

# **How Vertical Farming Will Change The World**

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## **Introduction**

There are numerous problems with the current way society produces food. Our current methods are wasteful, inefficient, and extremely harmful to the environment. While these methods may have been necessary years ago when technology was archaic by today's standards, the time has come to upgrade our food system infrastructure. The technology of old has scaled poorly with time and population growth, and now causes many problems that pose a serious threat to the environment and society.

## **Problems with Current Food Production**

The first of these problems is the mass use of pesticides. Each year the world uses around 2.4 billion kilograms of these chemicals on to our crops in order to cleanse them of insects, weeds, rodents, and fungi. According to the United Nations, these pesticides cause between 1 and 5 million people to get sick every year. Another huge problem is that, according to a recent study done by Cornell University, less than 0.1% of the pesticides actually reach their target pest, the other 99.9% unnecessarily run off and contaminate the local ecosystems. That's over 2 billion kilograms of wasted pesticides contaminating the soil and environment every year. Pesticides are also causing the death and contamination of Domestic Animals. A study done in Austria in 2016 found that pesticides poison a significant amount of domestic animals each year. This includes dogs, horses, cats, goats and sheep. Over 10% of the animals that were contaminated by the pesticides died as a result.

Pesticides have also been linked to Colony Collapse Disorder in bee populations. Colony Collapse Disorder is the phenomenon that occurs when the majority of worker bees in a colony disappear and leave behind a queen. This phenomenon is happening all over the globe and is decimating the worldwide bee population, threatening all the pollination their species completes every every year. Pesticides are now considered a main cause of Colony Collapse Disorder as the toxic effects of Neonicotinoids on bees has been confirmed. Neonicotinoids are a chemical used in industrial grade insecticides and have recently been found in 75% of global honey samples during a study that was conducted worldwide several years ago.

It is also worth noting that pesticides aren't cheap either. At the current average price of about 25 dollars per kilogram and with about 2 billion kilograms wasted every year. The world pumps around 50 billion dollars worth of pesticides into the earth every single year. That money could be saved and used in much more productive ways benefiting the earth.

Another problem with the current food production system is heavy environmental pollution. According to the Food and Agriculture Organization of America, current food infrastructure that consists of food production, processing, and transportation is also responsible for 30% of global energy consumption, as well as 20% of global greenhouse gas emissions. This is mainly due to factory farms, unregulated industrial farming machinery, megafactories, and convoys that travel thousands of miles to distribute food to local markets.

The final problems to be discussed are overpopulation and land degradation. Based on medium fertility estimates, the United Nations projects the population to reach 9.2 billion people by the year 2050. With an increasing population comes an increased demand for food and the land required to grow it. However, the human population is destroying more farmable

land every year. Leading experts say humans have destroyed one third of our farmable land over the last 40 years and there is no sign of slowing down. A possible solution to all of these problems is a technology known as Vertical Farming and will be discussed in the next section.[\[1\]](#),[\[2\]](#),[\[3\]](#)

### **Vertical Farming: what is it?**

Vertical farming is the practice of growing food indoors in vertically stacked layers or integrating crops into other structures. Vertical farms attempt to produce food in challenging environments, where farmable land is rare or unavailable. For instance, the method could help mountain towns, desert lands, cities, or metropolises grow different types of fruits and vegetables in a controlled environment.

### **Technology**

There exist several types of vertical farming but the propose of all of them is to try to mimic the ideal environmental conditions for the crop to grow. These environmental considerations are sunlight, nutrients, atmospheric concentration, and water. In vertical farming the sunlight has been replaced by LED lighting technology. The natural supply of nourishment for the crops has been replaced with hydroponic or aeroponic growing systems.

Another crucial piece of technology that goes into vertical farms is LED lighting. Since the 1970s, LED lights have been getting exponentially more efficient and only recently have LEDs become efficient enough to be practical in this sort of scenario. Researchers have found that a combination of high energy blue and low energy red is the most effective for plant growth during night cycles. For instance, purple (=red + blue) lighting is used to mimic night, while the white lights are adjusted slowly throughout the day to mimic a sun moving through the sky.

The third important piece of technology that goes into vertical farms are advanced Hydroponics. Hydroponic systems allow plants to grow in nutrient rich water. They can be categorized into four groups:

1. *Wick*: It uses capillarity effect to transport water and nutrient to the root through wick as transport medium. It works very well for herbs, but it is not much efficient when it comes to plants that need a lot of water.
2. *Ebb and Flow*: The grow bed is flooded until it reaches certain point and then the water is drained. This method is great to grow a variety of plant.
3. *NFT (Nutrient Film Techniques)*: it is mostly used in large vertical farm. Plants are placed in channels or tubes with roots dangling in hydroponic solution. The system has a slope, so that the nutrient solution run through the root and down back into a reservoir.
4. *Deep water culture*: Roots are suspended into a solution of nutrient and water and the air is provided directly to the root.

Another technology similar to hydroponics is called aeroponics and can also be used in vertical farms. In aeroponic systems, plants are suspended in the air and the nutrient solution is sprayed over the base of the plant. The nutrient rich water solution then diffuses into the roots to feed the plant.

Other technologies are needed to produce maximum yield, for instance: industrial grade humidifiers are used to control humidity. Highly sensitive thermometers are used to monitor air and the nutrient solution temperature while atmospheric regulators control the chemical composition of the air. Some companies are also integrating AI and machine learning in order to increase growth rate of crops by controlling of different parameters such as light intensity, humidity, temperature, etc [\[4\]](#),[\[5\]](#) .

### **Advantages**

Vertical farming methods have a large number of advantages over conventional farming methods. The environment is strictly controlled and predictable in vertical farming; therefore, the dangers brought by using pesticides are completely eliminated and so the food is healthier and safer. Since there are no pesticides used, the costs would decrease accordingly.

Use of advanced hydroponic, aeroponic, and water recycling systems reduce water consumption by up to 99% which is quite significant.

According to Chicago Council on global affairs, 20% of meat and dairy, 20% of oilseed, 30% of cereal, 35% of fish and 40-50% of root crops, fruits and vegetables are wasted each year. This means that about one third of the world's food, equivalent to 1.3 billion tons, is wasted annually and consequently 250 trillion litres of water is wasted in the production of that food. Vertical farming reduces the amount of food and water wasted by growing higher quality produce that is not likely to get thrown away because of the superior quality.

Localized farms use LED lights to grow plants. As LED lights are becoming more powerful and efficient overtime, vertical farming can have high-energy light at lower costs, which results in reducing energy consumption by 90%.

Traditional farms are far away from urban areas; therefore, long distribution chains are needed to carry the food to cities which means increasing fuel consumption and pollution. Vertical farming allows the world to have farms very close to, or even inside the cities. So, we can simply get rid of the long distribution chains and the problems brought by them.

Crops grown in traditional farming suffer from geological events such as undesirable temperature, rainfall, or drought. The protection of crops from weather is very important since global climate change has become such an important issue. Vertical farming allows the productivity of the food to be independent from weather. Since the productivity of this technology is significant and it is high in efficiency, vertical farming can be considered as a solution to food shortage problems.

### **Current Companies**

There are currently several companies which use vertical farming to grow food. Three of the main companies are "Plenty" [\[6\]](#) in Seattle, "Aerofarms" [\[7\]](#) in New Jersey, and "Mirai" [\[8\]](#) in Tokyo.

"Plenty" uses very huge vertical towers which contain substrates made out of recycled plastic bottles. This will allow water and nutrients to disperse over the plants by gravity force. This company claims that its products have better taste than those of conventional farming. The use of Artificial Intelligence and Machine Learning to grow and harvest products makes this company unique. It uses sensors to collect data and fine-tune the environment by AI.

"Aerofarm" uses aeroponic systems to grow food, which results in faster harvest cycles, reduced environmental impact, and increased food safety. The use of this method

causes the company to have considerably less water usage, saving around 95% and 40% when compared to traditional farming and hydroponic vertical farming respectively. This company claims to have control over size, shape, texture, color, flavor and nutrition of the products by using specific light wavelengths.

“Mirai” decided to build an indoor farm in response to food shortage problems due to 2011 earthquake. It recycles evaporated water and reuses it for the plants.

All of these three companies offer more productivity than traditional farming. The productivity of each can be found below:

<b>Company</b>	Plenty	Aerofarm	Mirai
<b>Productivity Per Unit Area</b>	x350	x390	x50-100

### **Conclusion**

In conclusion, Vertical Farming methods are able to produce much higher yields per unit area compared to traditional farming methods. Vertical Farming methods also use 90% less energy and 99% less water and completely eliminate the need for pesticides by operating in a completely controlled artificial environment. Some people will wonder if this produce will taste normal. The produce grown by the company “Plenty” has endorsements from many top rated chefs. In fact, the former sous-chef Anthony Secviar from the famous American restaurant “French Laundry” told the news company Bloomberg that “I’ve never had anything of this quality”. Vertical farming technology also has the potential to be used anywhere in the world with access to electricity without relying on good local weather conditions. This technology has the potential to change the way the entire world grows food, and improve society and the environment as a whole.

### **References**

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