Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 03 (MAY-JUNE, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Verticle Farming for Maximising Land Utilisation

(*Komal Bhatt[1], Mukul Anand Ray[2], Deeksha Gupta[1] and Swati Priya[3])
[1]Ph.D. Research Scholar, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, MP-482004
[2]Ph.D. Research Scholar, ICFRE- Tropical Forest Research Institute, Jabalpur, MP-482021
[3]Ph.D. Research Scholar, ICFRE-Eco-rehabilitation Centre, Prayagraj, UP-211002
*Corresponding Author's email: komalbhatt2797@gmail.com

Scientific and technological developments, along with the trend of global urbanization, are the key elements determining the direction and growth of agricultural research. Dietary choices have changed as a result of global connections, shifting employment and rising per capita wealth in developing nations. Because of these changes and population expansion, agriculture confronts challenges in producing more and better food. The productivity of agriculture is restricted by the application of traditional farming methods. These trends suggest that the adoption of new agricultural technologies is inevitable and that their integration with conventional farming practices is necessary. One area of research to address these constraints is vertical farming. Due to the vertical farming method, which involves stacking farms vertically, small plots of land can yield higher yields. Furthermore, given that food needs may be met in urban areas, this approach is highly appropriate for the world's rapidly urbanizing population. This lowers the expense of transport and the harm that gasoline consumption does to the environment. This farming method can be utilized to boost productivity and production in order to meet the growing demand for food.

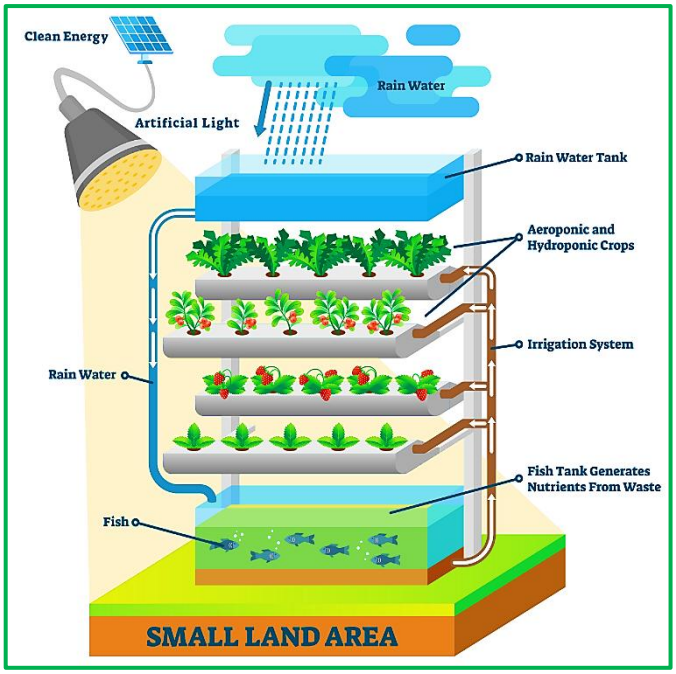
The biggest challenge facing agricultural sciences today is making sure there is a consistent and enough supply of food to support the growing human population. There has been a noticeable increase in the population of cities worldwide. Aside from these issues, fuel crops are becoming more and more necessary to sustain the rapidly increasing economies. According to UN estimations, there may be 9.15 billion people on the earth by 2050. This indicates that 2.25 percent population growth is predicted during the next 40 years (Alexandratos and Bruinsma, 2002). This offers a potentially massive market for food grains and food production will have to double to keep up with this demand. Projections indicate that food production needs to expand globally by 70% in order to feed the world's population by 2050, with rising countries needing to quadruple their food output (Fischer, 2009). A primary hindrance to this undertaking is the scarcity of water and land resources, in addition to the environmental strain caused by climate change. Scientific and information technology improvements have made the world more connected and comfortable, but they have also modified farming practices.

The use of intensive farming and vertical farming has increased recently in agriculture to meet the demands of a growing global population and solve environmental issues. Vertical farming will play a part in providing food and other requirements to the fast-growing urban population.

Verticle Farming

The concept of vertical farming was introduced by Professor Despommier. Vertical farming can be broadly defined as a commercial farming technique wherein living organisms are

purposefully stacked vertically on top of one another to cultivate plants, animals, fungus and other living forms for food, fuel, fibre or other purposes. Vertical farming is the term for large-scale cultivation carried out in urban high-rise structures. Urban areas are to be used for the production of fruits, vegetables, medicinal plants, fuel-producing plants and other plant products. Vertical farming is a technological advancement over greenhouse farming because it uses resources in vertical arrays and can meet food supply demands using resources from megacities. Three farming methods are included in vertical farming:



1. Gilbert Ellis Bailey first introduced the idea of "vertical farming" in his book published in 1915. Zhang (2018) claimed that he introduced the concept of subsurface vertical farming, which is being carried out in the Netherlands.
2. In the second type, vertical farming is carried out either outdoors or in sky scrapers with mixed purposes for temperature control and consumption. This type of sustainable farming can be carried out for private or communal purposes as opposed to commercial gain.
3. Large-scale, closed-system agriculture of plants and animals in sky scrapers is included in the third category.

Types of Vertical Farms

Vertical farms come in a variety of shapes and sizes, from small two-story or wall-mounted systems to massive warehouses, several storeys above ground. Nonetheless, the three soilless plant nutrition systems—aquaponic, aeroponic, or hydroponic—are utilised by all vertical farms. These are the descriptions of these three growing systems:

1. **Hydroponics:** The most popular growing technique used in vertical farms is hydroponics, which involves growing plants in nutrient solutions without the need for soil. The nutrient solution, in which the roots of the plants are submerged, is periodically inspected and re-circulated to ensure that the right balance of chemicals is preserved.
2. **Aeroponics:** The National Aeronautical and Space Administration developed the innovative indoor growth technique (NASA). During the 1990s, NASA began referring to "aeroponics," which is defined as "growing plants in an air/mist environment with no soil and very little water," to better facilitate plant growth in space.

Aeroponics systems are gaining a lot of attention, while being relatively unusual in the world of vertical farming. By far the most efficient plant-growing technique for vertical farms is an aeroponic system, which uses up to 90% less water than even the most successful hydroponic systems.

3. **Aquaponics:** Beyond a hydroponic arrangement, an aquaponic system combines fish and plants in the same habitat. The nutrient-rich excrement that fish bred in indoor ponds produce is fed to the plants in the vertical farm. The plants filter and purify the wastewater before recycling it to the fish ponds. While aquaponics is used in smaller-scale vertical farming systems, the majority of commercial vertical farm systems focus on producing a select group of fast-growing vegetable crops without the use of aquaponics. By doing this, production and economic issues are made simpler and efficiency is maximized.

Advantages of Vertical Farming

- **Increased crop yield and availability:** Regardless of the weather, this agricultural technology verifies crop productivity all year round.
- **Growing organic crops:** Vertical farming will make the cultivation of organic crops on a large scale easier. The use of chemical pesticides will decline as a result of the use of this technique.
- **Recycling and preservation of natural resources:** Two vertical farming techniques that utilise far less water than conventional agriculture are hydroponics and aeroponics. Further resource recycling can be facilitated by using composted and recycled urban sewage waste in vertical farming.
- **Environmentally friendly:** Vertical farming can help forests regenerate by lowering reliance on land resources. Additionally, by using equipment less, CO_2 emissions will decrease, contributing to environmental conservation.
- **Sustainable urban expansion:** By utilizing various technologies in conjunction with a comprehensive approach, vertical farming can assist urban regions in accommodating anticipated population growth while maintaining food security. Nonetheless, conventional farming will persist since numerous crops are unsuitable for indoor cultivation.

Main Obstacles Hindering Acceptance of Vertical Farming

- Because weather patterns vary greatly around the globe, uniform practices for vertical farming cannot be implemented.
- Insufficient crop varieties appropriate for vertical farming. The researchers must give this issue their full attention right away because it will be challenging to apply this technique without appropriate variations.
- Urban inhabitants lack the knowledge and abilities necessary for farming practices.

Discussion

Currently, the main goals of agriculture are environmental preservation and achieving food production sufficiency. The work at hand is hindered by the depletion of water and land resources, as well as the environmental health issues resulting from the overuse of pesticides in agriculture for pest control and nutrition (Khan *et al*. 2023). The rate of climate change has increased due to anthropogenic actions for development, which have further degraded the ecosystem. Worldwide endeavours have been launched to mitigate the impacts of climate change on the planet overall and agriculture specifically. These actions ought to be

complemented by advancements in agricultural production methods as well as the scientific application of indigenous knowledge, which has been shown to be more sustainable.

A new distinct agricultural approach has been discussed above that can be implemented globally and seamlessly incorporated into the current agricultural system. The growing per capita wealth of emerging countries and the shrinking amount of land available for agriculture make vertical farming, a relatively new idea in agriculture, extremely promising. Although the approach is novel for a developing country, it has a lot of potential and can effectively address the challenge in terms of quantity, quality and variety. This very distinct approach is a promising direction for global agriculture and need more investigation in terms of study and mainstream integration for a world that is fed and the environment is kept healthier.

Conclusion

In conclusion, new innovations in agriculture are being brought about by shifting demographic trends and technology breakthroughs. It is necessary to employ these new technologies carefully in order to satisfy the increasing demands of contemporary agriculture. To fulfill the evolving requirements and desires of humanity, vertical farming can be embraced as viable alternative to traditional agriculture. In addition, barriers to the adoption of the practice should be addressed and connections between farmers and researchers should be established in order to implement appropriate solutions.

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