**Now I know you wouldn’t think it to look at me, but I was actually born in 1969. Back then the global human population numbered about three point six billion and learned scholars of the day were already warning that we’d reached the maximum sustainable population size.**

**Today that number has more than doubled, and according to the UN it’s projected to hit more than nine billion in 2050, by which time about seventy percent of all the humans on the planet will be living in cities.**

**Here’s a useless factoid for you – by mid-century there’ll be more people living in the city of Mumbai than in the whole of Canada!**

**That population growth and mass migration of people will bring many challenges, not least how to feed everyone without completely destroying what’s left of the planet’s increasingly fragile soil. One of the solutions that’s been in and out of the news for about a decade now is to stop tearing down forests to grow crops outwards across an ever-expanding area of land and start growing upwards instead. As you’ve probably already gathered by the title of the video, it’s a practice called vertical farming and the first large scale operation was opened at this facility called Sky Greens in Singapore back in 2011.**

**The industry is not without its sceptics though. It’s regarded by some as a vastly expensive, energy intensive pipe dream. But others point out that the exponential advances in green technologies coupled with massive cost reductions make those claims less relevant in the twenty twenties, and in the last couple of years vertical farming has started to grow extremely rapidly indeed, if you’ll forgive the pun.**

**So…will it work?**

**Hello and welcome to Just Have a Think**

**Most of the food that we eat in urban environments will likely have been delivered from vast distances via sea, air, road and rail, all of which adds to the burden of carbon dioxide emissions into our atmosphere. In the US the average food item travels about fifteen hundred miles before it reaches the plate. So, growing that produce locally indoors in buildings with relatively small footprints does seem like a very compelling idea.**

**Essentially the vertical farm system is based on hydroponics, which is the technique of growing plants without soil. Instead, the plant roots are submerged in liquid solutions containing all the nutrients they need including nitrogen, phosphorus, and potassium.**

**That means the plants can be grown in trays that can be stacked up on shelving systems in industrial units where special ultraviolet lights shine down twenty-four hours a day and carbon dioxide levels are carefully controlled in the enclosed airspace to ensure photosynthesis happens right around the clock. And because there’s no soil in the system and the growing spaces are hermetically sealed, there’s no need to use toxic pesticides to fight off predatory bugs, because those bugs simply don’t exist inside the building.**

**Hydroponic systems reduce water use by about ninety percent compared to traditional soil farming, and vastly reduce the area of land required for a given yield. This new start up in San Francisco for example, run by a company called Plenty, reckons to harvest the same quantity of produce from its two-acre site as you’d get from a traditional farm taking up seven hundred and twenty acres of land.**

**An even more futuristic growing system called aeroponics is also gaining some traction in the industry. It was originally developed by NASA as an efficient way to grow plants in space. Instead of embedding plants into a nutrient rich liquid solution, that solution is pumped as a mist into special air chambers where plants are suspended. Aeroponic systems aren’t widely used in vertical farming just yet, but they’re certainly attracting a lot of attention and in fact the technique is already being used by a US company called Aero Farms. They operate some of the largest vertical farms in the world, like this six and a half thousand square metre converted steel mill in Newark, New Jersey producing a thousand tonnes of greens every year, and Aero Farms recently announced plans to build a fourteen thousand square metre state of the art facility in Danville, Virginia which will more than double that production volume.**

**Reducing land and water use aren’t the only benefits of vertical farming either. By its very nature the process is extremely reliable compared to traditional agriculture. There’s no seasonality in the weather conditions, so you get consistent crop production all year round with vastly reduced harvesting time and with no compromise in flavour or quality.**

**And of course, there’s no requirement for the old-fashioned back breaking, labour intensive farming practices or huge agricultural machinery currently needed to produce our food crops today.**

**It’s a not all rosy in the vertical farming garden though. The industry does face major challenges, predominantly in set up costs and energy consumption. As I mentioned earlier, one of the major criticisms is that these facilities use huge amounts of electricity to provide all that artificial ultraviolet light, and a great deal of power to run all the plumbing and climate control systems. This 2018 essay by Dr Jonathan Foley, who is a world-renowned environmental scientist and the Executive Director of Project Drawdown, argued that powering these systems on a worldwide scale could use even more energy than our existing high-emissions food industry does today.**

**These are perfectly reasonable concerns, and operators should surely be very mindful of the pitfalls, not least the fact that if all the energy for these facilities was being provided by fossil fuels then it would undoubtedly have a major detrimental impact on our climate. But LED lighting efficiency has improved remarkably, even in the last couple of years, while the costs of renewable technologies like solar and wind continue to tumble like they’ve just fallen off a cliff.**

**This huge new warehouse in Copenhagen, Denmark is run jointly by the YesHealth Group and Nordic Harvest. It’s a seven thousand square metre hall housing fourteen shelving levels of aluminium boxes stacked full of produce. It’s fully automated, with robots moving the boxes to optimise crop positioning and algorithms controlling nutrient balance, light availability and carbon dioxide levels. Twenty thousand specialised LED lights are installed here, all of which are powered by renewable energy from Denmark’s extensive wind farms. Once it’s fully operational the facility will have a similar output to Aero Farms New Jersey operation, at a thousand tonnes of produce a year.**

**The other site we briefly looked at earlier, run by Plenty in San Francisco, adds artificial intelligence- based software to the automated robots, to improve efficiencies still further, and they also use one hundred percent renewable energy to power their systems. As a relatively new start-up company, Plenty has attracted plenty of attention, having already received four hundred million dollars of capital from investors including SoftBank, former Google chairman Eric Schmidt, and Amazon’s Jeff Bezos. And they’ve struck a deal with Albertsons stores in California to supply four hundred and thirty stores with fresh produce.**

**On a smaller scale, imaginative pioneers are putting hydroponic systems into underground tunnels and vaults or even mine shafts, where the temperature and humidity are already quite warm and constant, which means less energy is needed to maintain the right atmospheric conditions.**

**Even recycled** [**shipping containers**](https://en.wikipedia.org/wiki/Shipping_container) **are being put to use for the purpose. In fact they’re become a very popular, low cost option that have the advantage of being ready made standardized, modular chambers that can easily be fitted out with** [**LED**](https://en.wikipedia.org/wiki/Light-emitting_diode) **lighting, hydroponic racking, and smart climate control systems. And you can stack containers up too, so in theory you can double, triple or even quadruple your yield from the same footprint of land that you started with.**

**One food stuff that has until recently been regarded as a complete non-starter for vertical farming though, is cereal crops like wheat, maize and rice, and that’s a great shame because the vast swathes of land currently being farmed to produce these staples of our diet are mostly found in the very regions of the world that are at the severest risk from climate change, and given that these crops provide more than half of all the calories consumed by human beings today, that means we could be looking at an existential food crisis by mid-century.**

**But this latest research published in the Proceedings of the National Academy of Sciences in August 2020 has demonstrated that wheat can be grown using vertical farming techniques, and if that turns out to be verifiable in a commercial setting then it really would be a game changer. Wheat is the most widely grown crop in the world, making up about twenty percent of all the calories and protein we humans eat.**

**The researchers created two growth simulation models of a 10-layer vertical farm with optimal artificial light, temperatures, and carbon dioxide levels. In that environment they found that the set up could yield as much as nineteen hundred and forty metric tons of wheat per hectare of land per year. That’s a massive increase on traditional wheat farming which manages just three point two tons per hectare. As always of course, someone will need to stump up some serious cash and take the financial risk of trying to make this theoretical simulation actually work commercially in practice, but let’s face it, that’s what entrepreneurs do every day isn’t it? And the investor that nails this one will find themselves with a very lucrative enterprise on their hands.**

**In the meantime, vertical farming for fruit and veg continues to go from strength to strength. Facilities are cropping up all the time, not just in the United States and Europe but pretty much anywhere in the world where there are large expanding urban centres.**

**These facilities are all very impressive, but I don’t think anyone is trying to pretend that vertical farming on its own will come anywhere near to solving the dual crises of food scarcity and soil degradation that loom large as we approach 2050.**

**Nevertheless though, as our way of life becomes increasingly more urbanised and more and more people move away from their dependence on meat and towards plant-based diets these new city-based fresh food factories look set to become an increasingly commonplace element of our everyday lives.**

**No doubt you’ve got your own views on the subject, or perhaps even some experience of working with these systems. If so, then jump down to the comments section below and leave your thoughts there.**

**That’s it for this week though.**

**Thanks to our fantastic Patreon supporters who help keep the channel independent and keep these videos ad-free, and a quick shout out to the folks who’ve joined since last time with pledges of ten dollars or more a month.**

**They are**

**Mike Duwe**

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**Mikael Jonsson**

**Andrew Aikman**

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**As always, thanks very much for watching, have a great week, and remember to Just Have a Think.**

**See you next week**