

VERTICAL FARMS AS A NEW TREND IN THE DEVELOPMENT OF THE AGRICULTURAL SECTOR OF THE ECONOMY

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Abstract

With the increase in population and urban population, there is an urgent problem of hunger. Therefore, agriculture is faced with the need to find new methods of food and raw material production. One of the innovative solutions is vertical farms based on advanced technologies and biomimetic principles. This article discusses the concept of vertical farming as a way to provide food and raw materials to the population using new technological and architectural approaches to the use of vertical surfaces. The development of this approach requires significant capital investments and is still feasible mainly in developed countries. The article provides examples of vertical farm projects and highlights the features of this approach, such as the possibility of independence from the soil, reducing the area used while maximizing production, the use of digital technologies for farm management, reducing logistics costs and offering fresh produce closer to consumers.

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With rapid urbanization growth and projected population increase in the coming decades, the problem of food security for urban populations is becoming increasingly urgent and complex. In this context, vertical indoor food growing systems are of particular importance, representing an innovative trend in agricultural development. This methodology revises traditional notions of agriculture, enabling the efficient utilization of urban spaces for food production. Vertical indoor farming is a tool that can redefine agriculture and ensure the sustainable development of urban societies in the face of demographic and environmental challenges.

Vertical farming is an innovative practice of growing plants inside urban buildings at an industrial level using full climate control. It differs from traditional farming methods in that it occurs regardless of the season, without the use of pesticides and other chemicals. Mainly focused on growing leafy plants, vertical agriculture occupies various levels inside buildings, including vertical surfaces.

B. M. Akimenko and S. V. Miskevich emphasize the importance of developing eco-friendly urban structures, including vertical agricultural buildings such as "agrochmaroches", which can significantly reduce the time of food delivery to final consumers. New technologies in architecture and engineering,

as well as information and communication systems that enable agro-industrial automation, are contributing to the development and implementation of vertical agriculture in various developed countries. [1]

Vertical agriculture is a concept of agriculture aimed at providing food for the population, and some industries with raw materials, using new technological and architectural solutions for the use of vertical surfaces.

The concept of vertical farming, although it has only become widely known in recent decades, actually has ancient roots, reflecting humanity's desire for efficient use of space and resources for food production. The first examples of "vertical farms" can be traced back to the Hanging Gardens of Babylon, created over 2,500 years ago. This majestic architectural feat, as historical sources describe it, was a system of vaulted terraces stacked one on top of the other and planted with a variety of plants. Legends say that the gardens reached a height of 20 meters and were irrigated with water from the Euphrates River using a chain pump, allowing for a unique environment for growing plants. [2]

In later times, the Aztecs used their own methods of hydroponic farming using "chinampas" rafts that floated on lakes and were covered with layers of soil and plants. These rafts provided a living environment for the plants, allowing them to grow and produce food. This example shows how ancient civilizations have long sought ways to optimize food production, especially when land resources were limited or the terrain was not suitable for agriculture.

With the development of scientific and technological knowledge, the concept of vertical agriculture has become more feasible. Important contributions were made by scientists and engineers such as Francis Bacon, who researched hydroponic methods, or John Woodward, who perfected hydroponic farming in the 17th century. Today, with the development of modern technologies such as information systems, process automation and new materials, vertical farming is becoming an increasingly feasible and effective approach to food security in the face of urban development and growing populations.

Vertical farms differ from traditional farms in that plants are grown indoors under artificial conditions. This allows for an optimal environment and efficient use of space. Various methods are used to transfer nutrients to the plants, including hydroponics, aeroponics and aquaponics, which allow the plants to do without soil. Light is supplied by LED lamps, and farm maintenance is automated with smart systems that monitor growing conditions and ensure optimal parameters for plant development. [3]

Aeroponics is a process of growing plants in an airy environment where nutrients are delivered to the plant roots in the form of aerosol. This method allows plants to grow faster and healthier as the environment remains free from soil related pests and diseases.

Hydroponics is a method of growing plants on artificial media without soil, where the plants are fed from a nutrient solution surrounding the roots. Hydroponics allows you to precisely regulate the growing conditions of your plants, ensuring high yields and better-quality produce.

Aquaponics combines aquaculture (raising aquatic animals) and hydroponics to create an ecosystem where fish waste is used as a nutrient medium for plants. It is an environmentally friendly method that reduces the time it takes to grow vegetables and reduces harmful emissions into the atmosphere.

To automate and remotely manage vertical farming, advanced technologies such as mobile internet, artificial intelligence, Internet of Things and cloud technologies are required. Some of the physical tasks can be performed by advanced robots, autonomous and semi-autonomous vehicles. In addition, renewable sources such as wind, solar and water power should be utilized as additional energy sources for such structures. The plan is to grow plants both in soil, hydroponics and aeroponics. Vertical farms can not only provide food security but also produce clean drinking water.

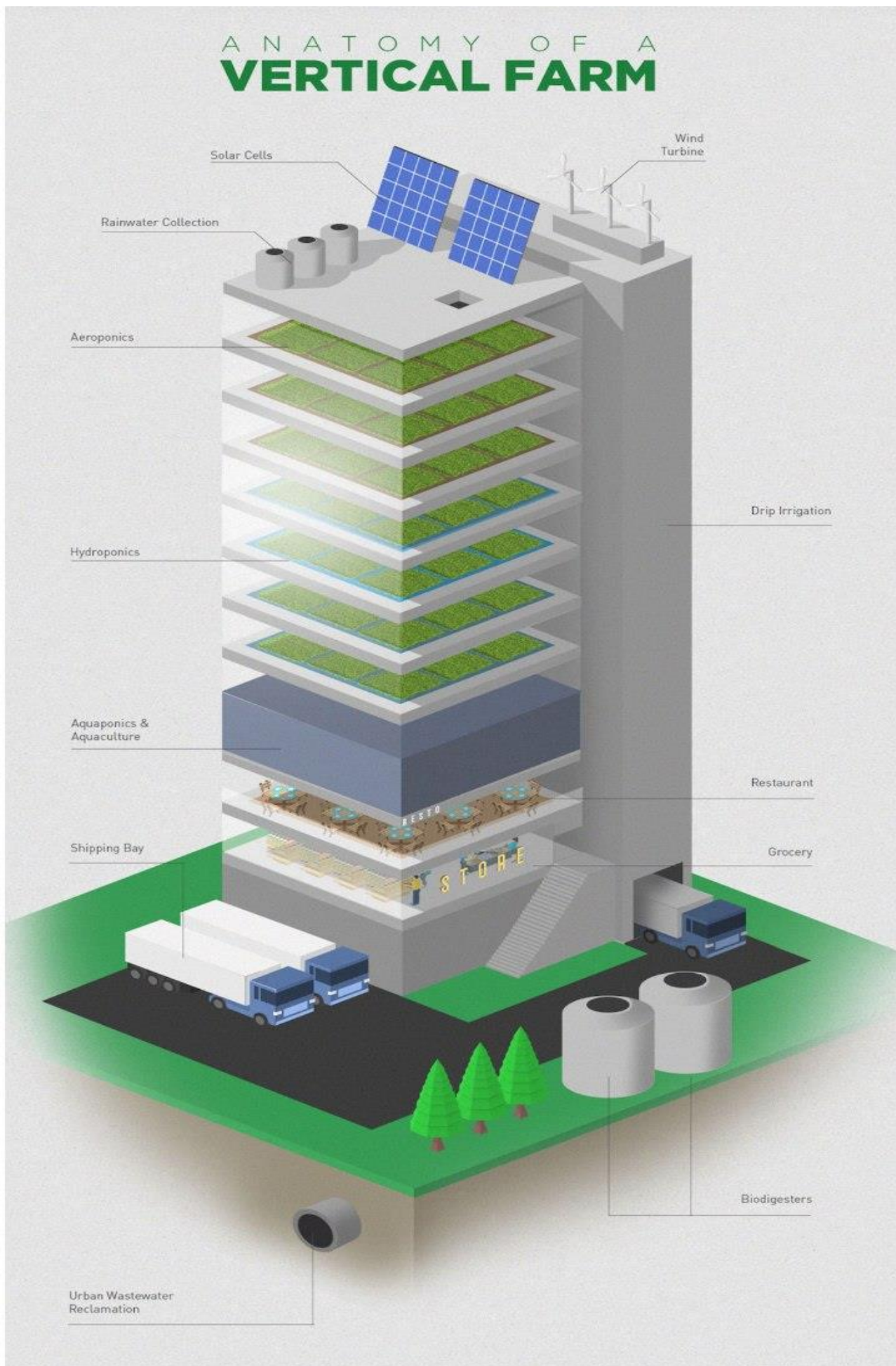
The main characteristics of vertical farming are: the possibility of implementation without being tied to traditional methods of cultivation in soil, lakes, rivers or pastures; minimization of the occupied area

while maximizing the use of farm volume; orientation to urban areas; reduction of logistics costs for delivery of products to end consumers; creation of digital ecosystems for effective management of vertical farms; application of the latest architectural, engineering and information and communication solutions, and the use of new technologies and technologies for the production of crops. [1], [4]

Table 1 Distinguishing features of vertical and traditional agriculture

№	Feature	Vertical farming	Traditional agriculture
1	Land use	Takes up a small amount of space	Spread over vast areas
2	Water usage	Less water resources are used	Water consumption may vary, but is generally higher
3	Energy consumption	Often high energy consumption (but renewable)	Moderate energy consumption (if properly managed)
4	Greenhouse gas emissions	Relatively low greenhouse gas emissions (with the right strategies)	Relatively high greenhouse gas emissions
5	Pollution and degradation of ecosystems	Minimal pollution and degradation of ecosystems	Most farming damages the environment (but regenerative, organic farming can improve biodiversity and restore ecosystems)
6	Supply chains	A nutritious food production system with short delivery distances and a less complex supply chain.	Complex food supply chain with long delivery distances.

Thus, vertical farming represents a promising strategy for agricultural development in the face of contemporary challenges. Its advantages such as increased yields, resource conservation and more efficient use of space make it attractive in the context of limited land and changing climatic situation. Overall, vertical farming is a promising area of agricultural development that can bring significant benefits in the form of sustainable resource utilization, increased productivity and reduced environmental impact.



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