

FEEDING HUMANITY ON A DEEPLY TROUBLED PLANET – A MAHB DIALOGUE WITH HEALTH SCIENTIST, INNOVATOR DICKSON DESPOMMIER

Geoffrey Holland



“There are no seasons indoors. The efficiency of each floor of a vertical farm, one acre in footprint, could be equivalent to as many as ten or twenty traditional, soil-based acres.”

Dickson Despommier

Geoff Holland - Some refer to you as the father of vertical farming. What is a vertical farm? And what would we see if we were looking at one?

Dickson Despommier - The term vertical farm arose in a class I taught at Columbia for 10 years titled, Medical Ecology. There were no definitions for vertical farm before 2008. Our feeling was that if it's not more than two stories tall, or if it's a one-story building outfitted with high tech grow systems, it's still a greenhouse. If it has more than two floors, the density of the crop increases by at least a factor of two; that's what we would consider to be a vertical farm. It's not growing the food vertically. It's growing food in a building that's higher than a single story. There's a lot of development of greenhouses on top of supermarkets and structures of that sort. But that's not increasing food density. What we have to do is apply this technology to an entire population of say, a country. So, what we would see if we were looking at a vertical farm is at least a two-story building. Some of the vertical farms that have come into

existence in the last five years are over 10 stories tall. I have visited a Texas operation that was 17 stories tall. So, quite remarkable the way you outfit the inside of the shell to accommodate high-tech growing systems, which can then be used for whatever crop you've set up your farm to grow.

GH - On a civilization scale, the field crop methods we have long depended on to feed humanity are failing. Can you summarize why these traditional farming methods may no longer be adequate to meet our food requirements?

DD - Why would vertical farming be an option when outdoor farming is ongoing? The fact is, we're in a very interesting era of hyper-urbanization as the result of failed farming in several major places like India, and China. A third of the world's population is in those two countries. Why are they failing to grow enough food? The answer comes with looking at the pattern of monsoons. The weather patterns that are associated with monsoon rains have changed dramatically over the last 20 years. In these critical areas of China and Southeast Asia, the water comes earlier, it comes more than usual, and it leaves earlier. So that means, your planting schedules are all mixed up. The amount of rain that gets into the groundwater is lower, because there's a lot of runoff and flooding. As a result of those two events, you end up with a drought situation at the end of the growing season. A lot of these crops fail; crops like rice and grains. It happens with vegetables as well. So, it comes down to the hydrological cycles being unreliable, and that is linked to climate change, and how that destabilizes the climate that we've depended on for so long. Another thing that's contributing to failure is the depletion of nutrients in the soil. If you farm the same crop, year in and year out, you get nutrient deficiencies. We invented artificial fertilizers, and we've used them extensively over the last 50 or 60 years. With heavy rains, the excess of those fertilizer nutrients not taken up by plants gets swept away as agricultural runoff. We now have a really serious situation with the world's estuaries getting choked with ag runoff, soaking up oxygen in the water the fish need to survive.

GH - When your seminal book, *The Vertical Farm*, was published in 2010, there were no commercial examples of vertical farms. How has that changed?

DD - It's now 2020, just 10 years after the book came out. Before the book came out, there wasn't even the term vertical farm. Now, we've got this term, which describes farming in multi-story buildings. Today, there are many vertical farms around the world. The number is in the hundreds, perhaps thousands. China, Japan, Taiwan, Singapore and the US; those five countries have taken this idea and run with it, and there are other countries as well. What's happened is a miracle, because this idea started in a classroom, with just seven students and myself, and now we're looking at an explosion of activity.

GH - What are the advantages of growing food crops in multi-story urban buildings?

DD - Let's start with indoor fruit. The greenhouse industry has long been lauded for its ability to grow crops during the wintertime. You can have winter strawberries as well as summer strawberries. There are no crops that cannot be grown indoors. Which ones will grow best indoors is more a matter of economics rather than of biological ability on the part of that particular plant. But greenhouses represent a monolithic approach to growing crops. If you've got a lot of land, and you don't mind dedicating it to greenhouse technology, then greenhouses are a great idea. But, now we're in a real crisis where outdoor farming is failing. Crop selections are limited with regards to what can and can't be grown in various areas. We've long used greenhouse technologies, but in order to make them practical for large populations, you've got to stack greenhouses on top of each other. And that's basically the definition of a vertical farm. Growing food indoors eliminates seasons, so you don't have to worry about winter crop failures. You don't have to worry about spring floods. You don't have to worry about a lot of things. Another thing indoor growing does is conserve water. There are many technologies available for growing food indoors. All of them are water efficient. Outdoors, when you irrigate, most of that water is not taken up by plants. It's just soaking into the ground, or it runs off. Indoors, you can recirculate the water with the nutrient solution. So, a big advantage indoors is that you can conserve water. That's huge in many places around the world. Another advantage is you can farm anywhere you want because no soil is required. And, you don't need a lot of water. I don't know any place on the planet that doesn't have any water. With the ability to regulate growing conditions indoors, you're not dependent on anything outside. You also can exclude insect pests. If you do your construction properly for the building, you can even filter out viruses. Where production cost is concerned, wherever we look for the price of food, it varies greatly with the amount of support that farmers get from government. There are many countries that protect their own farmers from outside competition by regulating how much money it costs to grow the crop within that country. Wheat, corn, rice, all those crops have international markets associated with them, and the price varies tremendously wherever you go. The indoor farming industry has not yet been privy to that advantage. But in the long run, it'll be much cheaper. You don't just get one crop a year indoors, like you do outdoors in many places, you get multiple crops. So, the return on investment isn't just for one year and one planting, you still would get the economies of scale, and would be able to deliver the food at a price people can afford.

GH - Does vertical farming have the potential to blunt the existential threats humanity faces from population growth, climate change and the loss of biodiversity?

DD - When vertical farming realizes its true potential, it could supply 60% to 80% of the food cities consume. Given that, vertical farming has a huge role to play in staving off issues like food shortages, and it offers a real opportunity for employment. The cities of the future will be growing food in almost every building that's in the built environment. There's no reason why that can't be done. It's just a matter of design. What you're going to see in another 10 or 15 years is many more, maybe a hundred times more vertical farms than you have now. And when that starts to happen, it's going to have a massive impact.

GH - What kind of crops can you grow in vertical farms?

DD- To answer this question, just visit your nearest botanical garden. There are many wonderful, indoor botanical gardens around the world. There's one plant, the corpse flower, that only blossoms once every 17 years. They smell really bad. They attract flies, and that's how they get pollinated. Almost every major botanical garden has one of those plants. They are extremely difficult to grow. You've got to control the environment long term to keep those plants healthy. So, if you can make it work with the corpse flower, then there's no limitation to what you can grow indoors. The crops we see today are selected for rapid growth and high value with regard to sales. That's what gets vertical farming started. But very soon, we're going to see some of these vertical farming industries looking like one stop grocery stores. They'll want people to come and visit them virtually every time they think about eating a meal. You go, you shop, you take it home, you cook it, eat it. There are no leftovers. It's all fresh. You don't have to refrigerate it. And, when you have a vertical farm with potatoes, rutabaga, turnips, or other root vegetables, which can easily be grown hydroponically or aeroponically, there's no reason why this industry cannot eventually morph into a one stop shop.

GH – E.O. Wilson, and others are calling for humanity to return half the earth to its natural wild state. Could this actually happen given the potential of vertical farming?

DD - The answer is yes, but I think it will need some help. Climate change makes outdoor farming untenable in many places. The tendency at that point is to abandon that area. When you abandon something in nature, of course, nature's matrix starts to reclaim what you took away from it. Eventually, 20, 40, 60 years down the road, you wouldn't recognize that place from what it was before it was repurposed for human use. Half of us live in cities. And if you add up all the farmland that we need to feed everybody on this planet, it's about the size of South America. If you could draw a line through all that land that is farmed, half is already spoken for, because that's how much we need to feed the people living in rural areas. But, the other half we can give back to nature, by feeding urban centers with vertical farming. So, returning a lot of former farmed land to nature appears very possible.

GH – Where cost to produce, quality of product, and esthetic factors like appearance and flavor are concerned, how do crop from vertical farms stack up against those from traditional farms?

DD - Produce grown on traditional farms don't necessarily have to taste good. They don't even have to look good, but they can't be damaged, because you could get huge losses. If you were to pick the tomatoes at the moment of ripeness, and try to ship those tomatoes from a traditional farm, they could all be damaged by the time they get to market. When you look at a vertical farm that's next to where you live, it's going to be the same or even a more tasty variety of tomato, and it can be picked and sold where it's grown, without shipping, versus a trucked tomato grown on a traditional commercial farm 1,000 or 2,000 miles away. You can easily see what the difference would be. The quality of the produce is always better and fresher, grown locally. There are a lot of studies that show a lot of nutritional loss from

harvesting a plant, then taking days or weeks before it gets consumed. So, the quality of crops grown in urban, vertical farms is much better. That's where vertical farming really shines. I get that there are a lot of skeptics out there. For whatever reason, they do not like indoor grown crops. Maybe they have a vested interest in traditional farming, like Monsanto. To produce crops that deliver in terms of taste and appearance, you have to be really lucky outdoors for the conditions to be just right. In the Fall, when you start to harvest, let's say tomatoes... I live in New Jersey. We have something called a jersey tomato, and everybody loves it. We don't always get good outdoor crops with Jersey tomatoes, because the conditions for ripening are not always the same. But indoors, I can produce Jersey tomatoes of the same high quality, consistently, every year. I can produce a tomato that's absolutely the best you've ever eaten, and you won't believe it was grown indoors. There's virtually nothing missing in an indoor grown crop, and you can pick them fresh the day before. You have to like that.

GH - Vertical farming appears to be a looming economic threat to industrial scale, corporate-driven, commercial agriculture. How do you see that conflict playing out?

DD – When you look at what's being grown commercially by the large-scale ag industry, a lot of it has nothing to do with human food. Basically, they're growing corn for ethanol; corn for high fructose sugar, for different vegetable oils, and animal feeds. They're growing wheat, perhaps, maybe for vitamin extraction so they can supplement the GNC products that are being sold across the counter. But most crops do not end up as human food. So, their producers aren't threatened by vertical farms, where only human food is grown. None of the big ag companies appear to be looking at embracing indoor growing technologies.

GH - What can individuals do to encourage vertical farming and other innovations in technology and public policy that will lead to a worthy future for the human species?

DD - Vertical farming is an idea that can help save the world. I was thinking about this with my students. Climate change is a huge worry. Yes, a big part of the problem is burning fossil fuels. Another big part is clearing land for farming. Deforestation is a huge issue, because we've short circuited the carbon sequestration cycle on our planet. Before there was agriculture, there were an estimated 6 trillion trees standing around the world. For the most part, we now have farms and civilizations. So, we're missing half the planet's former ability to sequester carbon. If you allow just half that farmed land to go back to forest, you've got another 3 trillion trees, all soaking up carbon. Let's allow trees to grow again on abandoned farms. One of the best-known examples of that is in a book called *Sand County Almanac* by Aldo Leopold. It's about him growing up with his family in rural Wisconsin, where farming was an impossibility, for a number of reasons. I mean, farming in that area failed miserably, but when left alone, the land grew back wonderfully into re-wilded forest. The wildlife came back as nature took over. We've got a lot of good examples: the demilitarized zone [DMZ] between North and South Korea is another great place to see what happens when people go away. Just since 1953, the DMZ has grown back to what it used to be before there were two Koreas. Leaving things to nature is the secret to repairing the environment. Imagine, for every acre of land you

give back, you're going to get more carbon sequestration occurring in a natural way. So, we have an alternative to farming. A good way to get that message across is through education, and that would encourage favorable change in public policy. We're seeing a lot of vertical urban farming in Japan. That government got on board and the indoor farming industry sprouted up overnight. It was just absolutely incredible to see how fast they came up to speed. There is no reason why other countries can't do the same. India is catching on with urban vertical farming. I think that government appreciates that vertical farming is technologically driven. It creates jobs. As time goes on, we're going to see people living well in cities, eating safe, healthy, efficiently grown food a short walk from home.

Dickson Despommier is Emeritus Professor of Microbiology and Public Health at Columbia University. His book, *The Vertical Farm: Feeding the World in the 21st Century*, St. Martin's Press, New York, 2010, was the first to illuminate the potential of urban vertical farming.

Geoffrey Holland is a Portland, Oregon based writer/producer, and principal author of [The Hydrogen Age](#), Gibbs-Smith Publishing, 2007.

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