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China, Factor 13: Demographics

Vertical Farming: The Solution to China's Growing Future

Population explosion, natural disasters, lack of land resources, and a massive age gap are all factors that lead to the detriment of Chinese agriculture. By 2030, the population will have jumped from 1.3 billion to 1.5 billion, with most of these people living in urban areas, according to the Institute of Environment and Sustainable Development in Agriculture (IEDA). This dramatic increase in the population creates a growing problem; feeding all those people. Many people want to continue traditional farming methods, but that is just not a plausible idea for the future. The amount of cultivated land is being reduced each year, due to natural disasters and city expansion (IEDA), so there is no room for additional farmland in China. In addition to that, over 60% of farmers in China are over the age of 60, and most young people aren't interested in pursuing the profession, creating an age gap and an uncertain future for farmers. To get the younger generation back interested in farming, as well as feed the growing population, new farming methods need to be implemented and fast. Few solutions have been proposed, and many are too expensive, unsustainable, or just plain unrealistic. One possible solution stands out among the rest, and that is the idea of indoor vertical farming. Growing fresh food inside the city close to the consumers without taking up much land sounds like a dream come true, but is it truly a viable and sustainable option?

If you asked people about indoor farming, they would probably tell you it's a radical idea of the future. In reality, the idea has been around since 1915, when Gilbert Ellis Bailey, a professor of geology at the University of South Carolina at the time, wrote a book called *Vertical Farming*. In his book he had the idea to take farming vertically underground as a way to revolutionize agriculture. Today, the idea has been modernized and is basically the opposite. Modern indoor vertical farming is literally vertical. People are utilizing abandoned warehouses and factories, as well as building new skyscrapers, to farm inside of. This is done with virtually no sunlight and has a faster harvesting time than traditional crop farming methods, and the research is there to prove it. Vertical Farming was really thrust into the spotlight after Dickson Despommier, a pioneer in modern-day vertical farming, released his book, *The Vertical Farm: Feeding the World in the 21st Century*, in 2011. It has since garnered incredible support, and vertical farms have sprung up all over the world, however they have yet to make an appearance in many developing countries.

Now let's dig into the facts behind indoor vertical farming. Scientists and indoor farmers have been working with Philips Lighting, as well as other light companies, to create customized LED lighting that makes indoor farming possible. These pink-tinted lights provide the red and blue wavelengths that allow the plants to photosynthesize and grow. The concentration of red and blue wavelengths changes depending on the plant's growth stage, allowing the plants to grow 3-4 times faster than traditional farming. These crops are the same in nutritional value as outdoor crops, according to Caleb Harper, a research scientist at MIT Media Lab. He says, "You would think, if it doesn't have sunlight, it can't possibly be nutritious, but the reality [is that] plants only harvest 10% of the sun's rays, which we can recreate in the lab. There is absolutely no nutritional difference between plants grown in sunlight and under an LED."

Indoor farming is also a very sustainable idea because it recycles most of the water. Almost 70% of the world's drinkable water goes to the agricultural sector, according to the Food and Agricultural Organization of the United Nations. Indoor farming uses 90% less water than conventional farming, so there would be more water for other uses. Most indoor farming systems grow their plants hydroponically, so the roots of the plants are in a mineral nutrient solution, or aeroponically, which means the plants are misted with a water solution. After those plants are harvested, the water is able to be used again for the next batch of plants. Harper believes that if these methods were to become standard the agriculture sector could reduce its water usage by 98%, as well as double the nutrient densities in vegetables.

Since vertical farming is done inside clean buildings closed off to the world, there is no need for pesticides, herbicides, or fertilizers. This means all the food is naturally organic. This is a huge bonus for consumers and farmers. Robert Colangelo, president and founder of Green Sense Farms in Chicago, touches on the reliability of vertical farming when he says, "In the field—there's pests, there's animals, there's fungus, and there's weather—the sun may shine, it may not. We see this as the future of farming." This method of farming guarantees fresh crops all-year around, and the size of the harvest is not dependent on weather factors or anything else. This also means that food can be grown in any climate, with any temperature, making it perfect for China's variable climate.

The biggest objection to indoor farming is the price tag. The LED lights, the cost of buildings, and the whole setup has a large initial price. However, since most of the labor is done by machines, it's lower in labor costs and also doesn't require tractors and some other mechanical equipment. This also means it has a lower carbon footprint on the environment. In addition, due to the reliable harvest, it is a steady income each time, unlike traditional outdoor farming where the weather can affect everything. Furthermore, the price of indoor farming has also decreased since its inception due to the new high efficiency LED lighting. According to Philips Lighting, the latest LED light bulb is 150% more efficient than the last. The lighting, which is likely the

biggest cost, lasts a long time and is very easy to maintain. Another downside is that most vegetables are not eaten fresh, they are processed into other products. This means that if indoor farming were to continue inside of cities, infrastructure, such as processing plants, would need to be relocated to be closer to the food. The upside to the location is that there are lower transportation costs, since the food is produced right inside the city. Another advantage is that unlike traditional farmland which is rather hard to come by, China is littered with thousands of abandoned factories and warehouses that would be perfect for indoor vertical farming.

Since China is still in the beginning stages of developing vertical farms, other successful farms around the world showcase the benefits of a vertical farm. One of the world's largest indoor vertical farms is currently located in Japan. It was created by plant physiologist Shigeharu Shimamura after the 2011 earthquake and tsunami that left a major food shortage in the area. Shimamura saw the need for safe food and created an indoor lettuce farm out of an abandoned factory. Since natural disasters are an issue in China, one that has destroyed farmlands and contaminated food around the country, vertical farming's promise for safe food is crucial. The 25,000 sq. ft. farm produces 10,000 heads of lettuce a day, which is 100 times more per square foot than traditional farming methods. The farm also uses 40% less power, 80% less food waste, and 99% less water than conventional farms. This is because the 17,500 specialty LED lights created by General Electric allows them to control temperature, humidity, and irrigation. This extreme level of control and perfect growing conditions allows the plants to grow 2.5 times faster than traditionally grown lettuce. The best part about the farm is its profitability; despite the high starting costs it shows that indoor farms can really make money.

Another successful farm that leads as a pioneer in this field is Aerofarms, a brand new vertical farm that opened in early January 2017 in Newark, New Jersey. It is now the largest vertical farm with 70,000 sq. ft. It showcases the major technological advances that have occurred in vertical farming, many within the last year. The farm is tracked on a second by second basis, measuring everything from temperature, humidity, and carbon dioxide content of the air to the nutrient solution, pH, and electroconductivity of the water. The data from all these factors, as well as the changing plant growth data, helps the farmers know what to adjust and ensure that the farm will be successful and yield a large crop. Mark Vickars, CEO of Choices Markets, says, "The quality is excellent, the nutrient levels are high, the shelf life is long. We're always trying to go local, and this gives us local 365 days a year."

Green Sense Farms, a successful vertical farm in Chicago, is expanding to China after partnering with Star Global Holdings, based in China. The CEO, Robert Colangelo, says, "With so many new manufacturing sites built on former farmland and more people living in urban centers, vertical farming is an ideal technology for China. By growing food indoors in a sustainable, controlled, and sanitary environment, we can increase food security and help feed the Chinese

people in an environmentally friendly way." Their first vertical farm just completed construction in the city of Shenzhen, a huge city with a population of 50 million within its 50 mile radius. The farm is expected to produce 750,000 to 1 million heads of lettuce and about 1.5 million leafy greens in its first year. Green Sense has plans to create about 20 more farms in other major cities, such as Beijing and Shanghai.

China is moving fast to secure vertical farming in their future, with 40 research institutes as part of the Chinese Academy of Agricultural Sciences partnering on the initiative. There are now several vertical farms in China, but it is still too early to tell if it will help with the food and sustainability issues long-term.

If indoor farming keeps growing and becomes a more standard type of farming, it has the potential to provide China with much of its food. Despite the potential financial disadvantages of it, indoor vertical farming could be the answer to the growing future. It's sustainable, fast, local, and takes up very little space, which leaves room for the expanding population. It's also becoming more efficient by the day, which will help costs to go down over time. There are already plans in place to finance vertical farms in cities across China, which will help to make vertical farming more accessible. This type of expansion will help prove that vertical farming is a sustainable and realistic option to feed billions in the future. Dr. Qichang Yang, who works at the Research Centre for Protected Agriculture & Environmental Engineering (CPAE), believes that vertical farming could be the answer to the growing food crisis in China, as well as revolutionize the agriculture industry.

BIBLIOGRAPHY

- \$6 Billion Vertical Farm Market. (2016, November 8). Retrieved January 11, 2017, from a
<https://urbanverticalfarmingproject.com/tag/vertical-farming/>
- AQUASTAT - FAO's Information System on Water and Agriculture (2015). Retrieved January 18, 2016, from
http://www.fao.org/nr/wateraquastat/water_use/index.stm
- Advantages of Vertical Farming. (2015). Retrieved January 14, 2016, from
<http://www.verticalfarms.com.au/advantages-vertical-farming>
- Ahmet, K. (2011, August 1). Vertical Farming Advantages and Disadvantages. Retrieved January 12, 2016, from
<http://www.agricultureguide.org/vertical-farmin-advantages-and-disadvantages/>
- Alter, L. (2017, January 09). I was wrong about vertical farms; Aerofarms shows how to make them really work. Retrieved January 11, 2017, from
<http://www.treehugger.com/green-food/i-was-wrong-about-vertical-farms-aerofarms-shows-how-make-them-really-work.html?scrllybrkr=5ae4f45f>
- At MIT, A Farm Grows That Is Built For A City. (2014, October 01). Retrieved January 18, 2016, from
<http://www.fastcoexist.com/3032505/at-mit-a-farm-grows-that-is-built-for-a-city>
- Bhanoo, S. (2014, December 03). Vertical Farms Will Be Big, But For Whom? Retrieved January 15, 2016, from
<http://www.fastcompany.com/3039087/elasticity/vertical-farms-will-be-big-but-for-whom>
- Brown, V. (2014, December 22). Part 2 - Feeding 9.6 Billion People: Pros and Cons of Vertical Farming. Retrieved January 6, 2016, from
<https://bridgebizstem.wordpress.com/2014/12/22/part-2-feeding-9-6-billion-people-pros-and-cons-of-vertical-farming/>
- Bryant, L. (2016, December 28). Vertical farm planned for Robertson County. Retrieved January 12, 2017, from

<http://www.nashvillepost.com/business/food-business/article/20847679/vertical-farm-planned-for-robertson-county>

Chow, L. (2015, March 10). 5 Ways Vertical Farms Are Changing the Way We Grow Food. Retrieved January 4, 2016, from <http://ecowatch.com/2015/03/10/vertical-farms-grow-food/>

City Farming. (n.d.). Retrieved January 15, 2016, from <http://www.lighting.philips.com/main/products/horticulture/city-farming.html>

Culzac, N. (2014, July 12). Produce 10,000 lettuce heads a day in LED-lit indoor farm. Retrieved January 8, 2016, from <http://www.independent.co.uk/news/science/japanese-plant-experts-produce-10000-lettuces-a-day-in-led-lit-indoor-farm-9601844.html>

Deboer, D. (2012, September 9). The Pros and Cons of Vertical Farming. Retrieved January 9, 2016, from <http://okaywhatever.com/wordpress/the-pros-and-cons-of-vertical-farming/>

Despommier, D. (2013, June 4). Can city farms feed a hungry world? Retrieved January 10, 2016, from <http://www.bbc.com/future/story/20130603-city-farms-to-feed-a-hungry-world>

Dubin, Judith, and Leeron Hoory. "Vertical Farms: How To Feed Our Rapidly Growing Cities." *Vocativ*. Vocativ, 17 Jan. 2017. Web. 13 Mar. 2017.

Duffy, C. (2015, August 05). Indoor Growing vs. Outdoor Growing (Pros and Cons). Retrieved January 2, 2016, from <https://thegrow.co/indoor-growing-vs-outdoor-growing-pros-cons/>

Frazier, I. (2017, January 03). The Vertical Farm. Retrieved January 11, 2017, from <http://www.newyorker.com/magazine/2017/01/09/the-vertical-farm?scrllybrkr=d042fa23>

GlobeNewswire. (2017, January 10). Indoor Harvest Corp Announces Vertical Farm Development Financing across North America. Retrieved January 11, 2017, from <http://finance.yahoo.com/news/indoor-harvest-corp-announces-vertical-140000073.html>

Indoor urban farms called wasteful, 'pie in the sky' by Cornell professor emeritus. (n.d.). Retrieved January 10, 2016, from <http://agriculture.com/post/78549926171/indoor-urban-farms-called-wasteful-pie-in-the>

King, D. (February 21). Gilbert Ellis Bailey. Retrieved January 18, 2016, from <http://www.newcity.com/tag/gilbert-ellis-bailey/>

Laverty, Deborah. "Green Sense Farms builds bridges by exporting know-how." Nwitimes.com. N.p., 14 Jan. 2017. Web. 13 Mar. 2017.

McKirby, E. (2016, September 19). The only way is up: Vertical farming in Kyoto. Retrieved January 11, 2017, from <http://www.cnn.com/2015/12/09/foodanddrink/kyoto-vertical-farm-spread/>

Nikolau, L. (2017, January 11). Vertical farming may not feed the world, but could empower cities. Retrieved January 12, 2017, from <http://www.humanosphere.org/basics/2017/01/vertical-farming-may-not-feed-the-world-but-could-empower-cities/>

Shackford, S. (2014, February 19). Indoor urban farms called wasteful, 'pie in the sky' | Cornell Chronicle. Retrieved January 9, 2016, from <http://www.news.cornell.edu/stories/2014/02/indoor-urban-farms-called-wasteful-pie-sky>

TerraSphere - Urban farming 2.0: No soil, no sun. (n.d.). Retrieved January 11, 2016, from <http://www.terraspheresystems.com/index.php/news-media/19-news/41-urban-farming-20-no-soil-no-sun>

Vertical Farming. (n.d.). Retrieved January 4, 2016, from <http://www.verticalfarm.com/>

Vyawahare, M. (2016, August 14). World's largest vertical farm grows without soil, sunlight or water in Newark. Retrieved January 11, 2017, from <https://www.theguardian.com/environment/2016/aug/14/world-largest-vertical-farm-newark-green-revolution>

World's Largest Indoor Farm is 100 Times More Productive. (2015).

Retrieved January 11, 2016, from
<http://weburbanist.com/2015/01/11/worlds-largest-indoor-farm-is-100-times-more-productive/>

Yang, Dr. Qichang. "Current situation & prophase exploration on vertical farming and urban agriculture in China." N.p., 2014. Web. 13 Mar. 2017.