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From Conventional Agriculture to Intelligent Urban Agriculture: The Economic Dimensions of Vertical Farming in Tamil Nadu

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Abstract- The specialization in urban agriculture includes the reality that agriculture has always been viewed as an activity carried out in the rural areas away from cities, even when agriculture has been viewed as the foundation of civilizations. According to Solomon, food and civilization are the two major elements of humanity, In addition to this, the urban farming techniques should be based on the location of the urban farms in the city, along with the adequate use of water sources. One more thing that is important is resource management by growing different types of crops. The skills required by an urban farmer are innovation and problem-solving skills. The fact is that horizontal agriculture has been the foundation of the creation of civilizations; however, the evolution of the three basic elements resulted in the division of agriculture from the city, which means that the search for alternative urban agriculture started.

Keywords- Urban Agriculture, Horizontal Agriculture, Technology, Sustainability, Economy

I. Introduction

Specialized Studies of urban agriculture involves the fact that agriculture has been associated with the rural environment far from the cities, despite the fact that agriculture has been considered the basis of civilization. Solomon highlights that food and civilization are the main components of humanity. Although (Eric) notes that there is an intellectual distinction in the manner of addressing agriculture during past times compared to present times, agriculture during present times has been separated from the urban setting because of the effect of three major factors modern times - industrial revolution - urbanization. (Hajer Ismail et al., 2020) In this regard, urban agriculture provides a different and supplementary solution for food security by producing food near the urban population. Urban agriculture can be instrumental in growing produce in urban settings, utilizing water more efficiently for production, and increasing accessibility to food.

While such practices have increased the land area available for farming, their role in improving local food security has been questioned. The farmland that has been restored is often controlled by big investors and multinational companies, and the food grown there is not guaranteed to make its way back into the community. This research bridges the existing gap through the development of a success index for the implementation of urban farming in Egypt. The objective of this index is to offer

strategic direction to policymakers, urban farm owners, private individuals, and local organizations in terms of the key indicators that determine the sustainability of urban farming activities. Moreover, the study makes a case for urban agriculture as an urban economy matter due to the potential for using rooftops, unused lots, public green spaces, and private land in order to foster micro-businesses, save on transport costs, provide employment, and increase urban economic resilience. (Menatalla Ashraf et al., 2026)

II. Review of Literature

In this paper, a Success Index for urban farming implementation in Egypt is developed and validated, due to the under-representation of urban agriculture in national food security policies. Egypt is exposed to a variety of structural problems that include the desert-like land availability, water scarcity, land fragmentation, food waste and dependence on imports that have grown to 58%of wheat imported and loss of around 74,500 ha of agricultural lands in 1992-2015. The research uses a mixed-methods design which incorporates literature review concerning food security resources and pillars, comparative analysis of cases of urban farming both from Egypt and abroad and semi-structured interviews with practitioners in Egypt including Tulima Farms, Shagarha, VertiCairo, GrowPro and urban gardeners privately owned. (Menatalla Ashraf, 2Hussam R. Hussain 2026)

The research focuses on the idea of Vertical Farming, which is one of the recent concepts that evolved as part of sustainable cities' trends, due to the shortage of green spaces, population growth, and insufficient ingredients needed for horizontal urban agriculture (water-energy-land), as well as other uses of land that could bring more profits. So, in this way, the problem was identified from the cognition aspect of studying the significance of vertical Farming against horizontal farming and creating sustainable cities. (Hajer Ismail Khalil and Khalid Abdul Wahhab 2020)

This chapter provides a comparison between the cost-effectiveness, advantages and disadvantages of controlled environment vertical farming (VF) systems (i.e. indoor hydroponic/aeroponic plant factories) open field methods, focusing especially on leafy vegetables. From various studies, it has been found that the two strengths of VF are land use and water use reduction, as well as shortening of the supply chain, whereas the weaknesses of the process include high energy and investment costs. (Naveen Chandra 2026)

The developments in the field of science and technology along with the phenomenon of global urbanization have become the main forces shaping the direction and evolution of agricultural research. Increase in per capita income in the developing countries has brought changes in the tates of food among others. However, vertical farming and organic farming are the key areas where these constraints can be combated. Vertical farming involves stacking the farms vertically; hence, less land area can produce more crops. (Anirudh Garg, Rekha Balodi 2014)

III. Success Criteria for an Urban Farm Approach

What criteria make an urban farm successful? How is the success of urban farms possible? The following section focuses on how experts and policymakers have come up with approaches for developing sustainable food production landscapes in the urban environment.

In the context of food production systems through urban agriculture at the urban scale, the strategy to be adopted will involve:

- Land availability for food production.
- Sustainability of the available land for a long time.
- Education in urban agriculture.
- Making sure that urban farms continue to be an important part of the community.
- Access for the city people to start rooftop farms and urban greenhouses for food production.

Considering urban agriculture on a regional level, the plan should consist of:

- Evaluating the possibilities and capabilities for urban food production in the region, including the land use, soil fertility, transportation, and infrastructure available.
- Developing a sustainable food production plan based on identifying the farmland resources and the urban food needs.
- Protecting the agricultural lands both currently and in the future in the region.

Furthermore, urban farming tactics need to be based on the location of urban farms in the city in conjunction with proper water supply and water management techniques. Another important aspect is that of resource management through cultivating different kinds of crops. Innovation and the ability to solve problems is what successful urban farmers possess. It is also necessary for the urban farming strategies to involve people with marketing and business management capabilities. Effective strategies also involve community involvement through educational sessions and tours.

Disadvantages of Horizontal Agriculture:
Environmental

- Horizontal agriculture through the rooftops of buildings helps in the purification and cooling of the air which surrounds the plants only (air surrounding the building). But without the air in the environment outside the building which has numerous pollutants and toxic gases
- However, horizontal agriculture practiced on the rooftops of the buildings does not contribute to the soundproofing because it comes about due to the activities of the urban population, such as vehicle noise.
- In the traditional form of horizontal agriculture, there is a use of both solar energy and energy from other artificial sources to perform tillage, irrigation, harvesting, among others.
- Horizontal farming is not considered environmentally friendly because of the harmful emissions produced during production and transportation. For the farming

of crops, large amounts of chemical pesticides are required and there is also a higher production rate.

Social

- Horizontal agriculture is done on the roofs of buildings, and hence it is out of sight. It is not in the angle of vision.

Economic

- Horizontal agriculture carried out on the roofs of the buildings is subject to direct sunshine during all day hours, especially in hot and dry climates such as that of Iraq, which exposes this roof cover to destruction since the value of this roof cover remains effective for a short period and even the process of watering and maintenance is also hard. The planting is done through special containers.
- The horizontal agriculture needs a wide land for the purpose of farming; for instance, the horizontal agriculture needs a width of at least 72m for production of 150kg of vegetables within a month.
- Traditional horizontal farming takes about 300-400 liters of water for production of 1 kg of vegetables.
- Traditional horizontal farming utilizes a lot of materials like seeds, soil, water, and food.
- Traditional horizontal farming does not contribute to the local economy and hence the costs associated with it along with the losses.

Advantages of Urban Framing:

Environmental

- Urban agriculture on the building walls helps in the purification and cooling of the air adjacent to the vegetation cover, as well as the cooling of the building walls' surface, and alleviating the climatic conditions of the alleys and streets of the city by decreasing infrared radiation in such a way as to enhance the urban environment in cities.
- Vertical agriculture on the building walls enhances the sound insulation, which arises due to the activities associated with people's life in the city, especially the sound of vehicles.
- Vertical agriculture requires artificial energy sources; it uses around 60 watts of energy per day to recycle the ponds in addition to using fewer solar energy sources for food production
- Urban farming, especially vertical wall gardens, has a faster evaporation rate, whereby the effect on the local weather is greater (urban street weather).
- Urban farming as a green activity There are no emissions in the process of production and transportation. No chemical pesticides are required for the cultivation of agricultural crops. The production cycle is shorter.

Social

- The vertical farming takes place on the walls of the buildings whether inside the buildings or outside them. This puts vertical farming into consideration under the

angle of view and is not restricted by the height of the building but adds to the aesthetic value of the city.

Economic

- Farming vertically along the walls of the buildings is subjected to both direct and indirect sunlight as it moves on a daily basis and hence is more durable and is resistant to damages.
- Vertical farming needs less space for growing foods, it only needs 6m vertical space to produce 150 kg of vegetables per month, which is ten times higher than the traditional horizontal farming methods.
- Vertical agriculture needs 12 liters of water to grow 1kg of vegetable, and therefore vertical agriculture can help in solving water scarcity problems.
- Vertical farming requires 75% fewer resources compared to the conventional way of growing crops since there was no waste of materials due to run-off in agriculture.
- Urban farming also helps in promoting economic activities in the local area through reduction in total cost of agriculture by 60% compared to the traditional way of growing crops horizontally. In addition, vertical farming helps drive technological innovations in agriculture. (Hajer Ismail et al., 2020)

Practices in Urban Agriculture

These challenges can be addressed through some of the best practices that maybe used to improve urban agriculture projects. Community Involvement: The involvement of the community in urban agriculture projects is crucial for success. The significance of community member participation in the decision-making process, since this develops a sense of ownership and ensures continued participation. Integrated Approaches: Employing an integrated approach that includes both urban agriculture and urban planning can increase the advantages of food production in urban settings. promote policies that emphasize the importance of green infrastructure and urban agriculture as part of city planning, thereby establishing a connection between food production, environmental sustainability, and urban resilience.

Technology and Innovation: Using technology may also help increase the efficiency and productivity of urban agriculture. Techniques like vertical farming and hydroponics can provide solutions that save space while producing food. Highlights the possibility of using technology in an efficient manner to ensure resource utilization for urban agriculture. (Bambang Tri et al., 2024)

Objectives

- To Assessing the relative efficiencies of land, water, labor, energy, and other inputs of agriculture in both of the farming systems.
- To Estimating the contributions of urban agriculture and conventional agriculture in the incomes and food security of households.
- To Examine the main constraints of both agricultural systems in economic, technological, and institutional aspects.

IV. Methods

This research makes to understand the part that urban agriculture can play in overcoming the problems posed by land scarcity during urbanization. who will include urban farmers practicing different types of urban agriculture, agricultural specialists, as well as government officials who work in urban planning and agriculture. While this methodology hopes to bring about important insights, the limitations of this method include its being qualitative in nature, which may influence generalizability, as well as biases present in self-reported data. Overall, the methodology is meant to bring about rich insights on urban agriculture as a solution to addressing land constraints in urban environments. (Bambang Tri et al., 2024)

Discussion - overall opportunities and challenges

Vertical agriculture brings farming into a new dimension. As opposed to soil farming and horizontal crop planting on a single plane, vertical agriculture introduces soilless farming in a vertical structure on several planes in an indoor environment such as a glasshouse or buildings. This enables growers to provide fresh, safe, and healthy food products throughout the year without any disruptions caused by soil pathogens. Vertical farming and Urban farming increase the productivity of plants per unit area much more than hydroponics cultivation horizontally. Despite being good sustainable solutions to ensuring food security, there are still various challenges associated with vertical farming and urban agriculture. One of the biggest challenges facing vertical farming is the expensive cost of setting up the infrastructure. In order to make up for the expensive costs, there is need for vertical farming to be resource-efficient in order to increase the yield and quality of crops together with the installation of an automated controlling system. (Soojin Oh et al., 2023)

V. Conclusion

Horizontal agriculture was at the core of the emergence of the first civilizations, yet, the development of the three key factors has led to the separation of agriculture from the city, and hence the search for an alternative solution of urban agriculture. These three key factors are: modern era, industrial revolution, and urban development and expansion. Urban agriculture is not an entirely novel idea; there is precedence in the past ages of many civilizations of vertical farming, which has been used for varied reasons, both aesthetically and productively, ranging from varied species to every effort to vertical greening, either interior or exterior, comes under vertical farming. Vertical farming is a sustainable agricultural practice that could be the replacement for traditional agriculture and it is known as the effectiveness that involves the integration of architecture, technology and agriculture in tall structures, showing the degree of interconnectedness of city life with nature. (Hajer Ismail Khalil et al., 2020)

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