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Policy Article



Vertical Farming: Future of Modern Agriculture

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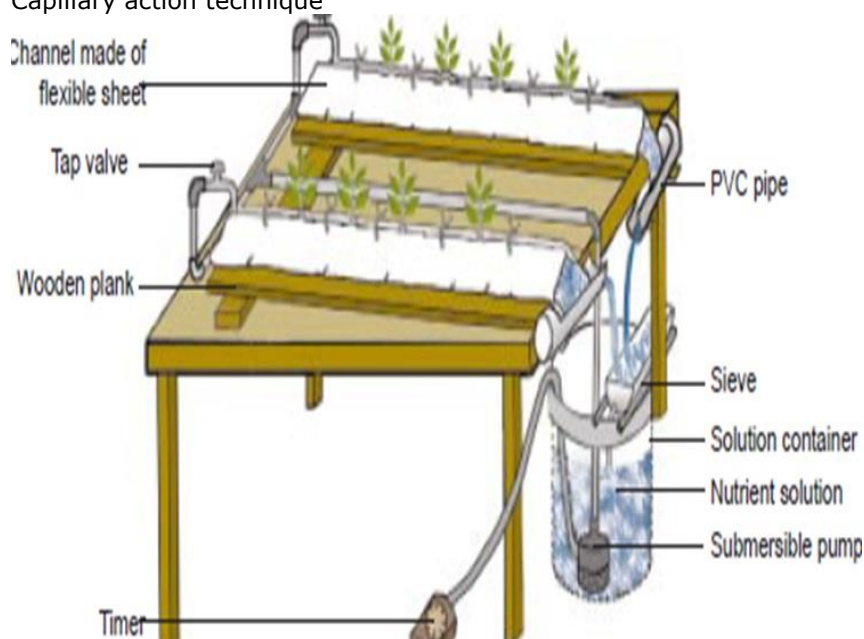
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As cities faces ever greater population pressure with inadequate infrastructure. The concept of a vertical farm was developed to remedy these crises. Vertical farming is a method of large-scale farming of fruits, vegetables, herbs and ornamental plants in multi-story buildings (living sky scrappers) in an urban environment. It is also called as controlled environment agriculture or building integrated agriculture. The term "Vertical farming" was coined by Gilbert Ellis Bailey in 1915 in his book *Vertical Farming*. The current ideas and concepts surrounding vertical farming are primarily championed by Professor Dickson Despommier at Columbia University in New York. It is an intensive farming strategy mainly employs advanced techniques such as hydroponics and aeroponics which enables year-round production in any geographical location far more quickly under artificial lighting with less use of water, labor and minimal land than traditional farming. There is vast scope for the growth of this concept of farming as many cities still need to have the requirement for self-sufficiency in fruits and vegetables.

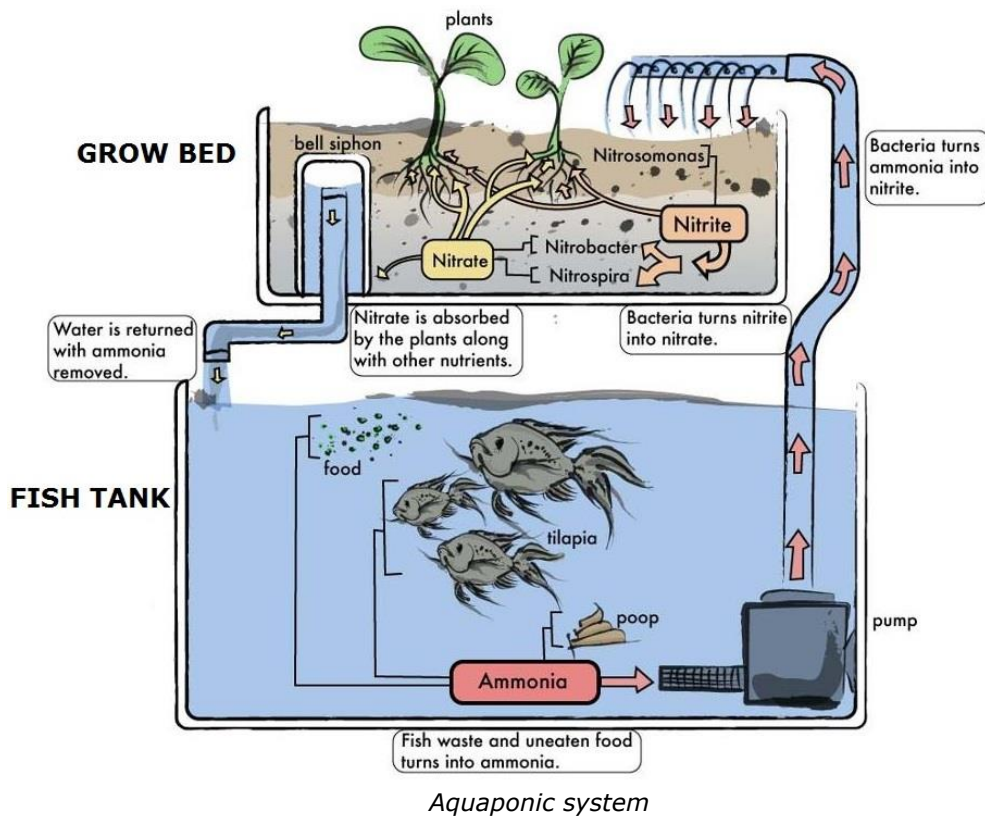
Techniques followed in vertical farming

1. **Hydroponics:** Cultivation of plants through continuous flow of oxygenated, nutrient rich water with or without the use of an artificial medium (inert material) for mechanical support.
 - a. *Circulating methods (closed system)*
 - Nutrient film technique (NFT)
 - Deep flow technique (DFT)
 - b. *Non-circulating method (open systems)*
 - Root dipping technique
 - Floating technique
 - Capillary action technique

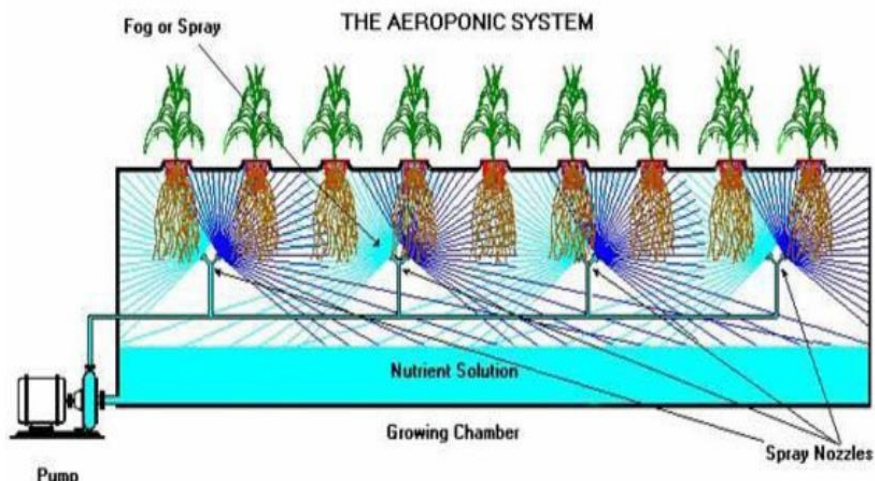


Nutrient Film Technique – commonly used hydroponic system

2. **Aquaponics:** It combines both hydroponics and aquaculture where we can get both crops and fish.



3. **Aeroponics:** Technique of growing plants with roots exposed aerielly, where nutrients are supplied/ sprayed in the form of mist or fog.
 - a) Root mist technique
 - b) Fog feed technique



Advantages of vertical farming

1. **Year-round crop:** It means that a grower can plan to grow crops year round. Not only is this a better and more reliable strategy for sustainable food production, but also it allows the grower to take advantage of seasonal markets that may permit a crop to be sold at a much higher than normal price.
2. **No agricultural runoff:** Runoff in most farming operations is laden with silt, fertilizer, pesticides and herbicides which usually ends up in some river on its way to the estuary. All of the

damage caused by runoff can be prevented by shifting to an indoor cultivation strategy. The water used to grow food inside can be even recirculated and used again provided that nutrients are replaced at the same rate that they are taken up by the hydroponically grown plants.

3. No use of fertilizers and pesticides: The vertical farm will employ state-of-the-art hydroponic and aeroponic technologies configured inside of a secure building. The design of the building takes into account the need for keeping out unwanted insects and microbial pathogens where it is difficult to control pests and diseases in traditional farming, so growers will go for pesticides. In addition, fertilizers are essential for maximizing crop yields in nutrient depleted soils. In contrast, the vertical farm uses pure water into which a set of highly purified, carefully balanced nutrients have been dissolved to satisfy the nutritional requirements of the plants.

4. Conservation of natural resources: As this farming includes hydroponics and aeroponics which consumes very less amount of water than utilized in the conventional agriculture. Thus, helps in conservation of the water resources.

5. Increase in production and availability in crops: This farming technology confirms crop production all year-round irrespective of the environmental conditions. According to "The encyclopedia of earth, 2010" A 30 storey high building with a basal area of 5 acres (2.02 ha) has the potential of producing crop yield equivalent to 2,400 acres (971.2 ha) of traditional horizontal farming. Expressed in ratio, this means that 1 high-rise farm is equal to 480 traditional horizontal farms.

6. New employment opportunities: The advent of vertical farms will create numerous new opportunities at many levels. Municipalities will use vertical farms to rehabilitate urban spaces once considered too degraded to serve as commercial properties. Areas in which vertical farms become situated will in turn attract new development, making the urban food desert a thing of the past.

Issues challenging the adoption of vertical farming

1. Selection of ideal crop for vertical eco-farming
2. Monitoring of optimum light quality, temperature, relative humidity, water quality
3. Maintenance of optimum nutrient concentration and optimal pH in nutrient solution
4. Substrate of vertical eco-farming
5. High initial cost

Crops suitable for Vertical Farming	
Fruits	<i>Fragaria ananasa</i> (Strawberry)
Vegetables	<i>Solanum lycopersicum</i> (Tomato), <i>Capsicum frutescens</i> (Chilli), <i>Capsicum annum</i> (Bell pepper), <i>Phaseolus vulgaris</i> (Green bean), <i>Beta vulgaris</i> (Beet), <i>Brassica oleracea var. capitata</i> (Cabbage), <i>Brassica oleracea var. botrytis</i> (Cauliflower), <i>Cucumis sativus</i> (Cucumbers), <i>Cucumis melo</i> (Melons), <i>Raphanus sativus</i> (Radish), <i>Allium cepa</i> (Onion)
Leafy vegetables	<i>Lactuca sativa</i> (Lettuce), Kale, Spinach
Flower/ Ornamental crops	<i>Tagetes patula</i> (Marigold), <i>Rosa chinensis</i> (Roses), <i>Dianthus caryophyllus</i> (Carnations), <i>Dendranthema grandiflora</i> (Chrysanthemum), Petunia, Pansy, China Aster
Condiments	<i>Petroselinum crispum</i> (Parsley), <i>Mentha spicata</i> (Mint), <i>Ocimum basilicum</i> (Sweet basil)
Medicinal crops	<i>Aloe vera</i> (Indian Aloe), <i>Solenostemon scutellarioides</i> (Coleus)

Conclusion

We are at least 5 - 10 years away from this type of concept. We still have enough land to feed our population and we haven't reached crunch point yet. However, concept of vertical farming needs to be given serious consideration, especially as water and land for agriculture is depleting day by day but population is growing rapidly. In this context, Vertical farming seems to be the only solution to solve the problem of hunger globally which also reduce the incidence of armed conflict over natural resources and converts abandoned urban properties into food production centres. This innovative approach could become the norm as soon as 2050, while crop land grows scarce and a booming population demands more food.



Vertical farming of Lettuce



Vertical farming of Straw berries