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Vertical farming for higher profit and family nutrition

Vertical farming is the practice of growing crops in vertically inclined surfaces. Instead of farming vegetables and other foods on a single level, such as in a field or a greenhouse, this method produces foods in vertically stacked layers commonly integrated into other structures like a skyscraper, shipping container or repurposed warehouse. Primary goal of vertical farming is producing more foods per square meter and to produce food and other items in doorstep in an urban culture to meet the need of various items of the family members. To accomplish this goal, crops are cultivated in stacked layers in a tower structure. The main advantage of utilizing vertical farming technologies is the increased crop yield that comes with a smaller unit area of land requirement. The increased ability to cultivate a larger variety of crops at once because crops do not share the same plots of land while growing is another sought-after advantage. Because of its limited land usage, vertical farming is less disruptive to the native plants and animals, leading to further conservation of the local flora and fauna. It offers a plan to handle future food demands. It allows crops to grow year-round and uses significantly less water. It can be used for organic vegetable production with less exposure to chemicals and diseases.

VERTICAL farming is limited in India at present to high value crops only. Cultivation under polyhouse and net house is done mostly in case of export oriented flowers and some vegetables. The scope of vertical farming is however increasing fast in India. The scheme has been reflected as one of the high priority area. Good technical and financial support is now available for establishing vertical farming units and protective agriculture. One innovation that has the potential to partly manage the above problem is by production of food items in cities itself in residential buildings, roof tops, public spaces, etc. Whereas the present improved agriculture practices put immense pressure on finite resources with diminishing returns on land, water, energy, etc., the innovative technology of vertical farming is expected to relieve this pressure to a large extent. Considering the above, year round production of large quantities of nutritious food from vertical farming within a limited space/area appears to be a revolutionary approach. Vertical farming (VF) generally refers to the growing of crops mostly vegetables, ornamentals, and herbs on stacks of indoor shelves using artificial light and nutrient solutions, without much sunshine and soil. Such farms are not dependent on seasons/controlled environment and have ability to enhance production round the year with little risk of crop failure. Further they give fresh quality produce without depending on favourable climate, healthy soil, high water consumption and above all saves on labour, a scarce commodity today. Vertical farming has potential to sustain ever increasing world population especially in the urban areas with family nutritional supplement thus providing food security. Vertical production of mushrooms, hydroponic green fodder, some vegetables and fruits and even poultry birds are either already in vogue or at advanced stage.

Vertical farming at College of Agriculture, Kyrdemkulai

The system of vertical farming started and practiced in College of Agriculture, Kyrdemkulai, Meghalaya on experimental basis during 2019-20. The purpose of study was to demonstrate the farmers of the area about the benefits of vertical farming. Different vegetables like capsicum (*Capsicum annuum*), tomato (*Lycopersicon esculentum*), chilli (*Capsicum annuum*), brinjal (*Solanum melongena*), king chilli (*Capsicum chinenese*), cabbage (*Brassica oleracea* var. *capitata*) and broccoli (*Brassica oleracea* var. *italica*) were grown under this system throughout the year. The crops were selected considering the market demand and family requirement of the vegetable of the farmers of the area. These crops are comparatively more profitable under conventional farming system and can be grown under organic environment. In this study the above mentioned crops were selected for promoting under vertical farming system and also promoted in nearby villages for additional income and add to nutrition to the farmers having limited land holdings.

Rake configurations

The crops were raised in pot placed on iron rake of 2.5 m 1.4 m size. There were total 4 rakes with 5 rows in each rake and 4 rakes with 6 rows. Each row accommodated 8 pots so total 352 pots were accommodated. In each pot one plant was grown and total 352 numbers of plants were grown. These pots were filled with soil, sand and vermin-compost with 2:1:1 (2kg: 1kg: 1kg). Each rake occupied an area of 2 m × 2.4 m (4.8 m^2). All the rakes were accommodated only with 38.4 m^2 area (Fig-1).The crops were sprayed Jivamruta (one organic input prepared from cow dung, cow urine, gram powder and soil) twice in a month. The seedlings were grown in pots in November, 2019 and the harvesting was completed by May end 2020.

Table 1. Fruit yield and yield attributes of different vegetables grown in vertical farming during 2019-20

Crop	No. of Plants	Duration (days)	Average fruits/ plant	Average fruit weight (g)	Yield (kg/ plant)	Total yield (kg)	Rate (₹/kg)	Gross Income (₹)
Brinjal	96	143	19.6	52.2	1.02	97.92	30	2937
Capsicum	96	201	7.8	24.2	0.19	18.24	40	730
Chilli	80	190	85.8	3.47	0.30	24.00	40	960
King Chilli	80	205	14.0	40.00	0.56	44.80	200	8960

Table 2. Fruit yield and yield attributing characters of different cucurbits under staking during 2019-20

Crop	No. of Plants	Duration (days)	Average fruits/ plant	Total yield (kg)	Rate (₹/kg)	Gross income (₹)
Chow chow	10	300	30	85.56	30	2567
Bottle gourd	10	75	6.54	78.48	20	1570
Cucumber	10	98	12.75	32.87	30	986

In addition to the above, the vegetables were also grown in vertical staking. The vegetable crops viz. chow chow (*Sechium edule*) , bottle gourd (*Legenaria siceraria*) and cucumber (*Cucumis sativus*) were grown. These three crops were grown in 30 m^2 (each with 10 m^2).

Performance of crops

In the vertical farming, the performance of all the crops was very good, though the crops were raised organically. The total vegetable yield of 185 kg were harvested (Table 1) from a small area of 38.4 m^2. A gross return of ₹ 13,587 were generated. Regular harvest of different vegetables not only generated income of the farm family but also met the daily requirement of the vegetables. Production of king chili in vertical farming was very promising, which was sold at ₹ 200/kg and provides a scope for producing its seed for commercial purpose.

Besides, under the vertical staking, the performance of all the three cucurbits/vegetables were very good. From a small area of 30 m^2 an yield of 197 kg of vegetables (6.6 kg/m^2) were produced (Table 2) with gross income of ₹ 5,123. The production of organically grown vegetables could meet the family requirement of vegetables and helped in nutrition of the farm family.

Vertical farming offers scope for producing quality vegetables and leafy vegetables at the door step to meet the family requirement of vegetables. Vertical farming offers scope to minimize the family expenditure on vegetables and spices (chilli), and provides fresh vegetables to the farm family. The idle time of the family members are better utilized in raising the crop at door step. Hence, vertical farming can be promoted for meeting the fresh vegetable requirement of the farm family for a healthier life.

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