Doubling of Farmers' Income by 2022, Strategy Document for Sikkim
Vertical Farming: Status, Researchable Issues and Way Forward- Orchids

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Introduction
In the changing climate, polluted soil and water, increasing urban population and continuous decline in cultivable land, countries all over the world are facing challenges feeding their citizen safe and healthy food. Several option like roof top gardening, peri-urban horticulture have been suggested to meet the daily requirement of fruits, vegetables and flowers in urban areas. However, these ideas did not caught attention due to many inherent reasons. Environmentally controlled agriculture is one to answer these challenges. Greenhouse technologies are well established for round the year production, more reliable for safer food supply and can also be located close to the cities. Staking kind of glasshouses on top of each other in an integrated and well-engineered fashion is termed as Vertical Farming (VF). The term Vertical Farming was coined in 1915 by American geologist Gilbert Ellis Bailey. By the end of the 20th century, Dickson Despommier, a professor emeritus of environmental health sciences and microbiology at New York's Columbia University seized upon the idea of VF together with his students.

Vertical Farming increases the surface area for cultivation in addition to other advantages of greenhouse technology. The proponents of the technology believe that such technology would reduce the consumption of fossil fuel required for transportation of food articles from the far flung areas. However, meeting energy requirements would be greatest challenge. The research is being carried out to use non-conventional energy sources and increase the efficiency of light. The energy is not only for meeting the light requirements but also for other purposes like controlling the environment as per requirement of the crops. The technology could be useful for production of vegetables especially leafy greens and short duration crops.

Majority of orchids are epiphytic i.e. they grow in forests on tree trunks. In other words they are accustomed of growing vertically in poor light conditions. They are perennial and the flowering is influenced by the temperature and light. They also require less light, nutrients and well suited for growing on soilless media. However, meeting the climatic requirement out of their production zones would cost heavily on energy requirements. Model systems for tissue culture laboratories coupled with vertical farming for hardening of tissue culture plants, growing potted flowering plants of orchids with supplemental lighting, partially controlled green houses needs to be tested in the country.

Status of VF in orchids
Urban horticulture activities are increasing. It is estimated that 100 million people are engaged in urban horticulture throughout the world producing about 50 kg/ m² vegetables. A true vertical farm with commercial applications has yet to be built. The cost of energy requirements in multi-storeyed farms renders them unsustainable. So far the application of vertical farming is limited to vegetables especially leafy greens. Its application in orchids is negligible. An invention on
'Method and Apparatus for Nurturing Phalaenopsis Orchid Seedlings with Stalk with High Performance of Land Use' has been patented in Taiwan.

**Taiwan**
Taiwan, a small Asian country, has the Asia’s largest. Taoyuan’s YesHealth iFarm is a 14-story vertical farm which sells produce to public and vendors located in the Northern Taiwan covering 2,645 square meters with 130 employers attracting investors. In Taipei 80% of department stores are supplied with iFarm produce. Recently boosting the bilateral trade of UK and Taiwan where UK to invest US$25 million in Britain.

**Australia**
Unlike Asia and the United states, Australia doesn’t have many commercial vertical farms apart from private venture facility in Queensland: Vertical Farm Systems. Having, the automated growing system (XA-SERIES), commercially produces leafy green vegetables like spinach and rocket. Another Sydney-based vertical growing systems company PodPlants developed a portable and lightweight vertical garden. In 2014, the unique technology won the Australian Innovation Challenge. Vertical Farm Systems successfully enter the commercial market; still it lies challenging for Australia to thrive on vertical farming on a commercial scale. Apart from vast land resources availability but largely due to high price real estate, this ultimately may result in high retail product prices.

**Netherlands**
The first European Vertical Farm was set to open in the Netherland. Staay Food Group is bringing up a nine-story-building is projecting to grow various types of lettuce.

![Lettuce with LED lighting (Staay Food Group)](image)

**India**
In India the concept of vertical farming is yet to be popularized/commercialized. However, trails have been started at ICAR-NRC for Orchids, Sikkim from the last two years.
Researchable Issues
So far no work has been carried out on vertical farming of orchids. Vegetables especially greens leafy have been assessed for vertical farming.

Infrastructure
I. Design of Vertical Farming structure
Harnessing sunlight is the greatest obstacle in vertical farming. Several designs have been proposed to harvest sunlight and minimise the energy consumption in vertical farms. Efforts are being made to use the non-conventional sources to meet the energy requirements in multi-storied farms. The energy cost of such farms is very high and renders them unprofitable. India can look for modified vertical farms with minimum degree of control for production of orchids or other commercial flowers. Most of the metropolitan cities are reeling under water crises. Vertical farms should have water storage and supply system. The systems for supply of nutrient and water should be suitably worked as per our requirements.

II. Production and Management
i) Temperature & light requirements: Orchids are large group of plants encompassing approximately 25000 to 35000 species. On the basis of climatic requirements they are roadly classified as tropical, sub-tropical and temperate. For commercial point of view
on few genera like *Dendrobium*, *Cymbidium*, *Paphiopedilum*, *Phalaenopsis*, *Vanda*, *Aranda*, *Mokara* and *Cattleya* are preferred. The controlled environment requirement of some of the genus like *Cymbidium*, *Dendrobium* and *Phalaenopsis* has been worked out, but in other genera these requirements are yet to be standardized. Such information would be indispensable for studying the suitability of orchids in vertical farming. For example *Phalaenopsis* is a tropical orchid and requires an average temperature of 26 - 27°C during active growth period and 19-21°C during flowering phase. Low light intensity (1000-1500 f.c.), free air circulation, warm room and 60-80 % relative humidity are ideal for its growth and flowering. Being a CAM plant, it takes CO₂ at night at the rate of 600-800ppm. A potting mix consisting of 60 percent medium cocopeat, 20 percent perlite and 20 percent chopped sphagnum moss is recommended. A one -quarter, diluted 10-10 -10 or 12-12-12 fertilizer should be applied weekly. *Phalaenopsis* prefer an evenly moist media and they are sensitive to drying out. Repotting of *Phalaenopsis* is done every one to two years in late spring or after the main flowering season.

**ii) Nutrient and water delivery systems:** Several nutrient delivery systems are used in controlled environment production. These include hydroponics, nutrient film technique, aeroponics, aquaponics, growing media etc. These systems need to be standardised for growing of orchids. In nature, orchids grow as an epiphyte, nutrient and water requirement are met through the rains and decaying organic matter of tree trunk. The studies related to aeroponics in orchids are scarce. These kind of studies can be conducted for delivery of nutrient and water requirements. Several studies have been carried out on soilless media for orchids and these studies could be beneficial for planning vertical farming in orchids.

**iii) Breeding /screening of varieties for vertical farming:** Orchids have less light requirement as compared to other field and horticultural crops. The varieties suitable for vertical farming need to be bred. The miniature varieties and responsive to artificial lighting would be more suitable for vertical farming of orchids.

**Conclusion**

Usually orchids are grown under partially or fully controlled environment. Converting the structure of today’s controlled environments and their technology would need information of these systems for converting them into vertical farming systems and their application in the metropolitans. In future, production areas will gain more importance to meet shortage of food owing to changing climate and population growth. Since the cultivable land is decreasing day by day and allocation of new production areas for agriculture be limited the establishment of these types of systems will gain impetus in time. In near future, vertical farming system is expected to meet the requirements for growing cities.