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## New technologies in support of urban agriculture

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**Electronic version**URL: <https://journals.openedition.org/factsreports/5874>

ISSN: 1867-8521

**Publisher**

Institut Veolia

**Printed version**

Date of publication: 24 September 2019

Number of pages: 112-115

ISSN: 1867-139X

**Electronic reference**Guillaume Fourdinier, "New technologies in support of urban agriculture", *Field Actions Science Reports* [Online], Special Issue 20 | 2019, Online since 24 September 2019, connection on 23 November 2021.URL: <http://journals.openedition.org/factsreports/5874>

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This text was automatically generated on 23 November 2021.



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Cooltainer in the Bercy district of Paris



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**AGRICOOOL HAS DEVELOPED A FARM MODEL THAT ALLOWS YEAR-ROUND STRAWBERRY PRODUCTION, WITHOUT SOIL OR PESTICIDES, IN CONTAINERS USING INNOVATIVE**

**TECHNOLOGIES (INTERNET OF THINGS, SOFTWARE, DATA, ETC.). WHAT ROLES DO AGRONOMY, ENGINEERING AND SOFTWARE PLAY IN YOUR FARM MODEL?**

**Guillaume Fournier:** We have indeed implemented different technologies to grow strawberries in the urban environment as cleanly and efficiently as possible. Most tasks performed inside the container can be automated using the techniques and technologies we have developed. Planting and picking are the only tasks that are still done entirely manually.

First, we decided to verticalize our farming by using plant walls on the sides of the containers, which are completely modular, allowing optimization of the usable surface of the containers and the urban land on which we plant. One farm, comprising between 1 and 10 containers, normally produces between 4 and 20 metric tons of strawberries over the year. The fruits are continuously picked, as we are regularly adding strawberry plants, which grow in a three-month cycle and bear fruit steadily.

In traditional agriculture, doubling plant density per square meter means sharing resources such as light, nutrients, root space, etc., and consequently halving production. Conversely, our model uses technology to maintain sufficient inputs and increase density without losing yield. To this end, we designed our own system of LED lights, which allows us to provide a spectrum and light intensity tailored perfectly to the life cycle of the strawberry. This system uses little energy, but provides optimal lighting that maximizes plant density.

We also developed an aeroponic system in which our plants grow without substrate. Their roots are literally in the air, fed by a nutrient-rich mist, allowing them to grow unconstrained. This means there is no barrier to increasing the density per square meter. We operate extremely precise climate control that reproduces the day-night cycles to allow the maximum number of plants in a minimum of air, with perfect management of moisture supply, carbon dioxide level, temperature, etc. This is carried out within a technologically complex closed loop. For example, we had to find a suitable system to allow the water used to irrigate the plants to be recovered and reused. This is a complex mechanism because the plants consume different nutrients depending on the phase of the strawberry's life cycle (flowering or fruiting periods, for example).

In the end, we developed our own software, which allows us to track 100 data points per second in the container environment, and to automate the whole strawberry life cycle via algorithms that control the air and water conditions. The data we collect can then be used to analyze any anomalies.

## Inside the Cooltainer



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### **WHAT ARE THE MAIN ADVANTAGES OF YOUR VERSION OF CONTAINER GROWING, PARTICULARLY IN TERMS OF RESOURCE USAGE (WATER, ENERGY, ETC.)?**

**G.F.:** Our model is based on rational, scientific thinking and resulted from various observations.

On one hand, France imports 75% of the produce it consumes, and we know that imports harm the planet, especially when the produce is out of season. On the other hand, current food production will need to increase 70% by 2050 to feed the global population. Producing food directly in cities is a necessary alternative to an unsustainable model. However, land in cities is far more limited, expensive and difficult to manage than in rural areas. If food production within cities is to be sustainable and sustain people, for example to feed 20% of a city's inhabitants, it needs to be much more productive, but without using pesticides or reducing nutritional quality.

Our technology allows us to create far greater production capacity in the urban environment than in the open air, meeting the double challenge of fighting climate change and increasing food production. After four years of research and development, we have successfully multiplied the yield per square meter by 100 and developed a production model that remains stable throughout the year. We currently have eight containers in Paris with 40 plants per square meter, which is 60 times higher than the strawberries sold by large retailers. We can produce 7 metric tons of strawberries per year, the equivalent of a half-hectare field.

This increase in yield was achieved with no loss to taste or nutrients. On the contrary, our strawberries contain on average 20% more vitamin C and 30% more sugars than those bought in supermarkets – without genetically modifying the plants or using pesticides, which are harmful to both human health and the environment. Additionally, the closed loop consumes 99% less water than an ordinary greenhouse,



and works using only renewable resources, whereas traditional agriculture uses machinery (tractors, etc.), transportation (ships, planes, trucks, etc.) and a lot more water. So, we are ecologically and sustainably producing pesticide-free strawberries that taste better and are healthier.

Right now, we're the first to make strawberries grow in Dubai, a rapidly growing city with high levels of wealth and consumption that is nonetheless forced to import almost all its food. Establishing local strawberry cultivation seems to be a change with enormous potential for expansion that could bring considerable environmental benefits.

#### Agricool strawberries on sale at Monoprix



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**YOUR MODEL RELIES ON TRAINING “COOLTIVATORS” TO WORK YOUR CONTAINER FARMS. IS THE JOB OF “COOLTIVATOR” MORE LIKE BEING A FARMER OR A PROGRAMMER/DATA SCIENTIST?**

**G.F.:** Our vision is to make better-quality products available to as many people as possible. To do that, we need to increase our number of farms, and therefore of farmers. However, the challenge is that farming is a job that requires several years of study and practice. The aim of our farms is to make the job of “cooltivator” accessible to as many people as possible.

Our “cooltivators” are not all agronomy graduates: our technology makes strawberry growing accessible by automating the most complex aspects and processes. The first things we look for in our candidates are motivation and a desire to learn, along with self-discipline and attention to detail. They then spend three months training in the planting, picking and monitoring of crops. Becoming a producer without being an expert is the key to our model, and will enable us to increase the number of farms. We hope that one day, anyone will be able to set up their own farm and become an Agricool farmer, working independently, but with our continuing support via

distance monitoring of the farms. As well as our technology, using containers contributes to the democratization of agriculture, as they enable the building of diverse farms adapted to the space, means and goals of their owners.

Our team currently consists of 80 people from extremely varied backgrounds, from engineering to farming via marketing. This diversity is an asset for Agricool, because a mixture of knowledge fosters innovation. Our R&D department is the largest in terms of employees: we have 50 people dedicated to research. Our teams constantly strive to improve our model and study new methods for growing fruits to diversify our production. The strawberry is a first step – chosen because it is currently difficult to find quality strawberries on the market – but we want to develop other crop types, such as tomatoes.

**ARE END CONSUMERS, AND EVEN TRADITIONAL FARMERS, NOT SUSPICIOUS OF AGRICOOl URBAN FARMS, WITH NO SOIL AND BASED ON CUTTING-EDGE TECHNOLOGY?**

**G.F.:** Most people have a quite emotional relationship with food and farming. Urban container farming, like many topics connected with technological innovation, can sometimes divide opinion. Different people react differently: optimists perceive technology as a key to solving problems, compared with more skeptical types who tend to be suspicious of things that might seem unnatural.

However, in our case this suspicious reaction is generally negligible. It seems most consumers are looking for ways to respond to the environmental challenges we all face, and are generally welcoming and positive about technologies that potentially offer solutions. Agricool is generally viewed as part of the solution to progressing to a more sustainable world.

As for the farming community, we have generally maintained highly positive relations with traditional farmers. Our relationship is not competitive, but rather complementary in terms of supplying cities with food. Many farmers come and talk with us with a great deal of enthusiasm and curiosity. We promote these exchanges with the aim of building and strengthening bridges between these different types of farming. In the future, we may see hybrid models emerge: an Agricool farm could be established within a traditional farm, or traditional farmers could work with us in the urban environment!

Cooltainer in the 13<sup>th</sup> arrondissement of Paris, near Station F

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**THREE YEARS ON FROM STARTING THE BUSINESS, YOU HAVE RAISED €25 MILLION TO INDUSTRIALIZE YOUR MODEL. WHAT ARE THE NEXT STEPS FOR AGRICOOOL?**

**G.F.:** We've devoted a lot of skill and time to research in recent years. The main use of these funds will be to continue our efforts in this direction. We want to consolidate and improve our model to increase our yield, consume less energy and diversify our production.

Investments will next be used for deployment: our goal is to increase our current yields and to multiply the number of farms in France and internationally. Our goal is to get 200 people involved at Agricool by 2021 to deploy hundreds of containers with a view to industrializing and scaling up our model.

## ABSTRACTS

Since 2015, Agricool has been developing container farm models designed for growing strawberries in the heart of the city. Following several years' research and development, this project, launched by two farmers' sons, uses a closed-loop aeroponic system, low-energy LED bulbs and software to provide optimal conditions for strawberries to grow. The yields obtained are 60 times greater compared with traditional strawberry-growing methods, and the strawberries have a 20–30% higher sugar and vitamin content, while the carbon footprint is reduced. To date, the Agricool model has relied on a few "cooltivators" trained in-house, but the aim is to harness new technologies to make this production method available to as many people as possible.

## AUTHOR

### **GUILLAUME FOURDINIER**

Guillaume Fourdinier gained a degree in management from the Grande Ecole IÉSEG in 2010. A farmer's son with real entrepreneurial passion, he set up his first business while still pursuing his studies, before founding Agricool with his colleague Gonzague Gru. The business started in 2015 on a family farm where the two co-founders decided to reuse an abandoned container. After several test phases and trials of more than 30 strawberry varieties, they came up with their first 100% connected and automated farm model with the goal of local, pesticide-free production.