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## From hydroponics to underground farms

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How can urban farming best contribute  
to long-term food security?

A report of the Business Forum meeting on  
Tuesday 5<sup>th</sup> July 2016

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## About the Business Forum

Ethical questions around climate change, obesity, food security, people and animal welfare, and new technologies are becoming core concerns for food businesses. The Business Forum is a seminar series intended to help senior executives learn about these issues. Membership is by invitation only and numbers are strictly limited.

The Business Forum meets six times a year for an in-depth discussion over an early dinner at a London restaurant.

To read reports of previous meetings, visit [foodethicscouncil.org/businessforum](http://foodethicscouncil.org/businessforum).

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## Introduction

More than half the world's population now live in cities, and the rising tide of urbanisation is set to continue. With more mouths to feed and growing resource pressure, it is not surprising that more and more people are looking to urban farming as an important potential contributor to long-term food security. The UK currently imports 40% of its food. Could urban farming boost UK farming output and improve UK self-sufficiency?

Many practices are being developed that increase food growing opportunities in cities, and urban farming can take many forms. They range from community gardening projects to large scale indoor farms. This report focuses predominately on indoor, high-tech urban farming.

Around 82% of the UK population live in urban areas. Could urban farming help reconnect people with their food by growing it nearer to point of consumption? Or might it instead disconnect people from so-called 'real' farming? How much food can realistically be produced on the (often) limited spaces in urban areas? Is produce from vertical or underground farms only likely to be available to those on high incomes? How nutritious is food from these closed systems compared to field-grown crops? And could urban farms play a meaningful role in corporate supply chains, decentralising supply in a similar way to community energy?

The July 2016 meeting of the Business Forum explored the opportunities for healthy sustainable urban farming, and discussed whether – and in what form – urban farming could improve long-term food security in the UK and beyond.

We are grateful to our keynote speakers, Dr Phillip Davis (Business Manager at Stockbridge Technology Centre); Dr Martin Caraher (Professor of Food and Health Policy, City University, London); and Kate Hofman (CEO and Co-Founder, GrowUp Urban Farms Ltd). The meeting was chaired by Dan Crossley, Executive Director of the Food Ethics Council.

The report was prepared by Anna Cura and Liz Barling and outlines points raised during the meeting. The report does not necessarily represent the views of the Food Ethics Council, the Business Forum, or its members.

## Key Points

- Technological advances in agriculture are nothing new, and have been driven in part by attempts to protect crops from variables such as the weather, pests and diseases. They have arguably democratised food, bringing a wider variety of healthy produce to the masses.
- Urban farming has many faces, including community plots, small commercial kitchen gardens, and high-tech, closed looped industrial systems.
- Proponents of indoor, high-tech urban farming argue it can deliver consistent food all-year-round, with low environmental impacts and (once scaled) for less money than conventional farming. It could play a part in land sparing, cutting food and resource waste, and delivering secure, year-round jobs. They argue that it could engage young people and inspire them to become growers themselves.
- Critics argue such farming can be energy intensive and that produce may be regarded as 'not natural' and not end up being widely accepted. They also argue that growing food inside in highly controlled environments may serve to disconnect people from food production even more than they are now.
- The current model is to deliver high-cost items to high-end restaurants or wealthy individuals. Hence, the model will have to change and reach scale, if urban farming technologies are to address overall food security for the most vulnerable in the UK.
- There may be a perception barrier to the wholesale take-up of food grown in urban farms. Some claim that people may distrust technologies employed to grow such food. As yet, though there has been little evidence to back up this perceived challenge. The way many people changed their mind about renewable energy may be a model for how people could come to accept urban farming systems.
- The lack of joined up government food and farming policy makes it difficult for urban farming. A joined up food policy would encourage urban food growing, including in public spaces.
- High-tech urban farming has potential, but it is not a panacea for all the challenges of the food system. It is only likely to ever be *part of* a broader set of solutions that deliver long-term food security.

## Long-term food security

“Food security is not just a ‘nice to have’ – it is inextricably linked to the health and well-being of the planet, to the global economy, and to the profitability of individual businesses.”<sup>1</sup> One simple definition of long-term food security is ‘good food for everyone forever’ (to quote the title of a book by Colin Tudge).

Crucially, food insecurity is a problem of the Global North as well as the Global South. There are many millions of the people in the UK who are food insecure.

Whilst the term ‘food insecurity’ is much debated, how to achieve it is even more contested. There are a whole range of factors driving food insecurity – not least population growth and climate change – that are likely to increase in the future.

## What is urban farming?

The picture that most often comes to mind when thinking about a farm is of fields ringed with hedges, set in the countryside, that produce arable crops or animals for meat. As much agriculture becomes more industrialised and large scale however, the way some crops are grown is beginning to look very different. Some high value crops – such as lettuce, herbs and tomatoes – are not always grown in soil in fields any more.

Agricultural and horticultural advances are not new: the Victorians heated their glasshouses in order to grow pineapples. The objectives have always been to protect crops from the notoriously fickle British weather, pests and diseases; to extend the growing season; or to grow crops not normally associated with the UK. From pineapples to lettuce; arguably technology has democratised food.

This begs the question: if light and heat is already being used to extend the growing season, or to produce food that is not usually grown in the UK, could the whole process be moved indoors? And if so, could it be relocated nearer to where more and more people are living – i.e. to urban areas, or distribution hubs? There are already experiments underway to see if this is possible.

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<sup>1</sup>[http://www.foodethicscouncil.org/uploads/publications/WF030\\_FoodSustainabilityReport\\_FINAL.pdf](http://www.foodethicscouncil.org/uploads/publications/WF030_FoodSustainabilityReport_FINAL.pdf)

Urban ‘farms’ are being built, where the environment is temperature-, humidity- and light-controlled, optimised for crop production. Most of these farms are still in the early stages of development, and there are some important questions still to answer. These include whether new crop varieties should be created for urban farming, or whether the environment should be manipulated to match the crop. Current experiments sit half way between the two – developing crop varieties that work well and deliver on quality, whilst developing manipulated environments to optimise their growth.

## The different faces of urban farming

It was suggested there are at least four ways of categorising farms and farming: (i) urban or rural; (ii) growing is in a controlled environment or an unprotected environment; (iii) farming businesses are profit-driven or values-driven (although it was argued by others that these are not necessarily mutually exclusive); and (iv) farming takes place at community scale or industrial scale.

It is estimated that there are around 800 million people worldwide practising urban agriculture<sup>2</sup> in one form or another. The Worldwatch Institute claims this makes up 15-20% of the world’s food<sup>3</sup>. Urban farming is much more widespread in some countries in the Global North than others e.g. Japan has a significant and growing number of urban farms, whereas in the UK, there are only a handful of high-tech urban farms at present.

There are many faces to urban farming, from community plots to high-tech closed loop systems. The latter includes, but is not restricted to, aquaponics – growing fish and plants at the same time in an integrated system, that combines aquaculture (fish farming) and hydroponics (soil-less growing of plants). This report focuses on indoor, high-tech farming.

## The potential

Some believe that high-tech urban farming has great potential in terms of food sustainability. It was argued that it could be seen as the Tesla of

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<sup>2</sup><http://www.fao.org/urban-agriculture/en/>

<sup>3</sup>[http://blogs.worldwatch.org/nourishingtheplanet/wp-content/uploads/2011/02/Chapter-10-Policy-Brief\\_new.pdf?cda6c1](http://blogs.worldwatch.org/nourishingtheplanet/wp-content/uploads/2011/02/Chapter-10-Policy-Brief_new.pdf?cda6c1)

food production, in that it is a technology (or suite of technologies) that might grow food sustainably for less money. This could be a game changer in terms of democratising access to sustainably produced food.

Urban farming could also be very useful in serving “just in time” food products, meaning fresh food would spend less time on the shelves – and potentially less would be wasted because the product would be delivered just when it is needed. Because urban farming technology is so consistent, it is easy to optimise the scheduling of the products with precision.

Urban farming could also allow growers to have year-round production of many seasonal crops, or at least to extend the growing season (e.g. strawberries). In an experimental project, Sainsbury’s allowed a UK grower to produce strawberries for Christmas for the first time ever – using LED lighting to extend the growing season. This around-the-clock availability may be convenient, and the majority of people may welcome it, but not everybody thinks it is a good idea. Some argue that such a technology would only serve to disconnect people even more from the food on their plates.

With pressure on land increasing as our global population grows, it was suggested that indoor urban farming could spare land for growing the crops that *have* to be grown outside, while perishable high-value crops, such as salad leaves, could be grown inside. The technology, once improved, has the potential to reduce waste and water use as well (as produce grown there would not need to be cleaned). These high-tech growing systems can be very water efficient if the right circulation systems are put in place (95% reduction of water usage compared to glasshouses). They also typically result in lower nutrient loss.

### **Social impacts**

Proponents of urban farming believe that – once taken to the commercial scale in areas on the edge of cities – such farming can offer long-term, secure employment that also delivers training and career opportunities for local employees.

Compared with more traditional farming systems, the relationship with the labour force is very different in an urban farming context. Rather than employing seasonal farm workers on short term contracts, workers in urban farming units are employed all year round.

## **Reconnection to nature**

If people are educated about where and how their food is grown, they may be more likely to make better decisions about what ends up on their plates.

Small-scale community growing initiatives in towns and cities may not make the UK food secure, but such initiatives can reconnect people to their food. Indoor urban farming systems could have a role to play in helping people understand more about growing food – particularly as their high-tech nature could be a way to inspire and engage young people, getting them excited about farming in the future.

Some, on the other hand, worry that such systems would only serve to make people even more disconnected from where their food comes from, given that the growing tends to be done out of sight in anonymous buildings, with seasonality being lost.

Whether or not high-tech urban farming helps reconnect or disconnect people from food, it may, in time, produce food at greater scale than currently. However, it was argued that it is unlikely to deliver food security for all.

There may be a role for both community growing initiatives and high-tech farming systems in educating people about how to grow and eat food in a way that is good for people, planet and animals.

## **Urban farm business models**

It was argued that urban farming systems are already economically viable and that relevant technologies are improving all the time.

Any business needs to deliver good value to customers, good prospects to employees and good returns to investors. It was suggested that being a business and being values-driven should not be incompatible – hence many urban farms are social enterprises.

Like any business, an urban farm has to account for every cost it incurs, and pricing will be set accordingly. Because the majority of UK citizens are unable or unwilling to pay what it really costs to produce their food, many high-tech urban farms are currently serving the high end niche market – restaurants and wealthy individual customers. This approach appears to offer the most financially sustainable business model at the moment.

Current trends in food suggest that people are increasingly interested in eating fresh and healthy food. This means that it is perfectly feasible for urban farming to provide the basis for supplying that particular market – which will only grow as the global urban middle class also grows.

However, this raises the question that if urban farming only serves those able to afford it, how ethical is it? If it has the potential to democratise locally grown, sustainable foodstuffs, then is it right to divert the technology to delivering high-end expensive food that is unaffordable to the masses?

Alternatively, in the future, major food crises may hit hamper food production and urban farming technology could be part of the answer to providing food security at a local level.

## Barriers

There are two key barriers to taking urban farming into the mainstream – financial barriers and public acceptance of the technology/technologies.

The first problem is a lack of funding for such technologies in the UK; an issue that is not so pressing in the US, where there is more investment in the technology. This may be because the return on investment is longer than financiers traditionally find acceptable. It was suggested that the return on investment in urban farming may be nearer to 15 years than five.

The second barrier relates to public acceptance of the technologies. There is a risk that urban farming technologies may be distrusted by some, and even viewed with the same suspicion as GM technologies. As yet, though there has been little evidence to back up this perceived challenge. There is perhaps a more positive model: renewable energy was initially viewed with suspicion and distrust, but in time people begin to

accept and even to welcome (some) renewable energy technologies.

There is also an issue with organic certification and urban farming technology, particularly if produce is grown without soil. Under EU legislation, hydroponics and aquaculture cannot be certified organic, because organic agriculture has to happen in soil. The US and Australia do allow these systems to be certified organic, so there is the option to change the certification rules – especially as the UK will no longer have to comply with EU legislation post-Brexit.

There is huge potential for other types of urban farming too – not just high-end hydroponic systems, but also urban community growing. There are many green spaces in the UK's towns and cities, including public land, which could be used for growing. Barriers to this include accessing supply chains due to health and safety. However, they may not be insurmountable problems.

## Lack of Government food & farming plan

It was argued that the distinct lack of a joined up government plan for UK food and farming makes it a difficult environment for businesses looking to disrupt the status quo. However, that does not mean a business can not do the right thing, even if government policy is not yet in place.

It was suggested that there needs to be more joined up thinking about how to deliver food security. A joined up food and farming policy should look at how to use public spaces for growing food. It would support food business development, and national and household level food security.

London is a city with a population of around 8.6 million that is nine generations removed from the land. Some residents in London (as across the UK) are somewhat suspicious of new technologies. It was argued that if the Mayor of London developed a food policy that genuinely encouraged urban growing for food security, it could play a part in alleviating household food poverty *and* reconnecting people to their food. New York gives tax breaks to people who grow their own food. Could London's government use such incentives to get people to grow food?

Currently, planners and city architects are reluctant to plan for food crops in urban

environments. They tend to block initiatives to integrate food crops and productive trees into the urban landscape.

There are examples of good practice in other countries. In Vietnam, people are allowed to claim land on the edge of railways to grow food. This would be unthinkable now in the UK – although many years ago allotments were a common sign.

## The elephant in the room

### Energy use

It was argued that LED is very energy efficient as a light source, making this type of urban farming practical. In addition, LED technology can be manipulated to create different colour lights that affect how plants grow. For instance, red drives photosynthesis, and blue is the most efficient light source – which is why most urban farming systems use pink LED lighting. The issue here is that LED lighting requires electricity – and some might ask why would we ever use electricity to provide a light source for growing food when the sun's light source is free?

However, proponents of high-tech urban farming systems argue that the sun's energy is variable and not available year around, which is not compatible with a constant need of food supply.

The UK's economy (and indeed the world's) and our way of life is entirely dependent on energy. As such, the debate about using energy is not specific to farming. It is necessary to develop sustainable energy across the board, and if and when that happens, urban farming systems could potentially be highly sustainable. Could urban farming be the catalyst that accelerates sustainable energy innovation?

## What future for urban farming?

Having produce all year around could mean fewer agricultural imports. If the general public want to eat strawberries over Christmas, they could be grown in the UK with urban farming technologies.

Financial uncertainty following Brexit could mean that imported food becomes more expensive. This may have the effect of making urban farm produce more affordable – at least in the short term. Geopolitical uncertainties such as international conflicts or any other issues that disturb global markets may drive a desire for

greater self-sufficiency and mean that urban farming systems become more acceptable.

Urban farming system technologies are at an early stage of development in the UK, and there are some ethical questions that need to be answered before they enter the mainstream. These range from whether they reconnect or disconnect people from food production; whether it is sustainable to use energy that has been extracted from the sun, rather than just the sun; whether it will democratise good food, or make it more exclusive. There is a danger too that the industry grows unregulated, which could ultimately lead to its downfall. Will technologies such as hydroponics in the future be perceived in the same way as large-scale intensive factory farms are by many at the moment?

What is clear is that there is space, and a need for *some kind* of urban farming in our towns and cities, to alleviate food poverty, provide jobs and training, and cut down on food miles and waste. What that will look like is – as yet – anyone's guess.

## Final thoughts

If urban farming technologies are to scale up and gain traction, then the general public need to be engaged and reassured, not simply told that they are wrong about indoor farming (as was arguably the case with GM technologies). There are likely to be sections of the UK population who regard urban farming technologies with suspicion, as they may deem it 'not natural' and 'not real farming' if produce is not e.g. grown in soil. Others will embrace it.

If renewable sources of energy are used, urban farming could be an environmentally sustainable form of production. It is perhaps harder to imagine that urban farming technologies might help reverse inequalities and address overall food security for the most vulnerable in the UK.

High-tech urban farming has potential, but it is not a panacea for all the challenges of the food system. It is only likely to ever be *part of* a broader set of solutions that deliver long-term food security.

## Speaker biographies

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**Dr Phillip Davis** studied for Biology degree and his PhD at Bristol University. For his PhD he studied the growth and photosynthetic rates of freshwater cyanobacteria. After his PhD he worked in Ireland (at University College Dublin) for three years examining the influence of different tillage systems on the carbon dioxide exchange of Barley crops with the aim of reducing agricultural carbon emissions. At Indiana University, USA, he spent 6 years studying plant responses to blue-light. This work spanned all areas of plant science from genetic studies through to whole plant physiology. He moved back to the UK in 2012 to take up a post at Stockbridge Technology Centre to run research on crop production in LED lit urban farms. In addition to his post at STC he is also an AHDB research fellow and plays an important role in educating commercial growers on how to gain the most from LED lighting systems.

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**Kate Hofman** always wanted to run a business that improved the world. Prior to starting GrowUp Urban Farms, Kate worked as a change management consultant for IBM, working on large-scale business and IT transformation programmes. Whilst on a sabbatical year studying at Imperial College London, Kate fell in love with the idea of aquaponics as a sustainable way of commercially growing food for London, the city she grew up in and has lived in all her life. Kate founded GrowUp at the start of 2013, London's first commercial aquaponics urban farming business. She thinks that innovation and sustainability are at the core of the best businesses. She's passionate about proving that urban food production can make a meaningful contribution to the way we feed people in cities, at the same time as creating skilled training and job opportunities. She has a dog called Pickle and in her spare time can be found digging around her allotment and cooking and eating the fruits (and vegetables) of her labour.

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**Dr Martin Caraher** is professor of food and health policy at the Centre for Food Policy at City University London. He has contributed to books on public health and health promotion. More recent work has included research on the European Most Deprived Persons Programme; a review of food taxation schemes; the Sugar tax; a critique of the English Responsibility Deal and a review of the Australian food plan. He was a founder member of the London Food Board and was the public health representative on the London 2012 Olympic Food Advisory Board. He sat on the National Institute for Health and Clinical Excellence (NICE) advisory board on preventing CVD and is a member of two scientific committees 1) the Irish Government's safefood and 2) the International Obesity Taskforce. Current research involves collaborations with researchers in Australia, Portugal and the US. In 2012 and 2013 he was the 'Thinker in Residence' at Deakin University, Melbourne. Martin was the Australian Healthway's fellow for 2008 and again in 2016.

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