How about growing food indoors and that too without soil and sunlight? How about getting your daily requirements of fresh vegetables, fruits, flowers, and other perishable farm produce met from a multi-storeyed building situated right next to your apartment?

Could vertical farming in cities and urban areas be the answer to meeting the future food shortages?

Sounds incredible? This farming scenario is no figment of imagination but a reality. It is gaining slow and steady acceptance worldwide with the United States showing the way. AeroFarms situated in Newark, US, is the world’s largest vertical farm occupying an area of 70,000 square feet and harvesting up to 2 million pounds of micro greens, herbs, etc. per annum.

It is called Urban Vertical Farming or simply Vertical Farming. It is nothing but growing your crops in tubs kept in racks mostly placed vertically in multi-storeyed apartments as high as
Implementing out-of-the-box innovations like vertical farming, which is the best bet from the viewpoint of human health as well as being environmental friendly,
twenty five to thirty feet. At present in the US Vertical Farming is primarily being carried out in underutilised or abandoned multi-storeyed apartments or warehouses in urban areas.

Dr. Dickson Despommier, a professor at Columbia University, US, is known as the father of the vertical farming concept. His acclaimed work titled “Vertical Farm-feeding the World in the 21st Century” caught the imagination of the scientific community and gradually his groundbreaking concept is being successfully implemented worldwide.

It is common knowledge that plants get their nutrition from soils and need sunlight for photosynthesis. Without these factors the plant cannot survive, leave aside grow. So, in urban Vertical Farms, where the crops are grown indoors in closed environment how do these plants grow without sunlight and soil?

Well, in Vertical Farms crops are raised in tubs kept in vertical racks and they get their nutrition either ”hydroponically”, that is, through nutrient-enriched water or “aeroponically”, that is, through nutrient-enriched air.

The entire farming process is closely monitored and controlled by automated computers that provide the precise amount of light, nutrients, water or mist, temperature and humidity to optimise the crop yield.

US-based AeroFarms grows its greens aeroponically in a unique closed loop system for which it has a patent. Aeroponics is used to mist the roots of the greens with nutrients, water and oxygen. A reusable cloth medium made out of BPA-free (Bisphenol A free) post-consumer recycled plastic is used for seeding, germinating, growing and harvesting. The cloth can be fully sanitised after harvest and reseeded. Acting as a barrier between the mists and the plants, the cloth allows harvesting a clean and dry product.

Another US-based vertical farm company named Green Sense Farms, second only in area to AeroFarms, uses a modified hydroponic ebb-and-flow process that involves pumping nutrient-rich water into the bottom of tubs filled with ground coconut husk.
The water flows into the root system before draining and then being repumped later.

It is estimated that the crops grown in vertical farms use 95% less water (that too is recyclable) than in a conventional field farm. When grown aeroponically they even use 40% less water than hydroponically, which speaks volumes about the potential of this form of agriculture, especially in view of conservation of water, a dire need today for the entire planet.

In vertical farms, you are not dependent on the climate for growing your crops. There is no fear of droughts or floods or infestations either. The weather is perfect every single day and 365 days is your growing season.

According to Robert Colangelo of Green Sense Farms, they can turn a micro green crop roughly every 12 days, baby greens about every 30 days, and lettuces about every 35 days. Field farmers get one or two seasons to turn a crop.

According to a study released by the United Nations Food and Agricultural Organisation in 2016, the effects of climate change on food production could cause 500,000 extra deaths by the year 2050 compared to a world without global warming. The World Bank also predicts that climate change could trim existing crop yields by up to 25 per cent.

The world population is set to increase to 9 billion from the present 7 billion by the year 2050. We need to produce 50% more food than the current level to feed the burgeoning hungry mouths. Feeding so many hungry mouths is turning out to be one of humanity’s greatest challenges since at present 800 million people in
the world are undernourished, which means they cannot meet their minimum daily dietary energy requirements.

In a vertical farm the micro and macro nutrient requirements are closely monitored and provided, which results in better growth of crops. The data of Aerofarms asserts that they are able to take the exact seed from the field and grow it in half the time as a traditional field farm leading to 75% more productivity per square foot than a commercial field farm. Plant scientists monitor 30,000 data points every harvest for improving the growing system.

Another major advantage that a crop grown in a vertical farm enjoys, and one that is being widely hailed by health enthusiasts, is that the crops are grown with zero pesticides, herbicides and fungicides, which translates into a healthy and fresh produce.

Going soilless has its advantages since most of the disease-producing microbes come from the soil. No one can easily forget the outbreak of infection from eating vegetables and salads in the US and Europe in June 2011 which was infected by a toxic strain of *E. coli* bacteria. Many people had taken ill and many had even lost their lives. Keeping the severity of the disease in mind the WHO had even declared the strain to be a rare one, seen in humans before, but never in this kind of outbreak.

Vertical farms work on the principle of grow your food in cities where you live, since it’s estimated that 66% of the planet will soon live in cities. Since the produce of vertical farms is supplied locally, helping reduce spoilage from trucking these perishables, cuts carbon footprint of refrigerated trucks or carriers and saves huge amounts of fossil fuel now used to refrigerate and ship produce from all over the world. It also cuts carbon footprint of farm tractors and saves energy costs by eliminating the need for fossil fuels used in traditional farming practices for ploughing, applying fertiliser, seeding, weeding and harvesting.

This amazing form of innovative urban farming technique is growing by leaps and bounds in North America particularly in the United States, Europe and in some Asian countries like Japan, South Korea, China, Abu Dhabi, and

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**Vertical farming – major advantages**

- Reliable Harvest
- Minimum Overheads
  - Low energy usage
  - Low water usage
  - Low labour cost
  - Reduced washing and processing
  - Reduced transportation costs
- Increased Growing Area
- Maximum Crop Yield
- Wide Range of Crops
- Fully Integrated Technology
  - Optimum air quality
  - Optimum water quality
  - Optimum light quality
  - Optimum nutrient and mineral quality

Vertical farming is being encouraged from the viewpoint of food security as well as zero carbon footprint.
In 2016, Kimbal Musk, Elon Musk's younger brother, launched an urban farming incubator programme called Square Roots to give young food-tech entrepreneurs spaces to develop and accelerate their vertical farming startups.

Along with fellow entrepreneur Tobias Peggs, Musk is creating vertical farms inside 10 steel, 320-square-foot shipping containers, which will contain rows of organic greens and herbs. Each mini-farm will be managed by a young millennial entrepreneur who’s interested in vertical farming.

Each of the budding entrepreneur will be given a designated shipping container farm for one year. They will be allowed to sell anything they choose to grow in it. The plants grown in the shipping containers, which could include Bibb lettuce and basil, will be rooted in water rather than soil and cultivated under LED lights.

The team has chosen to grow greens inside shipping containers because they are small enough to help young farmers learn the ins and outs of vertical farming, yet efficient enough to produce a large crop yield. One Square Roots shipping-container farm will grow the equivalent of two acres of outdoor farmland, says Musk.

Square Roots aims to help young urban farmers launch the next wave of innovative food startups. If the Square Roots campus of 10 farms is successful, Musk says the team will build more farms within New York City and eventually expand to other US cities.

(Adapted from Business Insider, 23 August 2016)
scale. They have used several storeyed racks and grown vegetables and fruits like tomato and aubergines in soilless condition by using a nutrient-rich liquid medium. Productive efficiency of vertical farming was also tested in Punjab where scientists attained initial success in growing potato tubers in soilless conditions.

At present, the vertical farms in the US are primarily growing microgreens, herbs and lettuces. The Pasona 02 Urban Farm situated in the heart of Tokyo’s business district has gone a step ahead. This farm located on the ground and the first floor level of a newly built office block is successfully growing rice paddy at the entrance lobby, managing to produce three rice crops a year. White flowers, herbs, melons, oranges, tomatoes, okra, lettuces and other vegetables and fruits are being grown in this vertical farm.

Earlier vertical farming was not considered feasible due to high costs of LEDs, which accounted for the major expenditure. But now failing LED costs has given a new impetus to this novel method of farming.

Vertical farming is being encouraged from the view point of food security as well as zero carbon footprint. AeroFarms has devised a novel method to involve school children to be a part and parcel of this mission. The students of Philips Academy Charter School in Newark harvest their own greens from an AeroFarm unit in their dining hall. The students gain access to fresh, healthy foods that are hard to find in parts of their city along with a deep connection to how food is produced and why methods matter.

Implementing out-of-the-box innovations like vertical farming, which is the best bet from the viewpoint of human health as well as being environmentally friendly, and has the potential to emerge as the key to feed the burgeoning human population is the need of the hour.