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Vertical Farming: An Effective Way to Overcome Food Shortage

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SUMMARY

Advancements in the field of science and technology along with the global urbanization are the major factors driving the course and evolution of agricultural research. Rise in per capita income in developing nations, occupational changes and global linkages have changed the food preferences. Increase in the productivity of agriculture by employing techniques of conventional agriculture is posing a limitation. Vertical farming employs vertical stacking of the farms therefore small land can be utilized for more production. In addition, this technique is well suited for the rapidly growing global urban population as the demands of food supply can be met from within the cities and thus reducing the transportation cost and environment deterioration caused by fuels in the process.

INTRODUCTION

Most challenging task for agricultural sciences today is to ensure for continuous and enough supply of food to growing human civilization. Urban centres throughout the world have experienced substantial increase in population; this growth is accompanied with change in food habits and rising concerns for food quality. Increasing global trade and easy accesses to chemical and technology has contributed to changes in agricultural systems. Recent trend in agriculture has seen rise in organic agriculture, vertical farming and intensive agriculture to accommodate the demands of increasing world population and address the rising concern for environmental issues. It shall help in meeting the food & other demands of the rapidly growing urban population.

Vertical Farming

Concept of vertical farming was given by Professor Despommier; the farm uses conventional farming methods such as hydroponics and aeroponics to produce more yields faster. Vertical farming can be defined generically as a system of commercial farming whereby plants, animals, fungi and other life forms are cultivated for food, fuel, fibre or other products or services by artificially stacking them vertically above each other. It is large scale agriculture in urban high-rise structures and a step ahead technology from green houses as it involves harnessing of resources in vertical arrays and can feed the demands of food supply

Techniques of vertical farming

Indoor Hydroponics

Aquaponics with catfish

Aeroponically-grown chives

Hydroponics: Hydroponics refers to the technique of growing plants without soil. The roots of plants are submerged in liquid solutions containing macronutrients, such as nitrogen, phosphorus, sulphur, potassium, calcium, and magnesium, as well as trace elements, including iron, chlorine, manganese, boron, zinc, copper, and molybdenum. Additionally, inert mediums such as gravel, sand, and sawdust are used as soil substitutes to provide

support for the roots. The advantages of hydroponics include the ability to increase yield per area and reduce water usage.

Aquaponics: Aquaponics takes hydroponics one step further by integrating the production of terrestrial plants with the production of aquatic organisms in a closed-loop system that mimics nature itself.Nutrient-rich wastewater from the fish tanks is filtered by a solid removal unit and then led to a bio-filter, where toxic ammonia is converted to nutritious nitrate. While absorbing nutrients, the plants then purify the wastewater, which is recycled back to the fish tanks. Moreover, the plants consume carbon dioxide produced by the fish, and water in the fish tanks obtains heat and helps the greenhouse maintain temperature at night to save energy.

Aeroponics: The invention of aeroponics was motivated by the initiative of NASA to find an efficient way to grow plants in space in the 1990s. Unlike conventional hydroponics and aquaponics, aeroponics does not require any liquid or solid medium to grow plants. Instead, a liquid solution with nutrients is misted in air chambers where the plants are suspended. By far, aeroponics is the most sustainable soil-less growing technique, as it uses up to 90% less water than the most efficient conventional hydroponicsystems and requires no replacement of growing medium.

Controlled-environment agriculture: Controlled-environment agriculture (CEA) is the modification of the natural environment to increase crop yield or extend the growing season. CEA systems are typically hosted in enclosed structures such as greenhouses or buildings, where control can be imposed on environmental factors including air, temperature, light, water, humidity, carbon dioxide, and plant nutrition.

Building-based farms: Abandoned buildings are often reused for vertical farming, such as a farm at Chicago called "The Plant", which was transformed from an old meatpacking plant. However, new builds are sometimes also constructed to house vertical farming systems.

Shipping-container vertical farms: Recycled shipping containers are an increasingly popular option for housing vertical farming systems. The shipping containers serve as standardized, modular chambers for growing a variety of plants and are often equipped with LED lighting, vertically stacked hydroponics, smart climate controls, and monitoring sensors. Moreover, by stacking the shipping containers, farms can save space even further and achieve higher yield per unit area.

Deep farms: A "deep farm" is a vertical farm built from refurbished underground tunnels or abandoned mine shafts. As temperature and humidity underground are generally temperate and constant, deep farms require less energy for heating. Deep farms can also use nearby groundwater to reduce the cost of water supply.

Advantages of vertical farming

- This farming technology confirms crop production all year-round irrespective of the environmental conditions.
- Vertical farming will facilitate production of organic crops in large scale production
- The vertical farming technology includes hydroponics and aeroponics which consumes very less amount of water than utilized in the conventional agriculture. Thus, helps in conservation and recycling of the water resources.
- Vertical farming will reduce the dependency on land resources and help in regrowth of forests.
- Vertical farming, applied with a holistic approach in combination with other technologies, will help urban areas to absorb the expected rise in population and yet still remain food sufficient.

Problems

- Vertical farms must overcome the financial challenge of large startup costs
- During the growing season, the sun shines on a vertical surface at an extreme angle such that much less light is available to crops than when they are planted on flat land. Therefore, supplemental light would be required.
- There are a number of interrelated challenges with some potential solutions:A vertical farm requires a CO_2 source, most likely from combustion if collocated with electric utility plants; absorbing CO_2 that would

otherwise be jettisoned is possible. Greenhouses commonly supplement carbon dioxide levels to 3–4 times the atmospheric rate.

- Some greenhouses burn fossil fuels purely to produce CO_2, such as from furnaces, which contain pollutants such as sulphur dioxide and ethylene. These pollutants can significantly damage plants.
- Light pollution: Greenhouse growers commonly exploit photoperiodism in plants to control whether the plants are in a vegetative or reproductive stage.
- Power needs: If power needs are met by fossil fuels, the environmental effect may be a net loss, even building low-carbon capacity to power the farms may not make as much sense as simply leaving traditional farms in place while burning less coal.
- Necessary ventilation may allow CO_2 to leak into the atmosphere, though recycling systems could be devised.
- Water pollution: Hydroponic greenhouses regularly change the water, producing water containing fertilizers and pesticides that must be disposed of. Spreading the effluent over neighbouring farmland or wetlands would be difficult for an urban vertical farm

Key issues challenging the adoption of vertical farming are

- Uniform practices cannot be adopted for vertical farming due to variable weather conditions in different regions of the world.
- Lack of crop varieties suitable for the vertical farming. This aspect needs immediate attention from the researchers, as in the absence of suitable varieties adoption of this technique will be difficult.
- Lack of knowledge and skills required for farming practices in urban populations.

CONCLUSION

Changing demographic trends and technological advancements are delivering new innovations in the field of agriculture. These emerging technologies are required to be used judiciously to meet the growing demands from modern agriculture. Vertical farming and organic farming can be adopted as the viable alternatives for the conventional agriculture to meet the changing demands and needs of mankind. Further, constraints in adoption of such practices should be addressed and linkages between researchers and farmers should be created for suitable measures.

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