

| From Soil To Sky: Vertical Farming in Uzbekistan

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Why can't we farm vertically if we can live vertically?

Abstract: Today's environmental scientists are in no doubt that the world's resources of fertile soil are rapidly deteriorating, and that new land for agriculture is becoming ever more scarce. Intensive farming, urbanization, desertification, and sea-level rises are all putting growing pressure on the planet's agricultural land and therefore on food supplies. The global population is expected to exceed nine billion by 2050 - up a third from today's level and studies suggest that food production will have to increase by 70 per cent if we are to feed all of those new mouths. This means that scientists will have to develop new ways of growing crops if we are to avoid a humanitarian crisis. Indeed, UN Food and Agriculture Organization figures suggest that the number of undernourished people is already growing, and with escalating climate change, crop yields in many areas have been projected to decline. This paper shows that Uzbekistan, an arid country in Central Asia, has significant potential in vertical farming.

Introduction: Vertical farming is the practice of growing crops in vertically stacked layers, harnessing otherwise unused vertical space that is left unconsidered in almost every conventional cultivation practice. Among the major issues facing the world, the population explosion stands out. It is estimated that approximately 800 million hectares of land are designated to soil-based farming globally, constituting about 38% of the total global land area. Moreover, about 80% of the total arable land is currently being utilized across the globe (Ellingsen E 2008). The whole world is on the verge of a population explosion, and it is a challenge to feed this ever-increasing population (MS. n.d.) (251). Some urban planners and agricultural leaders have argued that cities will need to produce food internally to manage the balance of demand and supply, in order to avoid falling food prices, harmful pollution, and inflation (Kheir. 2018). Since the era of the green revolution, technologies in the agricultural sector have continued to develop. New technologies consistently emerge, making older ones obsolete. The current technologies used for growing crops include aquaponics, nutrient film technique (NFT), aeroponics, and others. These methods are today considered best for crop cultivation; however, they may not be solely sufficient to run supply parallel to the demand generated by the fast-growing population. Some scientists therefore believe that urban agriculture could solve these problems by adopting vertical farming, consuming space in areas where land is expensive and limited. By farming upwards rather than outwards, this technique aims to reduce pressure on traditional agricultural land and, by incorporating soil-free growing systems, is particularly attractive for use in urban areas. However, the term 'Vertical Farming' has come to have a wide range of definitions that can cause confusion. Although not necessarily associated with urban agriculture, VF encompasses a range of growth systems of different scales, users, technologies, locations, and purposes.



Figure 1. Comparison between the greenhouse system and vertical farming

Growing media/substrates are the materials in which the plant grows, and they play a crucial role in productivity as well. They provide anchorage for plant roots, air spaces, and respiration support, and retain enough available water to enable plant growth. There is a wide range of growth substrates available for growing plants. The growing media are used solely or in combinations (ratios) for growing plants. For example, when vermicompost is applied to vegetables at a certain amount and time, it can enhance growth and yield in field conditions (Arancon NQ 2005). The types of combinations of media vary from species to species of plants, and also depend on the choice of grower and the stage of growing, i.e. for nursery raising or for transplanting. Nowadays, different types of growing media are available in the market, including coco-peat, coir, vermicompost, perlite, bagasse, and sawdust. However, some media such as wood straw and palm-leaf straw in cucumber production have performed well, although they were not significant in yield. (Rawahya MS n.d.)

Concept of Vertical Farm

Vertical farming involves growing crops within structures (such as a skyscraper or an old warehouse) rather than in the ground, which saves water and eliminates the need for soil. There is no weather or other natural factor that can stop food production in a vertical farm. A wide variety of plant species can achieve optimal growth rates year-round when grown in controlled environments with constant monitoring and manipulation of environmental factors such as light, humidity, and temperature (The Vertical Farm: Feeding the World in the 21st Century). The vertical farming strategy aims to boost efficiency rates. Temperature, light, humidity, and gases can be artificially controlled to enable indoor food and medicine production. Chemicals are kept out of the environment because closed growing systems are used.

Depending on the use, size, and main techniques employed in a vertical farm, vertical farms can be categorized into different types. However, the common goal of most vertical farms is to increase yield in a sustainable way. Table 2 shows the estimated yield of a vertical farm compared to traditional agriculture for 10 different crops. As expected, yields in vertical farms are usually higher. A good example would be potatoes: yield in traditional farms is 28 tons/ha while in vertical farms it is 150 tons/ha, which is almost 5 times more. The average yield of a vertical farm is about 2.5 times greater than that of traditional farms. These increases in yield from vertical farming are the result of the protected environment, additional growing cycles and harvests, as well as area utilization optimization.

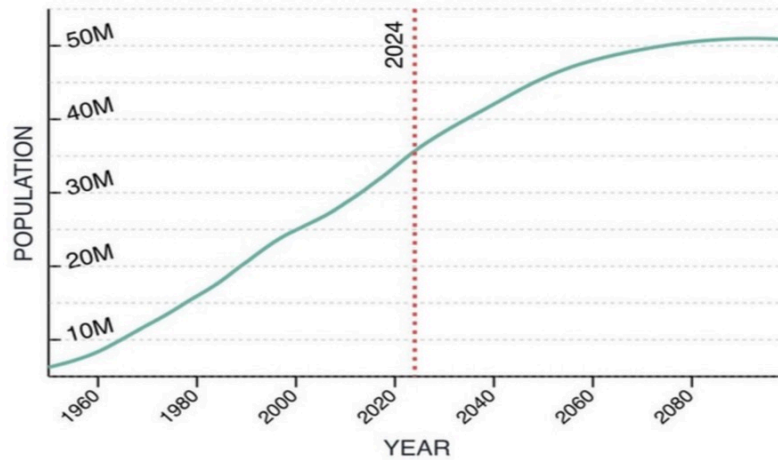
Crops	Yield in VF due to Tech (tons/ha)	Field Yield (tons/ha)	Factor increase due to Tech	Factor increase due to Tech and Stacking
Carrots	58	30	1,9	347
Radish	23	15	1,5	829
Potatoes	150	28	5,4	552
Tomatoes	155	45	3,4	548
Pepper	133	30	4,4	704
Strawberry	69	30	2,3	368
Peas	9	6	1,5	283
Cabbage	67	50	1,3	215
Lettuce	37	25	1,5	709
Spinach	22	12	1,8	820
Total (average)	71	28	2,5	516

Present Status of vertical farming in Uzbekistan

Uzbekistan is one of the progressive economies in the world. It is a hub of a wide variety of cultivated plant species. The majority of the population of Uzbekistan is dependent on farming for their livelihood. It is therefore necessary to develop, explore, and adapt new techniques to increase food resources amid this continuously increasing urbanization. Moreover, Uzbekistan has a variety of climatic conditions, which enhances its potential to grow a wide variety of crops throughout the year. This diverse climate has made Uzbekistan a significant exporter of fruits and vegetables, totaling 251,200 tons within just two months in 2024 (International Trade Council 2024). However, even though it is a major producer, it still faces food scarcity. The per capita availability of vegetables remains below the recommended rate of 275g and 300g set by ICMR for females and males respectively. The Uzbekistan population is expected to reach 44.4 million people by 2070 (worldpopulationreview 2024).

Uzbekistan Population 2024 (Live)

35,563,732



Vertical farming has been adopted by countries such as the USA and Japan. In India, vertical farming is still in a testing period; however, on a small scale, it has been implemented in major cities such as West Bengal and Punjab. Initial success in growing tomatoes and rice in vertical farms has also been recorded.

If vertical farming were to gain pace in Uzbekistan, it could help people access fresh vegetables easily throughout the year, help growers gain higher profits, and cumulatively affect the national GDP in a positive direction. It is clear that more and more crops must be grown permanently to provide food for all. To achieve this, integrating vertical farming hydroponics is one of the best options. One of the most significant benefits of vertical farming is its efficient water usage. Systems can save up to 90% of water compared to conventional methods (Dey 2023). This is particularly relevant for Uzbekistan, a region that experiences significant water shortages (UzDaily 2020). Additionally, vertical farming reduces the need for pesticides and herbicides, leading to cleaner produce. Vertical farming enables the production of fresh, locally grown produce in urban areas. This could make cities like Tashkent self-sufficient in food production, reducing money leakage from the city. Moreover, it is a more sustainable and environmentally friendly approach to agriculture, potentially reducing greenhouse gas emissions due to lower transport requirements and other factors (Campos 2020). Crops grown in vertical farms are protected from extreme weather events such as floods, droughts, and excessive sun exposure, making it a viable climate adaptation technology. This is particularly pertinent for Uzbekistan, which faces various climate-related challenges (GGGI 2024).

Challenges and Considerations

- **High Initial Costs:**

One of the major challenges of vertical farming is the high initial cost of setting up a system. The cost of equipment, lighting, and climate control systems can be significant, making it difficult for farmers to start a vertical farming operation.

- **Energy Consumption:**

Vertical farming requires significant energy to power the lighting and climate control systems. This can be costly and may not be environmentally friendly if the energy source is not sustainable.

- **Technical Expertise:**

Vertical farming requires technical expertise in areas such as hydroponics, lighting, and climate control systems. Farmers need to have knowledge in these areas to operate a successful vertical farming operation.

- **Crop Selection:**

Certain crops may not be suitable for vertical farming due to their size, shape, or growth habits. This limits the variety of crops that can be grown in a vertical farming system.

- **Scaling Up:**

Vertical farming can be difficult to scale up to large commercial operations. The high initial costs and technical expertise required make it challenging for farmers to expand their operations.

Uzbekistan's Engagement with Vertical Farming

Uzbekistan has engaged in talks with the Dutch company PlantLab, which specializes in vertical farming technology, to explore year-round cultivation possibilities (UzDaily 2020). The Dutch side has expressed readiness to visit Uzbekistan to study the situation and conduct negotiations with potential local partners (UzDaily 2020). The Uzbek government has shown a commitment to improving food and water security through various initiatives, including a \$150 million loan and a \$3 million grant aimed at upgrading irrigation and drainage systems (Asian Development Bank 2022). Additionally, the government plans to boost fruit and vegetable exports, with directives to construct fuel-free greenhouses and provide favorable loan conditions for agricultural equipment (HortiDaily 2024).

- Uzbekistan is seeing an increase in the use of water-smart greenhouses and hydroponic systems, which align with the principles of vertical farming by saving natural resources and increasing incomes (United Nations Water 2023) (EastFruit 2023).
- The Digital Villages Initiative by FAO is installing smart sensors in greenhouses and providing training to foster rural transformation through digitalization, which could complement vertical farming efforts (initiative 2024).
- Greenhouse tomato production in Uzbekistan has seen a significant increase, indicating a growing capacity for controlled environment agriculture (EastFruit 2023).

Conclusion:

Vertical farming presents a promising avenue for Uzbekistan to address its food security and sustainability challenges. By leveraging this technology, the country can improve its agricultural productivity, conserve water, and reduce its environmental impact. However, overcoming the initial costs, energy requirements, and scaling challenges will be crucial for the successful adoption of vertical farming in Uzbekistan. As Uzbekistan continues to explore vertical farming, it is essential to balance the potential benefits with the challenges, and to ensure that the necessary technical expertise and public support are in place to realize the full potential of this innovative agricultural practice.

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