

# Are high-tech urban farms the future of urban food security?

Although high tech farms seem like science fiction today, their development echoes very tangible urban food security challenges (growing demand, climate change...).

These farms face challenges (expensive land, high operating costs, productivity under lower light condition...), and innovate to answer to these challenges.

It is difficult to draw a conclusion regarding their full potential for urban food security. What we know is that they have not reached their full potential yet.

Credit: CSIRO Agriculture and Food

High-tech urban farms with futurist designs attract more and more investment, and capture the media's attention. Are they just a fad or are they relevant to the future of urban food? An article in *Agricultural Systems* introduces us to the potential and challenges faced by such farms.

## What are we talking about?

Which kind of farms are we talking about? As we know, urban agriculture refers to a great variety of practices (see our previous article [What do we know exactly about urban agriculture's environmental impacts?](#)). This article focuses on those farms that operate in air-conditioned settings, and are, more often than not, integrated into buildings. These are, for instance, rooftop glasshouses or fully indoor, artificially-lit, plant factories. **What they have in common is their reliance on a controlled environment.** Their expansion was made possible by innovation in the light industry, with the development of low-energy LED lights.

Today, such farms represent a very small amount of total food production. For instance, in the USA, in 2016, around 11 000 tonnes of lettuce were produced in greenhouses and 6 500 in vertical farms, which is not much compared to the 4 million tonnes produced in field farms.

## The future could be high-tech

If these farms seem anecdotal, why should we pay attention to them? The article reminds us that although they might seem like science fiction to many of us today, the development of these high tech farms echoes very tangible urban food security challenges. These are:

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Urban Food Futures would like to thank [Cathryn O'Sullivan](#) for her inputs and comments.

### Source:

[C.A. O'Sullivan, G.D. Bonnett, C.L. McIntyre, Z. Hochman, A.P. Wasson, "Strategies to improve the productivity, product diversity and profitability of urban agriculture". \*Agricultural Systems\*, Volume 174, 2019, Pages 133-144](#)

### Picture credits:

CSIRO Agriculture and Food

You can find this article on the URL below:

<http://www.urbanfoodfutures.com/high-tech-urban-farms>



- **A growing demand for food, especially in urban areas, and questions regarding the ability of open field agriculture to keep up with that demand.** Indeed, since the end of the Second World War, agricultural productivity has greatly increased (by 150-200%) while agricultural land only increased by 12%. However, this came at great environmental costs. Whether future agricultural practices will manage to keep a high productivity rate while decreasing their environmental impact is still an open question. Indoor urban farms could therefore be an option to increase productivity, by controlling the environment and expanding the time during which one can grow plants. Data regarding the productivity of such farms is still very difficult to gather because the high-tech indoor farming industry is relatively new. One crop category that has publicly available data, lettuce and leafy greens, shows that productivity is on average 2kg fresh weight/m<sup>2</sup>/year in open fields, but this increases to around 40 kg fresh weight/m<sup>2</sup>/year in greenhouses and up to 100 kg fresh weight/m<sup>2</sup>/year in vertical farms. Controlling the environment and having the possibility to grow during most of the year are key factors in increasing this productivity. More research is needed on other crops to be able to have a full picture of the productivity potential.
- Climate change will mean more weather variability and natural disasters, making agricultural production more unpredictable. **Controlled environments could be a way to reduce the vulnerability of food systems.**
- Urban food systems rely on complex supply chains that make cities dependent upon what happens along these chains, and sometimes, on the other side of the planet. **Such farms could contribute to bringing food production closer to where consumption takes place.**

For this reason, we should look at controlled-environment urban agriculture and its potential to contribute to urban food security in more details.

### Urban settings shape innovation

Farmers have been using greenhouses, poly-tunnels or netting for some time but growing food in highly controlled indoor environments is relatively new in agricultural practices. For this reason, many more innovations are likely in this area in the future..., and it is still very difficult to gauge whether indoor farms will be a relevant option for urban food security in the future.

These farms face a number of challenges:

- **The first set has to do with the fact that they are located in an urban environment.** This comes with very specific constraints. For instance, land is expensive. This means that innovations will seek to increase productivity, i.e. the annual yield per unit area, to **make the most of each square meter**. Farms will also seek otherwise disused spaces (rooftops, brownfield sites...). Urban areas also mean higher living costs, thus higher salaries. Some innovations will therefore seek to **increase automation to minimise labour costs**. For instance, robots can fill pots with soil, or harvest hydroponic, leafy crops but research is ongoing for automating more complex tasks like fruit picking or pruning. Farms can also compensate for higher labour costs by shifting the type of crops they grow, moving towards high added-value crops (berries, medicinal plants...).

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- **The second set of challenges lies around the high capital investment needed** to set up such farms. In 2017, in the United States, around half of controlled environment farms were not profitable, and it took around 7 years for such a farm to start making a profit. **This calls for high value crops to be grown** if these farms want to make ends meet.
- **The third set of challenges is about their high operating costs.** These farms require a lot of energy to operate. This means that any strategy to decrease their energy use is welcome. This can take several forms: more efficient lightening or access to “free” energy such as urban waste heat ([see our previous article Can urban waste become a resource for urban food production?](#)). Generally, anything that can decrease operating costs (sensor networks, automation, data analytics, even artificial intelligence) is a key area for innovation.
- **The last set of challenges has to do with agronomical innovation.** In open field agriculture, researchers have a long history of working with farmers. Indoor farms have been strongly engaged with science since their conception, but the collaborations between scientists and indoor growers are relatively young and there are many ways that they can work together to improve the productivity and profitability of these novel agricultural systems. Growing indoors means that crop features such as drought, frost or insect resistance are not useful, whereas **productivity under lower light condition, short life cycle or miniaturisation are key.**

### Answers are still to come, cities can help answer them

As of today, it is therefore difficult to draw a conclusion regarding the full potential of indoor farms for urban food security. What we know is that they have not reached their full potential yet.

**A key area of research in the future will be full life-cycle analyses of these farms**, in order to better understand their impacts. On the pros side, these farms require a lot less water than open-field farms, and they could even reduce the environmental footprint of the water they use if they manage not to rely on highly treated, potable water. And they induce less transportation. On the cons, they require a lot more energy to grow food than open-field farms, although they could manage, in the future, to tap into urban waste heat and renewable energy sources.

The future will likely be a tale of trade-offs between environmental impacts and food availability. According to Cathryn O'Sullivan, who co-authored the article, **cities should start thinking about how these farms can fit in to their urban plans and understand the pros and cons. They should also work with researchers to understand which system would work best in their settings.** What will work for New York, where fresh produced is transported from distant farms, might not be relevant for Sydney where horticulture farms exist in the peri-urban areas. Designs that are suitable in the Northern hemisphere, where crops need to be kept warm to allow production over the cold months, will be different from, say, what works in the Middle East, where cooling crops is a priority. Cities should prepare now to be sure to have all the information they need when they have to make decisions about these farms.

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