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VERTICAL FARMING; AN INNOVATIVE AGRICULTURAL METHOD TO THE URBAN AND ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT

Agricultura vertical: um método agrícola inovador para o desenvolvimento sustentável urbano e ambiental

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ABSTRACT

Of those issues that have concerned the government, academics and the public throughout the world, urban sprawl is one of the most prominent. There are conflicting views toward this growing trend. While it has been taken as a positive development in many newly emerging cities, it is increasingly perceived as a threat to the urban environment and considered as a trigger for numerous social problems, such as food shortages, increasing energy usage, global warming and deterioration of environment and urban areas. one feasible solution which can tackle this issue is vertical farming (VF). Promoting vertical farms in the cities can affect urban areas at the environmental, social and economic levels. Vertical farms do indeed have many advantages. A combination of new technologies in the fields of architecture, engineering and agriculture is needed to achieve maximum yield in this approach. therefore, this study is aimed to evaluate the advantages and possibility of vertical farming by reviewing existing and researched VF projects worldwide from 2005 to 2022. The aspects and phenomenon are derived from literature. The aspects offered can be a guide for implementation development and planning for innovative and farming industries of Vertical Farming in undeveloped countries.

Keywords: Vertical Farming, Architectural design, Urban Development, Environment, Sustainability.

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AGRICULTURA VERTICAL: UM MÉTODO AGRÍCOLA INOVADOR PARA O DESENVOLVIMENTO SUSTENTÁVEL URBANO E AMBIENTAL

Vertical Farming; an Innovative Agricultural Method to the Urban and Environmentally Sustainable Development

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RESUMO

Entre as questões que preocupam o governo, os acadêmicos e o público em todo o mundo, a expansão urbana é uma das mais proeminentes. Há pontos de vista conflitantes em relação a essa tendência crescente. Embora tenha sido considerada um desenvolvimento positivo em muitas cidades emergentes, ela é cada vez mais percebida como uma ameaça ao ambiente urbano e considerada um gatilho para vários problemas sociais, como escassez de alimentos, aumento do uso de energia, aquecimento global e deterioração do meio ambiente e das áreas urbanas. A promoção de fazendas verticais nas cidades pode afetar as áreas urbanas nos níveis ambiental, social e econômico. De fato, as fazendas verticais têm muitas vantagens. Portanto, o objetivo deste estudo é avaliar as vantagens e possibilidades da agricultura vertical por meio da análise dos projetos de FV existentes e pesquisados em todo o mundo de 2005 a 2022. Os aspectos e fenômenos são derivados da literatura. Os aspectos oferecidos podem ser um guia para a implementação, desenvolvimento e planejamento de indústrias inovadoras e agrícolas de Agricultura Vertical em países não desenvolvidos.

Palavras-chave: Agricultura vertical, Projeto arquitetônico, Desenvolvimento urbano, Meio ambiente, Sustentabilidade.

INTRODUCTION

Nowadays, the growing population in metropolises and the increasing demand for food are the most important current challenges in the design of urban spaces. In recent years, the approach of urban agriculture has always been considered as a factor to create sustainability and sustainability of cities (Figure 1) in the production of food products with respect to the rate of climate change and also to create food security (Kolagar, 2019). However, due to limitations such as population growth, increasing demand for food, lack of land in urban areas, rate of climate change, the quality and quality of food produced in cities, lack of water and energy resources, reduced soil fertility And environmental degradation, there are concerns about the possibility of achieving a stable supply of food products in cities (Kalantari et al., 2018). In this regard, finding appropriate answers using existing technologies and also using new solutions in agriculture in urban environments, can greatly improve the environmental conditions.

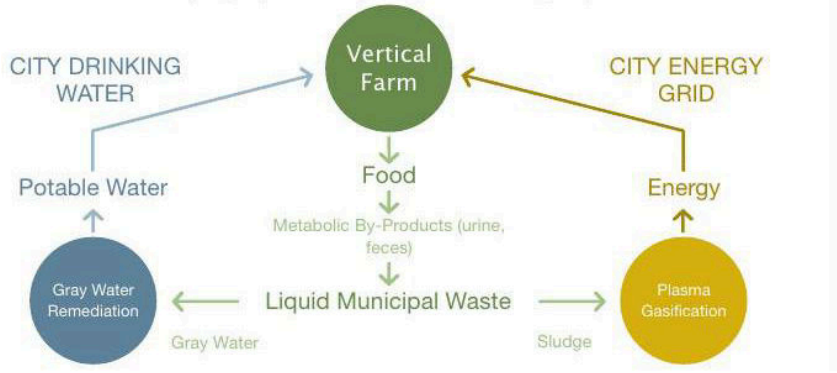
Vertical farming (VF) is an old idea. Indigenous people in South America have long used vertically layered growing techniques, and the rice terraces of East Asia follow a similar principle. But, now, a rapidly growing global population and increasingly limited resources are making the technique more attractive than ever (Despommier,2010). The Green Revolution of the late 1950s boosted agricultural productivity at an astounding rate, allowing for the explosive population growth still seen today. Indeed, since 1950, the Earth's population has nearly tripled, from 2.4 billion to 7 billion, and global demand for food has grown accordingly (Oenema, 1998).

Until now, the agricultural industry could keep up well enough -- otherwise swelling population figures would have leveled off long ago. But scientists warn that agricultural productivity has its limits. What's more, much of the land on which the world's food is grown has become exhausted or no longer usable. Likewise, there is not an endless supply of areas that can be converted to agricultural use (Tripathi, 2019).

By 2050, the UN predicts that the global population will surpass 9 billion people. Given current agricultural productivity rates, the VF Project estimates that an agricultural area equal in size to roughly half of South America will be needed to feed this larger population (Leridon, 2020).

Vertical farming has the potential to solve this problem. The term "vertical farming" was coined in 1915 by American geologist Gilbert Ellis Bailey. Architects and scientists have repeatedly looked into the idea since then, especially toward the end of the 20th century (Maleki, 2022). In 1999, Dickson Despommier, a professor emeritus of environmental health sciences and microbiology at New York's Columbia University seized upon the idea together with his students (Despommier,2011). After having grown tired of his depressing lectures on the state of the world, his students finally protested and asked Despommier to work with them on a more positive project. Agricultural researchers believe that building indoor farms in the middle of cities could help solve the world's hunger problem. Experts say that VFs could feed up to 10 billion people and make agriculture independent of the weather and the need for land. There's only one snag: The urban farms need huge amounts of energy.

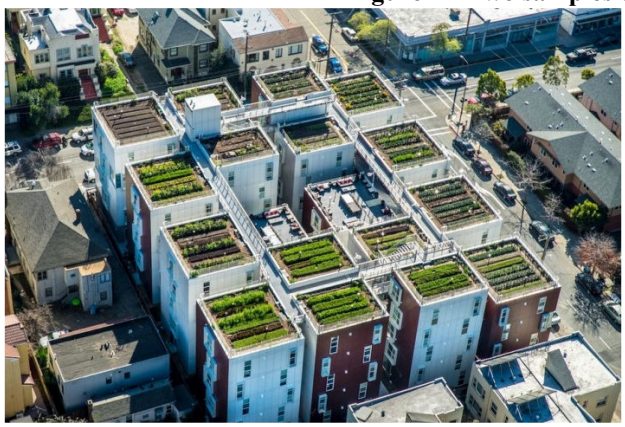
Figure 1 - The Sustainability Eco-City Model



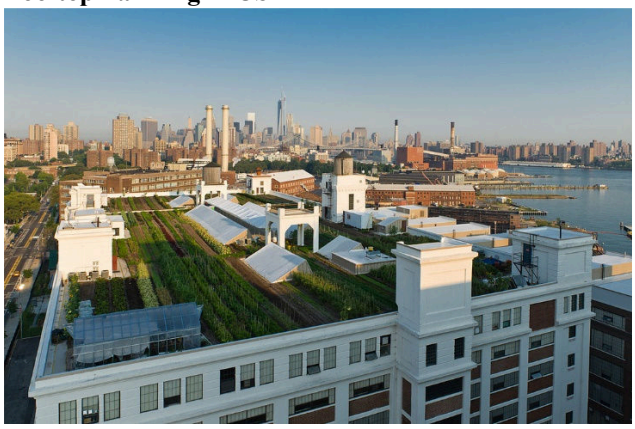
Source of data: Prepared by the authors (2023)

From the initial idea of "rooftop farming," the cultivation of plants on flat roofs, the class developed a high-rise concept (see Figure 2). The students calculated that rooftop-based rice growing would be able to feed, at most, 2 percent of Manhattan's population. "If it can't be done using rooftops, why don't we just grow the crops inside the buildings?" Despommier asked himself. "We already know how to cultivate and water plants indoors." (Despommier,2019)

Figure 2 - Two samples of Rooftop Farming in USA



Garden Village Apartments in Berkeley, CA; designed by Benjamin Fahrer



Brooklyn Grange's Navy Yard Farm in NYC.

Source of data: Prepared by the authors (2023)

In the present article, vertical farming strategy is introduced as a new solution to meet the nutritional needs of cities. The construction of these fields as buildings with the ability to control the growth conditions of plants and their production rate, in addition to preserving the environment (Hayati et al., 2018), can bring many social and economic benefits to cities. Achieving maximum efficiency in these buildings requires a combination of knowledge and new findings in the fields of architecture, engineering and agriculture.

1 LITERATURE REVIEW

The concept of VF Architectural building has gained immense traction in recent years owing to its potential to tackle the mounting global food crisis and environmental degradation. This revolutionary idea presents an innovative approach towards agriculture by cultivating crops within tall, vertical structures that are equipped with advanced technologies like hydroponics and aeroponics. By doing so, this model not only eliminates the need for vast amounts of arable land but also reduces transportation costs and carbon emissions associated with traditional

farming practices. Moreover, it offers a sustainable solution for meeting the demands of burgeoning urban populations while mitigating food shortages caused by natural disasters or other unforeseen events (Arabzadeh, et al. 2023). Overall, Vertical Farming is poised to play a significant role in revolutionizing our agricultural systems as we move towards a more resource-efficient and environmentally responsible future. In this section, the literature on the subject of study in the field of urban agriculture approach and its types is reviewed and then the vertical field strategy is introduced.

- **Urban Agriculture**

Over the past few decades, urban agriculture as a way to achieve self-sufficiency in the production of food products in different parts of the world has grown significantly. This strategy has played an effective role as a factor to generate income for city dwellers and reduce their dependence on food imports (Abdoellah et al., 2023).

Urban agriculture, according to its general definition, focuses on the process of growing fruits, plants and vegetables, as well as animal husbandry within urban spaces. These processes include other activities such as distributing and selling food within the city, collecting and recycling agricultural waste, collecting rainwater, organizing urban spaces, educating citizens, and creating job opportunities .(Zezza and Tasciotti, 2010). Agriculture in the city and suburbs is considered as a part of sustainable urban development. This type of agriculture is defined as the cultivation of plants and animals with the aim of producing food products and other activities such as production and supply, inputs, processing products and their marketing in and around cities. (2006, Veenhuizan). Paying attention to urban agriculture is a result of the development of rapid urbanization, especially in developing countries. Urban agriculture is a stable and dynamic part of the social, economic and environmental system of the city, which affects urban plans and contributes to the social and economic development of the city.

Local food production for cities and also provide food security (Pölling et al. 2016). Building-related agriculture is expanding in European and North American cities, which is described by concepts such as vertical cultivation, cultivation without the need for arable land, and integrated agriculture. It is used with building and sky agriculture (Sanye-Mengual & Specht, 2017) National and local governments in the world have understood the importance of playing the role of urban agriculture in various urban policies, these policies include local economic development through production, job creation and income generation, business development and health work through food security and nutrition, providing healthy food), managing the urban environment by creating a city, greening, improving the climate and biodiversity, recycling, reducing the ecological effect of urban life and social development by) eliminating poverty in terms of Taking deprived groups, social decline Widespread diseases such as AIDS, etc., improving recreation and education (Veenhuizen, 2007) is one of the most important things in the management of cities, using the roof space of buildings built in a green way.

In a division, its personal benefits include energy efficiency, improving the durability and longevity of the roof, creating a peaceful atmosphere, recreation, increasing the aesthetic value of the treatment, greenness, creating sound insulation and the possibility of food production, including improving flood management in the city, reducing the effect The thermal island, the city, improving the air quality, increasing the aesthetic value and green space, the community is the possibility to engage in urban agriculture (Sutic, 2003), for example, it has been determined that the presence of plants in the workplace increases the productivity of creativity, as well as the positive results of mental health and Zemi is associated 2017. Giancarlo et al.

The development of urban agriculture helps to reduce greenhouse gases not only through food production, but also by reducing the transportation of food from agricultural areas and thus reducing the distance traveled by food to the place of consumption. It has also been reported that if urban agriculture expands in the area of 15.51 square kilometers in the city of Seoul, the capital of South Korea, it will help to reduce the production and emission of 67.11 million tons of CO2 greenhouse gas per year (Gwan-Gyu, et al. 2015). Urban agriculture can play a role in the problem of food insecurity in the city (Zezza & Tasciotti 2010). Proponents of urban agriculture point to its potential to improve the health of citizens and the urban environment, and consider this capacity to include improving access to healthy food, promoting social cohesion, creating opportunities for physical activity, improving the economy of cities, providing welfare and revitalizing low-income communities (Angotti, 2015)

- **Types of Agriculture in Urban Spaces**

Activities related to the urban agriculture approach are generally classified into the following two groups:

- Urban agriculture in the uncontrolled environments (UEA)
- Urban agriculture in the controlled environments (CEA)

Both agricultural approaches in controlled environments and agriculture in uncontrolled environments have been formed with the aim of reducing poverty and hunger, creating sustainable patterns in the production of food products in order to achieve the goals of sustainable development and preserving environmental values (Game and Primus, 2015).

- Urban agriculture in the uncontrolled environments (UEA)

This type of agriculture is suitable for any urban outdoor agricultural operations. And the meaning of uncontrolled environments is that in this type of agriculture, there is no control over the environmental conditions and the factors that affect the growth of food and food production (Mwaura, et al. 2020).

Agriculture in uncontrolled environments can be divided into two groups in terms of construction objectives in urban spaces and also how they are implemented, the details of each of which are shown in the table below.

Table 1- Study of various urban farming methods in uncontrolled environments

Construction goals in urban spaces	Execution method
Commercial farms	Roof gardens or green roofs
Community gardens	Run in public spaces and urban parks
Institutional Farms and Gardens	Living walls outside buildings

Source of data: Mwaura, et al. (2020).

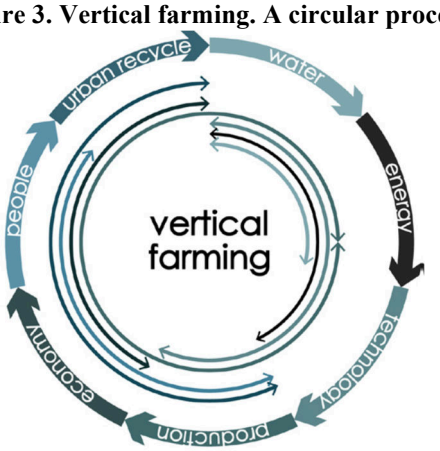
- Urban agriculture in the controlled environments (CEA)

Agriculture in controlled environments is a type of agriculture in which environmental conditions such as (light, temperature, humidity and nutrient cycle) controlled and linked to urban agriculture and green construction. Agricultural methods in urban environments have different types such as greenhouses, farming inside buildings and vertical fields. In this article, the solution of vertical fields of agricultural types in urban spaces has been studied (Mwaura, et al. 2020).

- **Vertical Farming**

In 1999, Professor Dixon Depmir, a professor and researcher in environmental health and microbiology at Columbia University, first proposed the idea of VFs, and in 2010 he published his book, "VFs, a Way to Provide the World Food for the Twentieth Century." First ", register your name as the leader of this approach in the world. In this book, he believes that cultivating the food of city dwellers inside vertical towers and inside urban spaces is a response to the miserable recession associated with the global food crisis, which has used soilless farming technology and used it to create more controlling conditions. Temperature, humidity and all the factors influencing the growth of products inside the building cause the cultivation of products inside the city ensure food security of cities and reduce costs and damages caused by transportation of these products from outside the cities. Vertical farming is the cultivation of plants and even animals inside skyscrapers and high-rise towers or on steep sloping surfaces, in which the hydroponic farming system is used to create synergies between the indoor environment and agricultural operations in various forms. It acts like there are multiple fields on the floors or in the glass space in front of buildings (Specht and partners, 2014). Trento AgroFarm is an experimental project that aims at highlighting how these innovative aspects can be integrated through vertical indoor farming (Fig. 3).

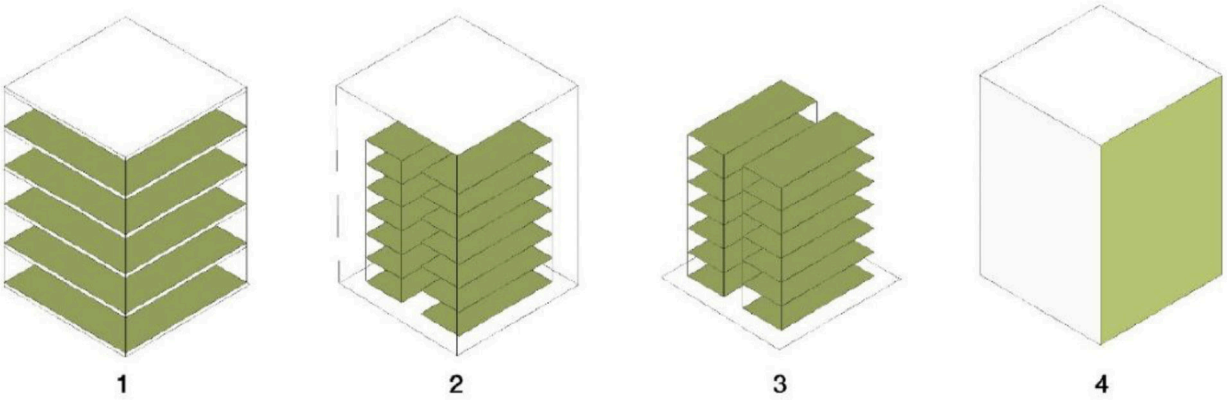
Figure 3. Vertical farming. A circular process.



Source data by Dal Ri et al. (2020)

Currently, the term VF (Zeidler, Schubert, 2015; Al-Kodmany, 2018) refers to a objects where vertical farming is carried out on multiple levels, e.g. on individual floors or using multi-storey growing infrastructure, as well as on the vertical surface of the building, e.g. on a facade (Fig. 4). VFs will differ in the method of cultivation, in-door or out-door farming, and in the method – soil-based or soilless (hydroponic, aeroponic and aquaponic cultivation methods) (Despommier, 2013).

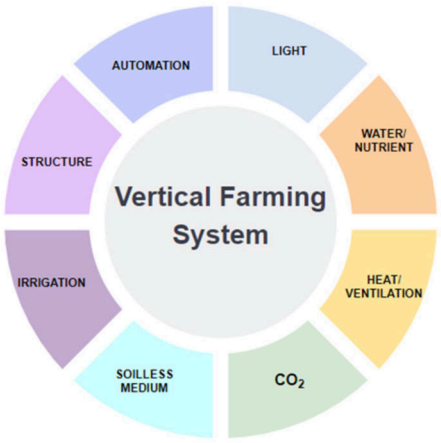
Figure 4 - Different types of VF in buildings 1 – a building in which floors food crops are grown (indoor farming); 2 – a building with a multi-level vertical farming installation inside (in-door farming); 3 – an outdoor multi-level vertical farming installation (out-door farming); 4 – a vertical surface such as a façade (out-door farming)



Source data by Nowysz, (2022)

A VF system is generally viewed as an indoor-based farm in a high-rise building with climate control technologies and advanced agricultural systems. The system encompasses the following essential components: lights, heating or ventilation, irrigation supply units, nutrient solution, CO2, a soilless medium, the farming structure to support the growing units and irrigation (Zeidler & Schubert, 2015). Another vital VF element is the automation system and sensor technologies. These technologies are currently being employed in multiple greenhouses and indoor farms globally for consistent, stable growth conditions all year round (Hallock, 2013). Furthermore, as labour costs in farming account for half the production costs, automated systems are utilised to minimise the operating costs (Bertram, 2019). The eight primary components in the VF system are illustrated in Figure 5.

Figure 5 - Vertical farming system primary components



Source data: Bertram, 2019; Despommier, 2009; Hallock, 2013; Zeidler & Schubert, 2015

2 CASE STUDIES

- **Pasona Building, Japan**

The creation of the new headquarters for Japanese recruitment firm Pasona consisted of refurbishing a 50 year old building to include office areas, an auditorium, cafeterias, a rooftop garden and urban farming facilities. Inside the 19,974 square meter office building there are 3995 square meters dedicated to green space that house over 200 species of plants, fruits, vegetables and rice. Pasona dedicated itself to creating this urban farm in part because of the growing reliance of foreign food. With a shortage of arable land in Japan (roughly only 12%, compared to 20% in the US and over 50% in Denmark), the country's food supply is highly unsustainable. By having this urban farm, Pasona is working to encourage and educate new farmers, while exposing urban people to food while it is growing. Employees of the farm are also encouraged to take part in the care and cultivation of its crops, which are eaten on site in the office cafeteria. Employees can be seen working in the rice paddy or broccoli field, pruning fruit trees, tending to lettuces and harvesting veggies (Lewis, 2010). The building has a double-skin green facade where flowers and orange trees are planted on small balconies. From the outside, the office block appears to be draped in green foliage. Inside the offices, tomato vines are suspended above conference tables, lemon and passion fruit trees are used as partitions for meeting spaces, salad leaves are grown inside seminar rooms and bean sprouts are grown under benches.

Form: A modern built concrete, steel and glass office building. The form is a standard square floor footprint. The building floor plates separate the office spaces from the growing areas yet still manage to incorporate the green design into the overall design.

Function: The building is a standard office building with the side function of growing plants within the building. The office spaces are designed both for office activities and to allow the workers to grow produce for their lunch or to take home. This is referred to as the farm-to-table office scheme. This particular building is reportedly the largest farmto- table office scheme in Japan. The spaces have central growing areas. Both soil and hydroponic facilities are available for the use on many floors of the building.

Aesthetics: The facade shows a mixture of green and modern design features. The use of materials along with the growing wall makes the building stand out within the city area due to the contrast of the green with the concrete jungle.

Sustainability: Fresh vegetables, green walls, cross ventilation and glazing. Self-food harvesting is a very sustainable concept. Many urban developments in Japan are now incorporating this approach. This idea suggests a new way in which we see our day-to-day relationship with food in the workplace.

Figure 6 - Pasona VF building in Tokyo Japan

Source data: www.inhabitat.com

- **Mashambas Skyscraper**

Mashambas is a movable educational center, which emerges in the poorest areas of the continent. It provides education, training on agricultural techniques, cheap fertilizers, and modern tools; it also creates a local trading area, which maximizes profits from harvest sales. Agriculture around the building flourishes and the knowledge spreads towards the horizon. The structure is growing as long as the number of participants is rising. When the local community becomes self-sufficient it is transported to other places.

The structure is made with simple modular elements, it makes it easy to construct, deconstruct and transport. Modules placed one on the other create the high-rise, which is a form that takes the smallest as possible amount of space from local farmers.

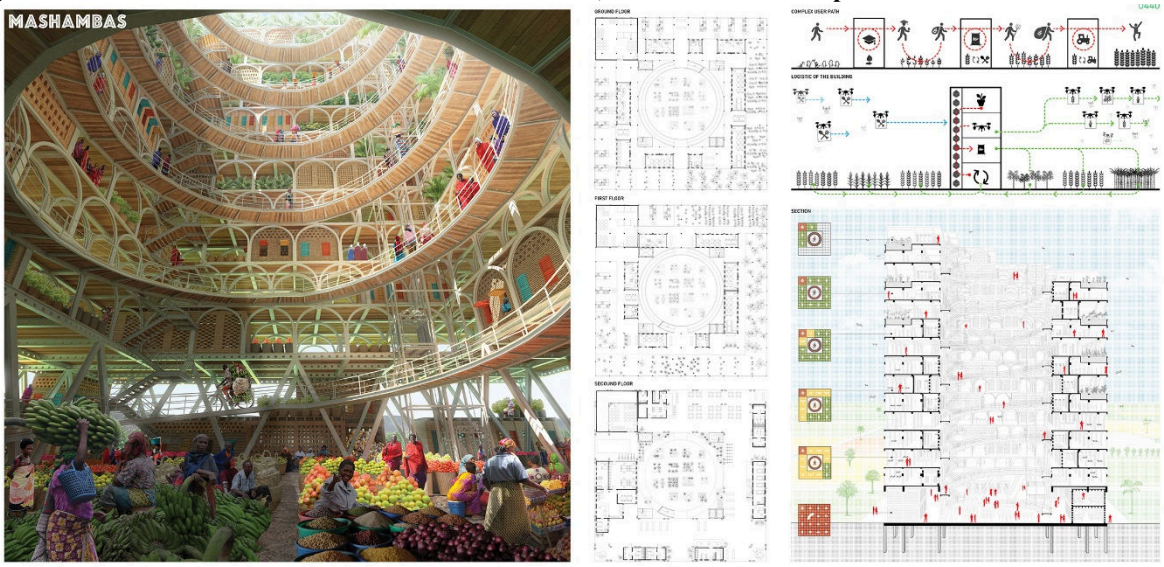
Form: The building is made up of arched sections. The sections can be put together to create large farms or small farm buildings. The kitset can be arranged as per the design according to the farmer's preference.

Function: The goal of this building is to be able to cultivate land in any area in Africa. The building will comprise of fruit-bearing trees in the lower levels and smaller crop plants in the elevated levels. This building will also have spaces for living areas for the farmers. The building functions as a farm. As this building only takes up a small area of land, large areas remain in which larger trees can be planted.

Aesthetics: the structure itself is comprised of modular elements. Materials have yet to be decided, so therefore timber or steel could be used to build the modular structure. However, temperatures and common materials of the area dictate concrete as a possible choice.

Sustainability: Natural fertilizers, open cross ventilation, open light penetration and fresh water collection.

Figure 7 - Mashamba VF Location: Sub- Sahara Africa, Architect: Pawel Lipinski and Mateusz Frankowski



Source data: Pawel Lipiński 2017

The designers envision that the skyscraper would help to distribute both produce and knowledge out into communities. The skyscraper would be built of simple arch-shaped modular elements, stacked around a central atrium. A ramp would spiral up the void to connect the different levels. As the modules would make the building easy to construct and disassemble, the designers envision the structure being moved to a new location somewhere on the vast continent once it is no longer needed in a community.

- **Thammasat University**

A Thai university in Bangkok has recently become the largest urban rooftop farm in Asia, transforming 236,806sqft of its rooftop into an agriculture hub. Thammasat University Rooftop Farm (TURF) incorporates sustainable food production, renewable energy, organic waste, water management and public space (Figure 8). The $31 million projects were completed in December 2019. 32% (1.7 acres) of the green rooftop is dedicated to urban farming activities. The urban farm is powered by solar panels capable of producing up to 500,000 watts per hour and also powers the building beneath it. The farm grows more than 40 plant varieties, including rice, indigenous vegetables and herbs, and fruit trees, yielding up to 20 tons of organic food per year. The campus canteen uses the concept of 'farm to table,' and waste was used as compost to fertilize crops. The rainwater goes down to slopes and finally to the retention ponds (Greenroofs, 2021). The above concept could be adapted in the Malaysian government building where the cafes and in-house canteen harvest the crops from the rooftop farm.

Figure 8 - Thammasat University Rooftop Farm (TURF), Thailand.

Source data: Damian Holmes (2020)

Here are some other examples from urban farming specially in residential buildings from China, Iran, Sweden and Singapore.

Figure 9 - Different VF projects in the world

Qiyi City Forest Garden residential complex in Chengdu, China

Bagh Irani (Iranian Garden) residential complex in Tehran, Iran

World Food Building located in the Swedish town of Linköping

PARKROYAL. By WOHA Architects Located in Singapore

Source data: Author from different websites (2023)

3 DISCUSSION & RESULTS

According to the analysis performed in the response section of each source, the benefits of using the vertical field solution can be classified into three groups of environmental goals, economic goals and social goals.
To review of the results of using the vertical field strategy to advance the goals of urban agriculture.
Advantages of Vertical Farming:

Environmental benefits:

- Absence of contaminants in drinking water
- The possibility of returning to the natural ecological state for the environment
- Abandoning the use of chemicals to control pests and growth promoters
- Water conservation is about 70 to 95% less than traditional agriculture
- Closer distance to required facilities and no use of fossil fuels
- Possibility of treating wastewater and ground water and turning it into drinking water

Social status benefits:

- Ability to enjoy fresh vegetables and food for city dwellers
- Possibility of more control and security in cultivating agricultural products
- Solidarity and popular participation in the production of agricultural products
- Increasing the amount of green space in cities and beautifying the urban environment
- Essential food production
- Improving the food security situation of the community

Economic benefits

- Possibility of cultivating agricultural products in all areas
- Eliminate the destructive effects of climate change and produce multiple products
- Creating local markets and producing cuts
- Creating new job opportunities
- Less need for packaging, storage and transportation of food

Utilizing the vertical field approach as a new solution in urban agriculture, given the growth and development of new technologies in engineering, architecture and agriculture can be a useful solution to deal with existing constraints such as population growth and the need to provide Address the nutritional needs of urban populations. The findings of this study show that using this approach in urban spaces can have many environmental, social and economic benefits for cities.

In Iran, due to the existence of issues and limitations similar to those mentioned in Table 3, the results of using vertical farming methods can be effective in the following tears:

- Improving environmental conditions:

1. In Iran, with the loss of gardens and land suitable for agricultural activities due to the growing trend of urbanization and increasing the amount of construction and overcrowding in urban centers, farming in urban areas with a shortage of land properly encountered. Also, due to the rate of climate change in the country, the amount of rainfall is decreasing And the phenomenon of drought has necessitated the use of new methods in urban agriculture. According to forecasts, Iran's population will reach 100 million by 1400, which will reduce the average per capita available water resources. (Saberifar, 2023) Therefore, meeting the water and food needs of this population by using the vertical field strategy that uses modern irrigation methods in the production process can be very useful. Collecting surface water and rainwater and purifying

them for reuse, in addition to the sustainability aspect, contributes to water scarcity. There are various methods to remove water pollution, which are mentioned in the article of Samadi-Darafshani et al. 2021.

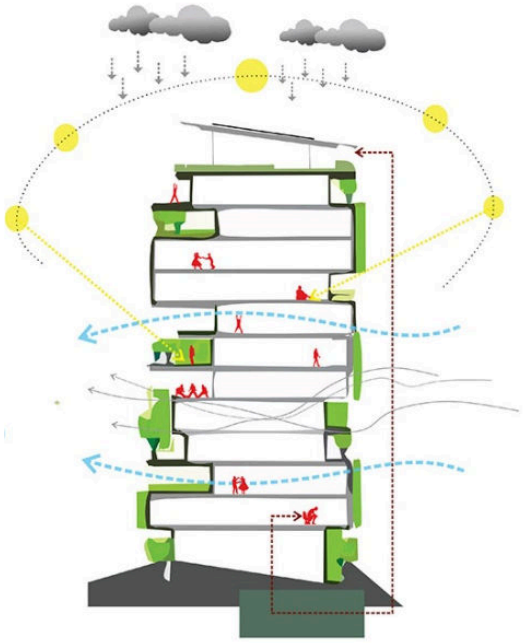
2. Today, with economic growth, the need for energy in the country has greatly increased, while the source of energy production is very limited. Therefore, using the vertical field approach, which leads to the optimal use of resources by applying the latest technological achievements, can be of particular importance for the sustainable production of food products in the country.
3. With the increase of the area of the urban area and the energy consuming sectors (transportation, residential, commercial, industrial and agricultural) in the country (Ilbeigi et al., 2022), the amount of energy consumption has increased in all sectors and finally the emission of greenhouse gases and air pollution Urbanites have had a huge impact. Besides construction industry is a pollutant-maker industry (Shirkhanloo, 2021) therefore, as a result of using the vertical field approach due to its benefits in eliminating fossil fuel consumption and food production inside buildings and under controlled conditions will reduce the amount of environmental pollution caused by agricultural activities.

- Social improvement

1. Spatial development and distribution in Iranian cities and the lack of proper land use planning have led to the loss of aesthetic aspects of cities and reduced communication between citizens and nature (Goudarzi et al., 2022). Due to the advantages mentioned in the construction of vertical fields, these buildings can play an important role in increasing the amount of greenery and creating a relationship between citizens and nature. Which leads to increasing the sense of belonging of inhabitants and improve and increase Sustainability (Khademi et al.,2019).
2. Due to the increase in pollution in urban spaces, using the vertical field strategy that cultivates the crop through agriculture in controlled environments, it is possible to ensure a healthy and safe crop.
3. Considering the intensive constructions in urban spaces and reducing the amount of attention to the physical and mental needs of citizens in cities, especially the elderly, the construction of such fields in urban spaces can play an important role in increasing social interaction and creating communal spaces.

- Improving economic conditions:
    1. Due to its climatic and geographical conditions, Iran is naturally a country of water shortage. In addition to these conditions, Iran is also experiencing a drought phenomenon with the abundance of baht. According to UN reports, Iran has suffered from successive droughts from 1998 to 2001. (Manshadi and Biniaz, 2011) Therefore, using a method that can meet the food needs of citizens regardless of climatic conditions and in Iran can It can be very effective.
    2. 2. It may seem far-fetched to mention that sections of Iranian society are now aging and the trend of aging is spreading rapidly. For example, this phenomenon can be seen in the labor force in the agricultural sector, and this is while the agricultural sector, in addition to this challenge, is faced with the reluctance of agricultural students to work in this field, and now according to Increasing the number of graduates in this field, the presence of skilled manpower in this field is still felt. (Shafiee and Ali Fami, 2007) The rate of improvement and growth affected the economic conditions of the country's cities.

Figure 10 - Sustainable design scheme of VF residential building in Iran



Source data: Author (2023)

CONCLUSION

The use of new strategies in urban agriculture can be useful as an effective factor in reducing the existing limitations in advancing the goals of this approach and also ensuring food security of urban communities. One of these effective solutions is the idea of vertical fields, which in this article has been studied by considering the existing limitations in doing agriculture in urban spaces in various ways. The main purpose of writing this article was to identify the benefits of using this solution in urban spaces that the content analysis method has been used to find appropriate answers.

Preliminary studies on the subject of urban agriculture showed that due to the existing issues such as population growth, land shortages, climate change rates, increasing demand for food, environmental pollution and water and energy shortages in urban areas The issue of meeting the food needs of citizens will face a serious threat in the not too distant future.

Therefore, the vertical field approach as a new solution to face these limitations is presented in this paper. The results of analyzes conducted in the field of this approach showed that using it in urban spaces and creating buildings with the ability to meet the food needs of cities can be a useful solution to improve the environmental, social and economic level of cities.

In Iran, due to the existing environmental problems and constraints, moving towards building buildings with this capability can have similar benefits and also cause comprehensive growth and expansion for the country.

In this regard, due to the lack of samples made based on this approach and its novelty, research on various aspects of the construction of these fields and the performance of the samples can play an important role in gaining knowledge and feasibility of their construction in different parts of the world including Iran.

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