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Vertical Farming of Vegetables: Developments and Future Directions

Shilpa
Senior Research Fellow, CSK HPKV Palampur, Dist. Kangra, Himachal Pradesh

SUMMARY

This article is related to the vertical farming of vegetables. It includes SOWT analysis of vertical farming. Market potential and achievements of vertical farming in the world. Indian scenario and vertical farming start-ups in India.

INTRODUCTION

Vertical Farming as a concept was developed in recent years (1999) through the advances in technology by Dickson Despommier at Coloumbia University. He also explained how hydroponic crops can be grown on upper floor and the lower floors would be suited for chickens and fish that eat plant wastes.Vertical farming is the practice of producing food and medicine in vertically stacked layers, vertically inclined surfaces and/or integrated in other structures (such as in a sky scrapper, used warehouse, or shipping container).Vertical farming in India have challenges like public awareness, inclusiveness of farming community, technical know-how, cost incurred in managing and mainlining the vertical farm systems, and also its economic viability (Sonwane, 2018).

Problems

Arable land is finite, with agricultural land covering 38%and arable land covering 11%of the total land area. The global projections show that up to 2040 agricultural land can only be increased by another 2% (FAOSTAT, 2012). By 2050ground water levels are going to be depleted severely, where scarcity of water for irrigation and even for drinking (FAO,2013). Climate change possess great challenge and also degradation of soil.

Why Vertical Farming?

Vertical Farming holds the promise of addressing environmental issuesby enabling more food to be produced with less resources use.Vertical Farming is steadily becoming a subject discussed broadly in industrial and scientific communities (Al-Chalabi, 2015).Minimisation of water requirements(through water recycling).Steady supply of the products to the centres of demand, bringing down the necessity for storing and refrigeration.

Vertical Systems

Vertical systems are ones where some plants are on the ground while others are stacked in rows vertically. Tested for crops with small plants like strawberry and lettuce with limited results.The nutrient solution is applied at the top and drips through a bag filled with substrate. Drain water is collected at the bottom. Similar systems are used in aeroponics or as stacked containers (Liu *et al*., 2005).The main reason is to make optimal use of available space in an attempt to maximize the yield per square meter.

Vertical Towers

A tower garden, also called a window farm is a system of vertical hydroponics, which includes an A-Frame hydroponic system, hydroponic wall and cascades of bottles. It can be used for growing various crops like strawberry, lettuce, Swiss chard, herbs, spinach, kale, broccoli and flowering petunia.It can also be used for growing plants indoors if lights are provided above the tower, which is popular in urban areas with only a small space for gardening.The design can be modified according to preference. For example, towers can be hung from the top and can drain to a single tank to collect the nutrient solution (Dunn, 2017).

Advantages of Vertical Farming

- Increased Crop Production
- Protection from Weather Related Problems.
- Environment Friendly
- Growing Higher Quality Produce
- Conservation of Resources
- Vertical Farming Flexibility

Vertical Farming v/s Traditional Farming

- Yields are approximately 5 times higherthan the normal production volume of field crops.
- Vertical crop requires only 8% of the normal water consumptionused to irrigate field crops.
- High levels of food safetydue to the enclosed growing process.
- Significant operating and capital cost savings over field agriculture.

Minimizes the negative environmental effects of agriculture:

- With regard to greenhouse gas emissions.
- Soil degradation.
- Protection of already dwindling water supplies.
- Biodiversity arises.

SWOT Analysis

Strength

Abandoned urban properties, abandoned mines can be converted into food production centers thereby eliminating the need for expensive constructions. Eg. 1 indoor acre is equivalent to 4-6 outdoor acres or more, depending upon the crop (e.g.,strawberries: 1 indoor acre = 30 outdoor acres).Due to provision of artificial light at the required wavelength (380-450 nm in the violet end and 630-700 nm in the red end) for an optimal duration, crop production becomes a year round enterprise, comparable with other manufacturing industries. It also creates new employment and research opportunities. Technologies developed for VF may prove to be useful not only for remote research stations like in the poles, but also in refugee camps especially in flooded or earth quake affected areas where camp dwellers need to be fed for prolonged period of time. No weather-related crop failure due to droughts or floods as irrigation is artificial and controlled.

Weakness

Crops require space, light, carbon dioxide and water, which is available freely in nature. In case of Vertical Farming all these need to be supplied at a cost. Structures need to be built, generating additional costs. Taking this into consideration, Vertical Farming is logically viable only in places where agriculture is necessary but agro-climatologically difficult to be practiced in the open, like in desert nations or mountainous nations lacking flat arable land. But by 2050, our growing global population will require an estimated 60% more food than we produce today (Alexandratos and Bruinsma, 2012; Tilman*et al*., 2002; Green *et al*., 2005).Until 2050, the number of people living in urban areas is expected to rise to more than 6 billion.Food and Agriculture Organization of U.N. predicts that about 1.3 billion tons of food are globally wasted or lost per year(Gustavasson*et al*. 2011).

Opportunity

There is an increasing demand for protein, vitamin and mineral rich food as more and more countries transition from developing to developed nations. According to the United Nations World Food Programme, nearly 1 billion people worldwide are undernourished (FAO, 2012). The recent developments in the field of renewable energy, like Photovoltaics, Solar-Thermovoltaics, Wind or even Pumped-storage Hydroelectricity, are mostly located in areas unfit for agriculture. Even a small fraction of their generating capacity might be used for the purpose of a vertical farm.

Threat

It is feasible to grow only high value crops for consumers with dispensable money for such products. It has no merit to flourish even in Mega-cities in resource rich nations as long as conventional agriculture can supply food cheaply.

Market Potential

Presently the biggest markets for this technology according to the SWOT analysis, is in Desert regions, Taiga region and Megacities. The criteria are that we consider only those countries or cities where the GDP per capita is $ 20,000 or more and there is a demand emanating from a population of 5 million or more.Considering the countries in the desert, the Taiga regions, and the mega-cities, there is a potential of setting up around 2900 VF. Although this projection looks utopian, mass production will bring down costs, research will make production cheaper, as a result of which the market potential will extend to cities and countries not anticipate in this analysis.With an increasing threat of desertificationcaused by climate change, this segment is also going to retain its importance.

Achievements

According to vertical farming market report (2017): World's largest vertical farm in Newark, New jersey. Futuristic Japanese indoor vertical farm,produces 12000 heads of lettuce a day with LED lighting. Singapore's giant vertical farm**,** grows 80-120 tonnes of vegetables every year.

In March 2016, Illumitex (US) expanded its LED lighting services to six international countries in the vertical farming market. Among the International vertical farms, Illumitex is currently working with Remy located in Israel and Asahi Techno in Japan.

Indian Scenario

"ICAR is looking into the scope of vertical urban agriculture. This could cater to the need of fresh vegetables in the cities which are growing in terms height with numerous multistoried buildings cropping up and this farming will be done soil free."- Deputy Director General (crop science) ICAR. Scientists in at the Bidhan Chandra Krishi Vishwa Vidyalaya, Mohanpur, Nadia, West Bengal, have already had initial success in working on a small scale on brinjal and tomato, but implementing it on a large scale would require additional fund. Productive efficiency of vertical farming was tested in Punjab where scientist have attained initial success in growing potato tuber, fruit and vegetables in soil less and controlled environment.

Start-ups in India

Here's a list of four start-ups in India that are innovating agriculture methods and leading the way in indoor farming.

Letcetra Agritech

Goa's first, indoor hydroponics farm, growing good quality, pesticide-free vegetables, produces over 1.5 to 2 tons of leafy vegetables like various varieties of lettuce and herbs in its 150 sqmetre area. The start-up is founded by Ajay Naik, a software engineer-turned-hydroponics farmer. He gave up his IT job to help farmers in the country.

Junga Fresh n Green

Agri-tech start-up Junga Fresh n Green has joined hands with InfraCo Asia Development Pvt. Ltd. (IAD) this year to develop hydroponics farming methods in India.The project started with the development of a 9.3-hectare hydroponics-based agricultural facility at Junga in Himachal Pradesh's Shimla district.

Future Farms

Chennai-based Future Farms develops effective and accessible farming kits to facilitate Hydroponics that preserve environment while growing cleaner, fresher and healthier produce. The company develops indigenous systems and solutions, made from premium, food grade materials that are efficient and affordable.

Greenopiais

Bengaluru based startup Greenopiais selling kits with smart self-watering pots, enriched soil and the right seeds. The sensor-embedded pots replenish moisture in the soil on a need basis, and notify you when you need to refill water externally.

CONCLUSION

- The land productivity of vertical farming is twice as high as traditional agriculture.

- Yields are approximately 5 times higher.
- It can produce crops year-round.
- Less spoilage, infestation, and energy required than conventional farming encounters.
- Mostly independent of weather and protected from extreme weather events.
- Reduces transportation distance, thereby reducing cost, energy and carbon footprint.
- Higher quality produce with greater nutritional value and a longer shelf life.
- No need for the use of harmful herbicides or pesticides.
- Conservation of resources.
- Applicable on non-arable lands.
- Requires only 8% of the normal water consumption.
- Minimizes the negative environmental effects of agriculture.
- Operating and capital cost savings over field agriculture.
- High levels of food safety.

REFERENCES

Al-Chalabi M. 2015. Vertical farming: Skyscraper sustainability. *Sustainable Cities and Society*18: 74-77.

Alexandratos, N. and Bruinsma, J. (2012). World Agriculture towards 2030/2050: The 2012 Revision. Food and Agricultural Organisation, Rome.*Journal of* ***Natural Resources***, Vol.7 No.1, January 14, 2016.

Chirantan Banerjee. 2014. Up, Up and Away! The Economics of Vertical Farming in *Journal of agricultural studies*, Vol. 2, No.1.

Despommier D 2010. Book on The Vertical Farm, Feeding the world in 21st century, published by Thomas dunne books.

Despommier D. (2008)."Vertical Farm Essay I" Vertical Farm.Retrieved 2009-06-26.

Dunn B and Singh H. 2017. OSU extension fact sheets:Building a Vertical Hydroponic Tower, Oklahoma cooperative extension service.

FAO.Food and Agriculture Organization of the United Nations (FAO); Rome, Italy: 2012.World food programme:The state of food and agriculture.

FAOSTAT.Food and agricultural organization of United States;Rome, Italy: *FAO Statistical yearbook*, 2012. World food and agriculture, www.fao.org.

Gustavsson J., Cederberg C., Sonesson U., van Otterdijk R., Meybeck A. Food and Agriculture Organization of the United Nations (FAO); Rome, Italy: 2011. Global Food Losses and Food Waste: Extent, Causes and Prevention.

Liu W, Chen DK, and Liu ZX. 2005. High efficiency common culture system in China. *Acta Hort*.(ISHS), 691: 495-500.

Rathinakumari AC, Kalaivanan D, Smitha GR and Kumaran GS. 2019. Vertical garden: Sky is the limit. *Indian Horticulture* 39-40p.

Raviv M and Leith JH. 2013. Text Book on *Soilless Culture: Theory and Practice*, published by Elsevier, a division of Reed Elsevier India Private Limited.

Sonawane MS. 2018. Status of Vertical Farming in India.*International Archive of Applied Sciences and Technology* 9: 122-125.

Tong Z, Whitlow TH, Landers A and Flanner B. 2016.A Study at Brooklyn Grange Rooftop Farm.Published by Elsevier Ltd.