

Food Forward: High-tech biology and physics lessons from the greenhouse



In short

High-tech biology and physics lessons from the greenhouse

Biological and natural principles are being practiced in the greenhouse on a daily basis. As a result, growers reduce their emissions and avoid using chemical crop protection products. The transition from soil to stone wool growing media in 1969 and the invention of bumblebee pollination in 1988 were only the start of a whole range of innovations in the area of controlled and natural cultivation.

In this Food Forward we speak about the latest developments in the greenhouse with Peter Maes of [Koppert Biological Systems](#), Jim van Ruijven of the [Wageningen University & Research, Business Unit Horticulture](#), and Sander van Golberdinge of Grodan. These include:

- 1.** Vegetables and fruits that have been cultivated outside of the soil are automatically categorized in the supermarket as non-biological. However, a tomato from a high-tech greenhouse in the Netherlands has actually been cultivated in a very natural, sustainable way, without the use of any chemical crop protection products.
- 2.** Biological crop protection products have become mainstream in the greenhouse and form an important base for the cultivation and health of the crops. Nowadays, bio stimulants are increasingly used to make sure plants stay more resilient and healthy.
- 3.** More research is being done on the (re)use of water in the greenhouse and the life that exists within this water. For example, think about the water around the plants' roots, within the growing media, but also in the water that's discharged outside of the greenhouse.
- 4.** Seventy percent of evaporative water from the greenhouse is lost through the ventilation systems. By applying other methods of dehumidification, the grower can limit the amount of water that's lost.

Read more about sustainable cultivation methods and next steps we can take towards a resilient greenhouse in this Food Forward.



Did you know that as early as 1988 it was discovered that bumblebees are the best pollinators of tomatoes? Thanks to their 'buzz-pollination' technique, where the bees shake the flowers, bumblebees are now used for more than a hundred different crops. And did you know the water evaporated from plants can be reused in greenhouses? These are just two examples of the many ways in which the principles of biology and physics can be used and reused in greenhouses on a daily basis. As a result, growers can reduce their emissions and avoid the use of chemical crop protection products. In this Food Forward, we sketch the latest greenhouse trends with Peter Maes from [Koppert Biological](#)



Sander van Golberdinge, Public Affairs manager at Grodan

[Systems](#), Jim van Ruijven from [Wageningen University & Research, Business Unit Horticulture \(WUR\)](#) and Sander van Golberdinge from Grodan.

Greenhouses: pioneers in sustainability

"In recent years, consumers have increasingly started to ask questions about the origins of their food products," explains Sander van Golberdinge, Public Affairs Manager at Grodan. Sander is on a mission to show supermarkets and consumers just how sustainable, healthy and safe the production of fruit and vegetables in the greenhouse actually is. "At the moment, there is more attention for the origin of products that have a visible impact on nature, such as coffee, tea, wood and palm oil. But supermarkets and consumers are less critical when it comes to the origin of, for example, tomatoes", says Sander.

"Currently, supermarkets only make a distinction between organic products (cultivated on the land, without chemical crop protection products) and non-organic products. So fruits and vegetables not cultivated on the land are automatically classified as non-organic. And that's strange, because a tomato from a high-tech greenhouse in the Netherlands is



Peter Maes, Director Corporate Marketing at Koppert Biological Systems

actually cultivated in a very natural, sustainable way, without the use of chemical crop protection products. The high-tech greenhouses are the [pioneers in the field of sustainability](#), if you ask me."

Saving water

Sander talks enthusiastically about the sustainable cultivation methods in greenhouses. "For example, at Grodan we discovered already in 1969 that stone wool is a good and sustainable growing medium. As the stone wool growing media can be steered and can retain water well, growers can adjust their watering strategy very precisely (an important factor in [precision growing](#)). Besides saving a lot of water in the



greenhouse, this also makes the plants more resilient.”

Organic pesticides

Another important and unique factor in greenhouse cultivation is the use of biological crop protection. Peter Maes, Director Corporate Marketing at Koppert Biological Systems, can endorse this. “Biological crop protection products have been on the market for years, but used to be seen mainly as an alternative (for chemical products). Now, we’re seeing that biological crop protection has become mainstream and are forming a firm foundation for the cultivation of healthy crops,” explains Peter. He’s been working with the company since the nineties and has seen the organization grow from a relatively small firm into one that employs 1750 people and has 28 sister companies all over the world.

Koppert Biological Systems was founded in 1967 by Jan Koppert, a cucumber grower in the Netherlands. He was the first person to introduce a natural enemy to control an infestation of spider mites in his own nursery. Since then, the quest for biological solutions has kept accelerating and Koppert solutions are now used in over a hundred different countries.

Plant empowerment

“Growers are now increasingly concerned with the question of how to grow delicious food as efficiently, sustainably and effectively as possible, with minimal use of chemicals and maximum use of biology. We’re seeing an increasing focus on the health and resilience of the plant itself. And I think that’s a great development. For years, our biological products have concentrated on combatting pests and diseases, optimizing pollination and contributing to plant growth and resilience. And now we’re adding a new dimension: the use of biostimulants.”



Jim van Ruijven, Researcher Water & Emissions at WUR

Biostimulants

Peter says, “Biostimulants help regulate the balance of the plant. We can remove stress from the plant, or create targeted stress to trigger a resistance in the plant, so it defends itself against a disease or pest. The plant’s roots are surrounded by life and there is a constant exchange of sugars and enzymes. As the plants grow in a greenhouse, these processes are influenced by external, abiotic factors, such as the temperature or light in the greenhouse. Using biostimulants ensures the plant remains more resilient and healthy. It works the same as our own gut system, where we drink a Yakult to balance the bacteria. We can do the same thing for plants’ root systems.”

The biology of water

Alongside the development of biostimulants, more research is being conducted into the use and reuse of water in greenhouses, and the life that exists within the water. This includes the water around the plant roots, in the growing media, as well as the water that is discharged outside of the greenhouse. An expert in this field is Jim van Ruijven, Researcher Water & Emissions at WUR. Jim joined forces with Grodan in conducting [research into the zero-emission](#)



[greenhouse of 2014- 2017.](#)

"In the Netherlands, we're striving toward [\(near\) zero-emission cultivation in 2027](#). Moreover, as of January 1st, 2018, it's [obligatory to purify drain water from greenhouse horticulture](#). So, my research focuses on the question how we can ensure growers don't need to throw away any water," says the enthusiastic 33-year-old researcher from Rijswijk.

Nature person and researcher Jim calls himself a real 'nature person'. As a baby, he was always in his playpen in the garden, and watched his father, a horticulturalist, at work from an early age.

"I did think about taking over my father's company. But in the end, I chose for the research side of things. Because where I am now, I can have a much bigger impact on what happens in the whole sector. On the one hand, our research is all about the growth of the plant itself, without the use of protection products. But on the other, we're also dependent on social trends and the continually changing regulations. That's what makes my job so interesting."

Improving water quality

Now, Jim is involved in 10 – 12 research projects that focus on the maintenance of water quality in

greenhouses. For example, he's conducting research on how to maximize the recirculation of water in greenhouses, how to get enough oxygen to plant roots and how to [avoid biofilm formation in pipes](#).

"In one of the projects, we're looking at how growers can make specific and continual measurements of the fertilizers that are present in the water around plant roots, so they can adjust accordingly. Now growers are measuring this once every two weeks, whereas there's a big wish to be able to do so continually. Growers are very enthusiastic about this research," says Jim.

At the same time, Grodan is constantly working on improving and optimizing the plant root steering through the growing media. This also benefits the plants' resilience. Sander says, "Using [GroSens](#) enables real-time measurement of the temperature, the water content and nutrient (EC) levels of the growing media. That provides valuable, timely information and guidance for optimizing production."

Reuse of evaporated water

Jim also looks at preventing leaks in greenhouses and reusing evaporated water.

"Today, 70 percent of the water that

evaporates leaves the greenhouse through the ventilation systems. By using other dehumidification methods, we can limit that amount of water. Although it's technically possible, we still need to find a way to make it more affordable and energy-efficient," explains Jim.

"And that's the nice thing about my work. At WUR, we can take risks, and develop and test various new technologies. This sort of research is often too risky and expensive for the growers themselves. But there's always a lot of interest from growers in our research projects. We get more than 5000 visitors a year from all over the world, who want to look at projects like our zero-emission greenhouse. And in recent years, we've been able to help growers in dealing with the purification obligation in the Netherlands, by bringing various parties together. That's something I'm proud of, as it makes our research tangible and practical."

Impact of globalization

The growing interest in organic processes and products in greenhouses is not limited to the Netherlands.

"For Koppert, Russia is currently a major developing market. There's a lot of interest in biological crop



protection products. And growers in America, Mexico and Canada are taking important steps as well. We're also seeing increasing levels of ambition in the Gulf States to be more self-sufficient in their food production. They're increasingly showing interest in high-tech greenhouses and the associated biological crop protection products," says Peter.

This international collaboration is important, also because the frequency of greenhouse pests and diseases is increasing at a global level.

"That's a consequence of climate change and an effect of globalization. New diseases and viruses keep appearing, which aren't always easy to combat. So, the complexity of horticulture is increasing all over the world. For us, it continually presents new challenges. Sometimes, our R&D Center succeeds in developing a new biological crop protection product within six months, but sometimes it can take 5 – 7 years to develop and register a product."





Next steps toward the resilient greenhouse

1. Importance of collaboration

It's important as a sector and as a society to work together to make our food production even safer and more sustainable in the long term: "In the Netherlands, for example, we're seeing that growers are getting together and build collective purification installations. Although it's not always successful, it does show that growers are taking an increasingly serious look at the quality of their water and they want to learn from one another. In the Westland, for example, growers are setting up a [collective for waste water purification in Hoek van Holland](#)," says Jim.

At the international level, too, there can be more collaboration between growers. "Soilless cultivation makes it easier for growers to work with the same standards at different locations throughout the world, provided they have sufficient light, high-quality water and good infrastructure," explains Sander.

2. Resilient cultivation methods

There are limits to achieving maximum output in our food production, and this has been emphasized by the corona crisis, according to Peter. "People are not able to control and influence everything. It's important we join forces to develop safe, resilient cultivation methods, so that we achieve an agro-economy that is future-proof. Because a resilient agro-economy allows us to take a step towards a resilient, sustainable society." According to Sander, it's important to minimize the cultivation risks. "In high-tech greenhouses, it's easier to isolate and eliminate soil-based diseases, in particular. That ensures higher levels of food safety and certainty."

3. More interest from supermarkets

It's also essential that supermarkets and consumers show more interest in the products cultivated in high-tech greenhouses. Sander says, "Retailers must be prepared to pay more for safe and

sustainable food from the greenhouse. This has already been achieved in France, where growers get a better price for products which have been grown without chemical crop protection products or which are delivered residue-free. I think this should become the norm in all countries."

Cleaner and safer

Eventually, it's not a question of whether it's possible to grow fruits and vegetables in a controlled environment, while applying natural processes at the same time. The switch from soil to stone wool growing media in 1969 and the discovery of bumblebee pollination in 1988 were just the beginnings of a whole series of innovations in controlled, natural cultivation. It's now important that there is more recognition of and interest in the long-term resilience of the crops. Because, as Sander says, "The more naturally we grow fruit and vegetables in greenhouses, the cleaner the soil, groundwater and surface water around the greenhouses will be, and the safer our own food will be!"

Bios

Sander van Golberdinge

Sander van Golberdinge has been Public Affairs Manager at Grodan since the beginning of 2019. It is his mission to bring the greenhouse cultivation sector and the retail sector closer together to work collectively on a more sustainable food chain.

Peter Maes

Peter Maes, Director Corporate Marketing at Koppert Biological Systems, is an agricultural engineer from Belgium, with a Master's degree in human ecology. Since 1998, he has been working with Koppert Biological Systems, a family firm that has developed over 20 years into the market leader in the area of organic crop protection and natural pollination.

Jim van Ruijven

Jim van Ruijven, Researcher Water & Emissions and son of a horticulturalist from Rijswijk, has been working for eight and a half years at Wageningen University & Research. He is involved in more than ten research projects in the areas of microbiology in water, water purification and water (re)circulation.

About Food Forward

In Food Forward papers, Grodan highlights current developments and trends in horticulture by talking to various experts. By discussing their perspectives, Grodan provides more background information about topical issues and contributes to social discussions concerning our current food production system.



Grodan supplies innovative, sustainable mineral wool substrate applications for professional horticulture, based on the Precision Growing principle. These applications are used for the growing of vegetables and flowers, such as tomatoes, cucumbers, capsicums, aubergines, roses and gerberas. Grodan supplies stone wool substrates in combination with customized advice and innovative tools to support growers with Precision Growing. This facilitates sustainable production of healthy, safe and delicious fresh produce for consumers.

Rockwool BV / Grodan

Industrieweg 15
P.O. Box 1160, 6040 KD Roermond
The Netherlands

t +31 (0)475 35 30 20
f +31 (0)475 35 37 16
e info@grodan.com
i www.grodan.com
in www.linkedin.com/company/grodan
🐦 www.twitter.com/grodan
@ @grodaninternational

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