASTORE, 2019).

According to Rasmus Bjerngaard, co-founder and CEO *of Nextfood*, a vertical farm based in Copenhagen, the capital of Denmark, this new food supply chain is efficient and isolated, not extracting natural resources, not wearing down the soil, using little water and does not compromise the biosphere (no carbon footprints), and does not contaminate water or use pesticides (FORBES, 2022). It can be seen that to solve the problem of enough space to grow food and preserve nature, by decoupling food and nature, and integrating it with food production with nature as a true circular/regenerative food production, is that, there are already 'beef' without cows, precision fermentation and vertical farming on the market, which is proposed.

In Brazil, agribusiness has been recognized as a crucial vector of economic growth, in 2020, the sum of goods and services generated in agribusiness reached R$ 1.98 trillion or 27% of the Brazilian GDP. Among the segments, the largest share is in the agricultural sector, which corresponds to 70% of this value (R$ 1.38 trillion), livestock corresponds to 30%, or R$ 602.3 billion, as for international trade, 48% of Brazilian exports, in 2020, were agribusiness products (CNA, 2021).

There is also a strong contribution of agribusiness to the performance of the Brazilian economy, as a result of the contemporary challenges in the domestic and international markets, the destinations and diversity of products exported by Brazilian agribusiness have increased significantly, which favors investment in more vertical farms, which end up helping to protect agricultural crops from climate change, increasingly influential with major climate change. due to global warming. Of course, other factors can negatively influence the design of vertical farms, such as possible impacts on cities and even some nuisance that may cause planting in urban areas – such as noise pollution at different times or even problems arising from the use of water from the treatment system in cities.

6 FINAL THOUGHTS

From the research on the urban vertical farms market, it is concluded that it is suitable and recommended for the future, if cultivated in a sustainable and technological way, not negatively compromising the planet. These vertical hydroponic ventures consciously target the needs of their customers in the healthiest way possible as a priority, thus resulting in hydroponic products that are produced through the NFT system in a greater proportion because it is an urban vertical farm, all made in a shed that does not shine natural sunlight and only LED lights that have all the nutrients that plants need for their photosynthesis process.

From the analysis of the researches, it is possible to observe the necessary aspects to make this type of construction possible: the environmental comfort strategies used, which support areas are necessary and how the external climate is not one of the most relevant aspects for the projects, due to having a machinery that contains all the necessary systems to replace the natural climates. thus nurturing all the needs of the plants. As presented, Brazil has a great capacity for growth in agriculture, already being a powerhouse. The activity of the agricultural sector is one of the most important in the Brazilian economy, because, although it currently makes up just over 5% of the Brazilian GDP, it is responsible for almost R$100 billion in export volume.

Therefore, the initiatives for the production of vertical farms in urban areas, which around the world are already becoming a trend, due to the population increase, which requires more and more cultivation areas and several countries are adhering to this practice and debating on the subject, developing new research and technologies facilitating production and its yield, As seen in the studies in this document, Brazil cannot be left behind. The first commercial urban vertical farm in Latin America was launched in São Paulo, with ambitious plans, which proved to be just the beginning of the future of the segment in the country, *Pink Farms* is one of the cases to be followed and studied in the coming years, as others will emerge and win the increasingly competitive agrotech market.

Another point questioned in relation to vertical farms was their economic viability, at this specific point the productivity of these environments still needs to be higher than traditional environments, since the expense required in assembling the structure is high, but one thing is certain: vertical farms are the great laboratories for the use of the most modern digital technologies existing so far. In other words, the *high-tech* world has many tools to help in the evolution and development of vertical crops, given the large number of technologies that can be used to leverage this type of production.

These vertical farms in buildings generate better revenue per square foot than vertical farms in containers, for example, as the former use less capital and incur lower operating expenses for the same area. Container-based shipping is ideal for serving small consumer bases, since crops are grown in limited spaces, making it ineffective and expensive to serve a larger consumer base. However, the

containerized vertical farm market is likely to register a higher growth rate as it is an off-the-shelf solution, and a cheaper one. This will help meet the growing demand for fresh, high-quality produce more quickly.

Finally, it is extremely feasible to develop and invest privately and publicly in vertical farms, as they are more flexible in terms of production, easy to operate, portable, and with lower maintenance costs compared to traditional ones. Consequently, the increasing demand for fresh produce is expected to create remarkable growth opportunities for this segment in the coming years, which shows that it is worthwhile to further study and further research on vertical farming, as well as a number of new investments in R&D to enhance the segment.

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