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A survey on Vertical Farming

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Abstract **- As the world population growing in an uncompromised way, soon in few years 70% of the agricultural lands will be superseded by flats and buildings. In order to maintain the stability of food production, a boon was brought forth in the name of Vertical Farming. This is one of the growing modern farming methodologies. The introduction of Vertical Farming into the cities have helped the development of food industry and it simultaneously reduces poverty, adds food security and enhances human well being.**

Key Words – Vertical Farming(VF), Agriculture, Hydroponic, Aquaponic

1.INTRODUCTION

Soon in 20 years, the access to the agricultural lands will be limited. Growing population, depletion of agricultural lands, using chemicals, earth erosion, nutrient depletion all will suppress the food industries. The only solution to these issues is Vertical Farming.

Vertical Farming combines the design of building and farms all together in a high-rise building. In Vertical Farming, different types of crops, fungi and cattle are grown in vertical stacks. Recently, Vertical Farming is being implemented successfully in many countries. This farming technology helps to produce a lot of crops inside the city.

Fig.1: Interior of an Vertical Farm

Many information is available on Vertical Farming. But little have been published regarding the technologies of Vertical Farming. This survey reveals techniques and technologies that are been used in the Vertical Farming.

2. VERTICAL FARMING

2.1 Material

The façade of the building is made with a self cleaning and clear material such as ETFE (Ethylene Tetra Fluoro Ethylene). This material is transparent and allows 95% of the sunlight into the building. The ETFE layers have a different pressure, which helps the screen open and close depending upon the intensity of sunlight.

2.2 Lighting

Lighting is an important factor that governs the growth of the crops in Vertical Farming. While constructing, the farm should be planned to use natural light or both the natural and the artificial lighting. Artificial lighting may include LEDS, Solar cells. The range of light intensity is needed for enhancing the growth of the crops.

2.3 Water Requirements:

In traditional farming most of the water supplied gets evaporated. But in VF, that issue is limited by adopting a number of ways, which are mentioned below:

2.3.1 Recycling:

The city waste water is recycled and it makes a very good source and makes the farm self sustainable. Not only the vertical farms can use rain water, they can also use gray water or the water collected from the roof of the building during rain. Water that is processed only once and which is not eligible for drinking can also be used in vertical farming.

2.3.2 Dehumidification

Water that is evaporated can be gathered again and used. This process is called dehumidification. In VF, there are certain devices installed which can perform dehumidification. The water produced this way is clean and it can also be used for drinking purpose.

2.4 Farming System

2.4.1 Crop Selection

In VF, any type of crops can be grown. But the only limiting factor is that trees cannot be grown. The most commonly produced crops are lettuce, leafy greens, carrots, strawberries and other creepers. Corn and wheat can be produced along with biofuel crops and other medicinal plants.

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2.4.2 Hydroponic

Hydroponic is a strategy where there is no soil medium is used. Instead, an aquatic solution is given to the roots of the plants. Compared to traditional farming, this saves a lot of water. In this system, nutrients are made to dissolve in the water and they are absorbed by the plants. The plants are directly placed in this solution or along with some sands or gravels. This planting is done in cylindrical shaped pipes (usually of PVC type). There are six hydroponic systems, they are: Nutrient Film Technique (NFT), Wick System, Water Culture, Ebb and Flow (Flood and Drain), Drip Feed System and Aeroponic System.

Since the plants that are grown in hydroponic greenhouses tend to grow faster, hydroponic greenhouses are tend to become so popular in recent days. They ripe in a short period and yields 70% more than traditional farming.

2.4.3 Aquaponics

Fish farm inside the Vertical Farming greenhouse can help to get rid most of the bio-wastes. Fishes are grown in large tanks. Since fishes excrete a lot of ammonia which are great for the growth of plants, the water from the fish tanks are used for the plants and the fish tanks are refilled. This type of system is called aquaponics. Statistical report say on an average 80% of the plant waste and by products are used to feed fishes like Tilapia. Meanwhile these fishes have considerable market value. So this aquaponic system is highly productive and can yield a lot of profit. The water temperature are controlled using solar heaters.

2.5 Livestock production

Livestock with pasture incorporated in Vertical Farming have a very good environmental advantages. The waste from the live stocks can be used as manure and the by products of the crops can be given as fodder for the cattle.

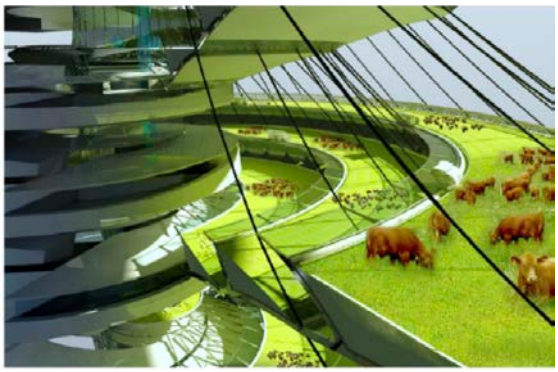

Fig.2: Conceptual depiction of livestock in VF

2.6 Control Systems

Considering the designing of vertical farming, the factors such as temperature, air conditioning and ventilation plays the priority role. So the greenhouse is fitted with sensors such as temperature and humidity sensors. This helps to monitor the temperature and the water content inside the farm systems. Moreover, coolants can be used to reduce the temperature inside. The coolant can be gray water or recycled water. This can also be further used for plants. Uncontrolled humidity may result in the growth of fungus which may cause depletion of essential nutrients. So dehumidification devices are installed. There are usually three different techniques for dehumidification:

1. Natural Ventilation (through the open windows) and forced ventilation (fans) can help in controlling the humidity. This can also help to bring in fresh Carbon dioxide for the plants and ejects the produced Oxygen from the greenhouse.
2. The atmosphere can be desiccated using desiccants such as aqueous chloride which is a combination of chlorine and lithium for removing water from air.
3. Among the three transparent glasses is the most applicable technique for indoor crop production. They usually act as natural dehumidifier.

2.7 Waste Management

The yearly bio waste from plant cultivation is about 2442 metric tons. But in aqua phonic the waste produced 80% less. In vertical farms, the by-products such as leaves, stems, damaged fruits and vegetables) are used as food ingredients for the fishes in aquaculture. Since the vertical farm is a closed loop, the waste is supposed to turn into beneficial sources of liquid fertilizers or bio fuel.

3. EXISTING SYSTEM AND LIMITATION

Though Vertical Farming may have excessive potential, it has some constraints and weakness. Those are mentioned below:

1. Nearly 40% of the whole energy used for VF is spent in construction. Building VF efficiently can spend the reduction of energy spent on heating or cooling the farmhouse. Architects should concentrate on building much more efficient farmhouses in future.
2. Another limitation is the selection of plants. Since vertical farming encourages plants of small sizes to get better yield, bio-technology should concentrate on bringing plant species with miniature sized traits.
3. Lot of man power is required to make the vertical farm system organized. Vertical Farming can be made completely automated with the help of internet of things and sensors with no human interference. With the presence of IOT a single device can be used to control the entire Vertical farm. So it's in the hands of the technology to make Vertical Farming more reliable and efficient.

4.CONCLUSION

Agriculture is one of the vital activity that helps supporting the human life for years. But timely due to the shortage of fresh water, the agriculture is being affected on a large scale. Annually more than 40% of the fossil fuel are consumed for the transportation purposes in traditional agriculture. Moreover, overpopulation succumbs the farming lands into buildings and flats.

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Only Vertical Farming can be a panacea to these issues in the upcoming years. With technology applied, we can do efficient farming in urban areas with limited resources and can surfeit food for the entire population. With time, with growing technology, Vertical farming will be the only reliable source of food in the near future.

The above graph differentiates the yield between Traditional farming and Vertical farming. This proves that in future we can meet our demands in food with the help of vertical farming.

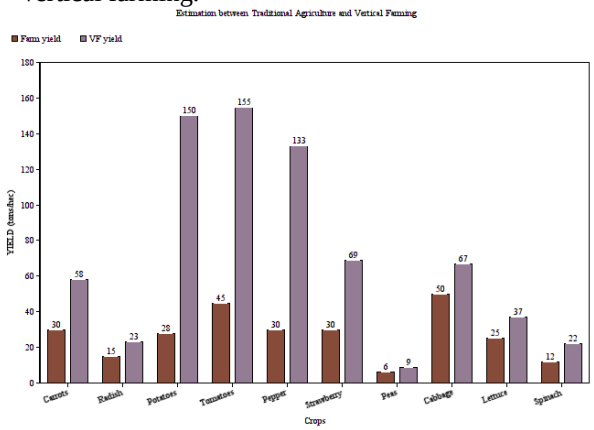

Fig.3: Graphical representation of the yield

Optimally speaking, Vertical Farming is cheap, reliable and easily operable with less financial support. VF has the power to reduce poverty and famine in the near future.

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