Part 2 - The impact of data-driven growing

Whitepaper

Grodan®

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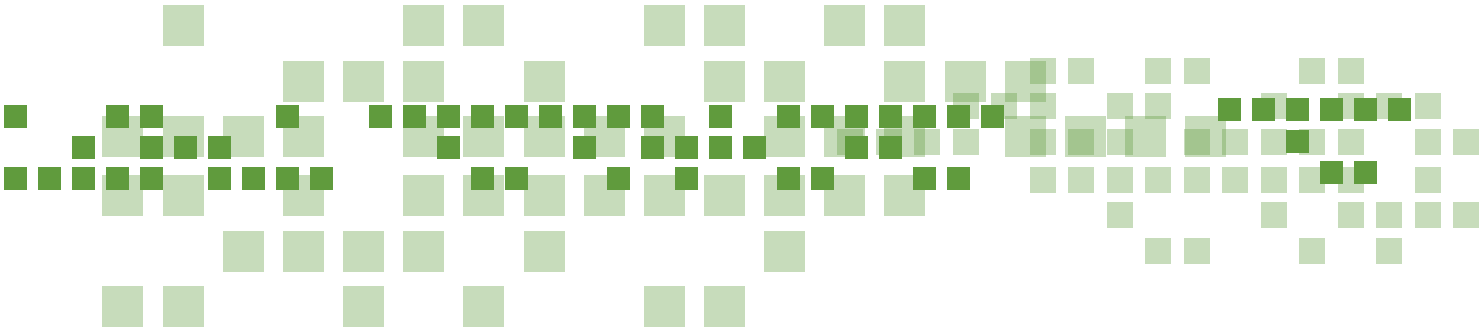
Introduction

In today's conditions, growing crops can be likened to performing sport at elite level. Green fingers and a passion for growing no longer guarantee good operating results. The goalposts are constantly being shifted. Stringent environmental regulations and legislation, excessive demands placed by customers, fierce competition and small margins force growers to maximise the potential of their crops efficiently and sustainably. At the same time, the continuing trend of upscaling, the tight labour market (smaller pool of available labour) and dwindling numbers of experienced crop managers (vanishing expertise) are all obstacles along the path of achieving business continuity and success. Not just today, but also tomorrow and in the years ahead.

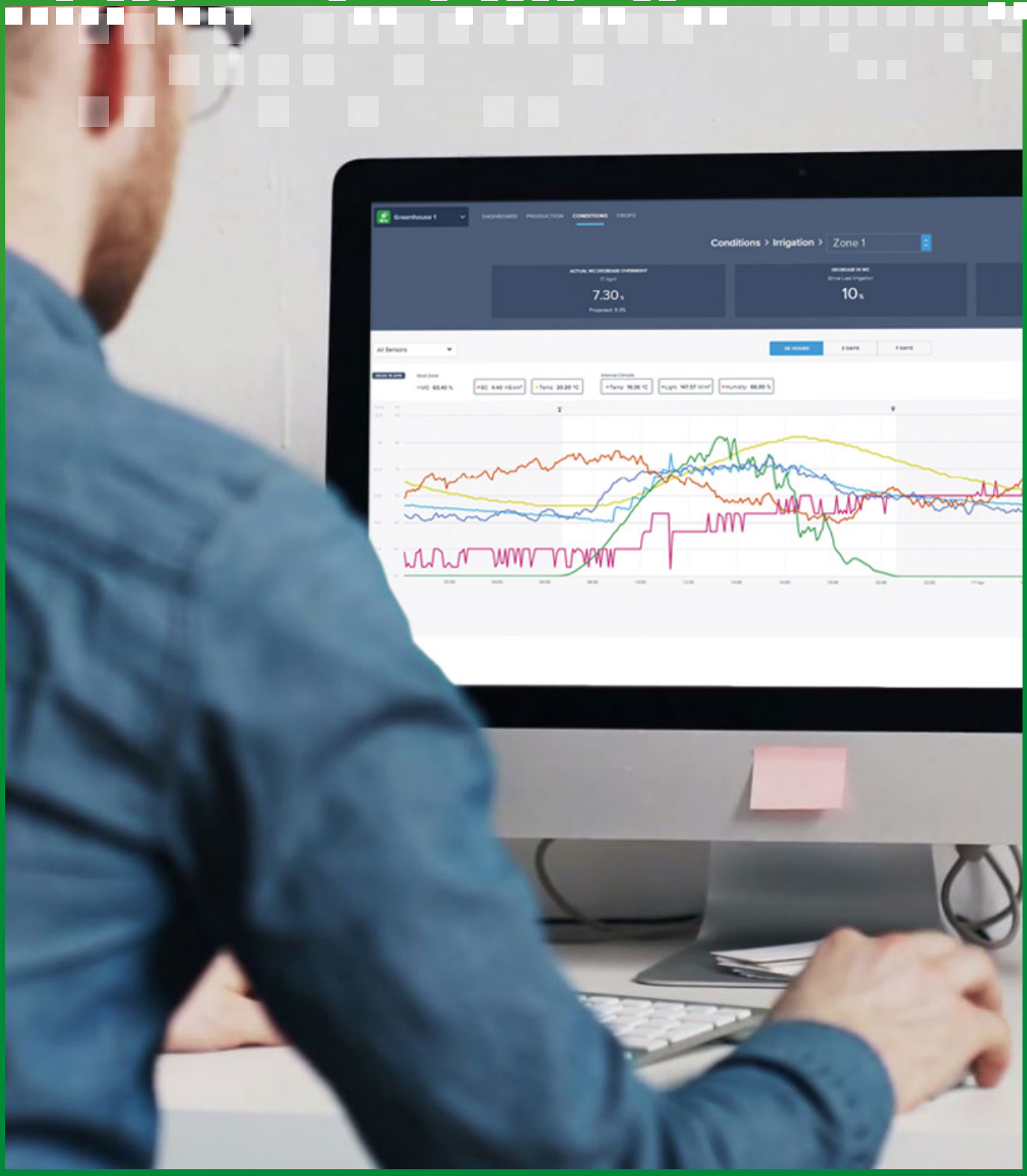
Technological innovation is increasingly part of the solution to that complex puzzle. A growing arsenal of measuring units, cameras and other sensors allows us to monitor what is happening in and around the plant, in the parts visible above the growing media and in the root zone environment, more accurately and real-time. This facilitates extremely accurate crop steering and avoids suboptimal performance. But, until recently, what was lacking was an instrument able to analyse the correlation between all these multiple data flows, compute calculation models and translate this into advice and recommendations for objective, concrete control measures.

In this document respected researchers, innovation experts and the people at Grodan involved in these developments outline their view of the past, present and future of data-driven growing. They explain the road map ahead for high tech horticulture and the compelling reasons to follow that road. Grodan's management and team hope that their reflections, vision and insights will contribute to a better understanding and inspire you to push boundaries together. Enjoy the read!



Chapter 1
Data-driven growing promotes production and efficient water use

With *Paulina Florax*



Greater attention is being paid to the domain of data-driven growing. Grodan is also collaborating in the digital transition phase through the development of an open platform. The e-Gro concept was launched in 2019. Soon after it was awarded the Greentech Concept Innovation Award. "Detailed and accurate information about growth factors is crucial to supply plants with precisely what they need," says product marketing manager Paulina Florax. "Important principles in this respect are efficient water use and an optimal irrigation strategy."

Real-time information
It now takes much more than green fingers to obtain maximum production of top quality using a minimum input of energy, water and nutrients. Anyone wishing to steer and manage crop growth effectively, unconstrained by physical location or time, needs reliable, real-time information on all relevant growth parameters in addition to green fingers. Moreover, this management data must be analysed, combined and presented in such a way that growers can maintain a clear overview and take well-informed decisions. This sums up the core of what data-driven integrated growing is.

New standard
"We have been convinced for years that this approach leads to better results," says Paulina Florax. "High-tech greenhouse horticulture has been gearing up for this for a long time. But the pace of change has been accelerated by new measurement and control technology, which is urgently needed in the sector. Companies continue to grow in size, and often operate on multiple sites, sometimes even in more than one country. Without the help of advanced technology, maintaining an overview of the situation in the greenhouse and timely, adequate intervention is simply impossible."

For decades, Grodan has developed substrate products and tools that give growers more grip on the root zone environment. These products enable improved results with more efficient water use. In the past years, the company has introduced various tools that give growers access to the collected data anywhere and at any time.

A single dashboard
But the strategists and product developers at Grodan were driven to take developments to the next level. "For truly integrated, data-driven growing management, you can't just limit yourself to the root zone," Florax explains. "Our e-Gro platform is based on that principle. This software platform unites various growth parameters, including from other sources, in a clear dashboard. Part of the platform is a crop registration module that visualises different parameters. The dashboard delivers a comprehensive and clear insight into the growth status of the crop and an evaluation of the vegetative and generative measures taken. You can also view historical data and look ahead."

Predictions
A feature that is highly appreciated by users is the accurate prediction of the extent of slab drain during the night. "If you know how quickly the water content of the slab drops, it is far easier to align the stop and start times of irrigation, and how much water is given with the actual needs of the plants", say the product marketing manager. "An extremely useful tool, as the plant can continue to perform optimally, and you can satisfy its precise needs at that moment. The more efficiently you can leverage this and other growth factors in your favour, the greater the chance of a healthy crop and healthy operating results"

Continued development
Florax is keen to stress that the platform will see continued development in the coming years, both technically and in terms of visuals. "It should be a product that is transparent and delivers added value for all users," she says "We use feedback from growers as input to further optimise the software platform."

It should be a product that is transparent and delivers added value for all users.

Chapter 2
From green fingers to data-driven growing

With *Vincent Deenen* and *Gursel Karacor*

At Grodan the possibilities of data mining and combining this with the opportunities offered by artificial intelligence are subjects that have intrigued us for years. In this way we can support the horticultural sector in moving towards the next phase: data-driven growing - which we refer to as Horticulture 4.0. We interviewed Vincent Deenen and Gursel Karacor on developments in Horticulture 4.0.

Horticulture 4.0: distant future or new reality?
We asked Vincent Deenen, who has more than 30 years of experience in the agriculture sector. "With e-Gro, Grodan is taking another step toward this new reality. The past 50 years have seen Grodan evolve from a company with a focus purely on stone wool substrates into a global provider of data-driven solutions such as e-Gro. Firstly via a mobile app and now also available as a software platform for desktop, tablet and mobile. This is where the terms data mining and machine learning converge, and in my opinion that interface is an amazing innovation for greenhouse horticulture."

What are data mining and machine learning?
Gursel Karacor, Senior Data Scientist at Grodan and closely involved in the development of e-Gro, explains. "The really unique feature of e-Gro is that it gets smarter and smarter. By the day, in fact, as the various data flows integrated into the system are deployed 24/7 by the software to make better predictions."

Can you give an example?
"e-Gro has a module that predicts the yields of tomatoes," says Karacor. "This ability to predict requires a massive volume of data sourced from the digital environment inside and outside the greenhouses. This includes crop data such as stem density, the duration of flowering and fruit set, harvesting and fruit data, information about the indoor and outdoor climate, such as temperature, wind direction and speed, solar irradiance and absolute and relative humidity. Based on differences between the predicted and realised yields and analysis of the setpoints used in those cropping cycles, the calculation model learns from its mistakes or inaccuracies and constantly adjusts itself to improve the precision of the predictions. We call this 'machine learning'. In this way, growers have greater control of their production process and can optimise the crop performance."

What about AI?
"We combine this smart software, i.e., artificial intelligence with the knowledge and experience of cultivation experts," Karacor replies. "By uniting the best of both worlds, we can speed up the machine learning process and sharpen the precision and capabilities of our calculation models. In this way e-Gro helps growers take smarter, more efficient decisions."

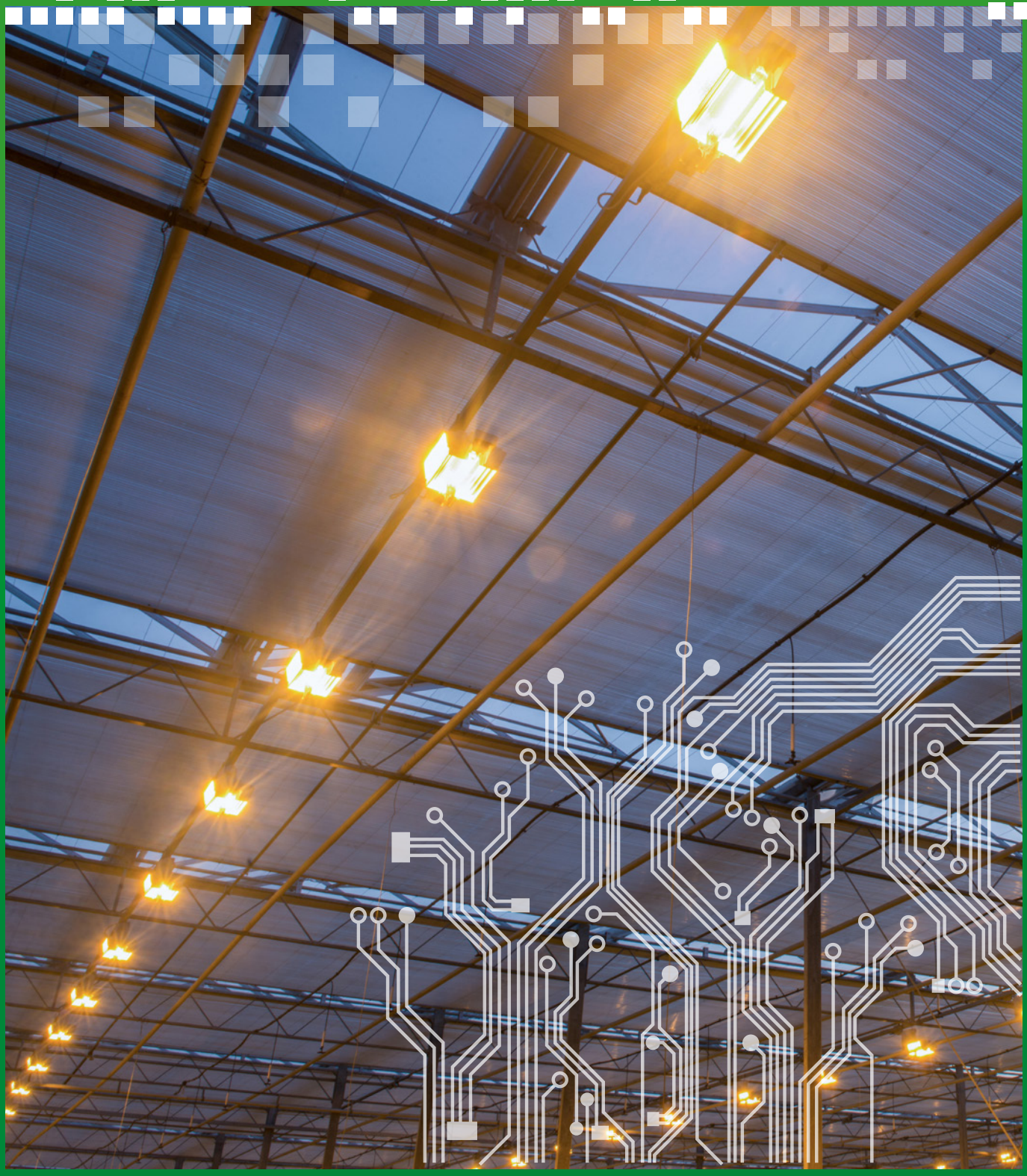
Will we still need growers?
"Absolutely! To get the very best results, we combine artificial and human intelligence. The skill and expertise of growers is, and will remain, a vital component in growing systems. I would even call the role of a grower indispensable."

What role does technology play in the future of horticulture?
"We humans utilise our resources much faster than any species. Data technologies are developing rapidly, however, and on the back of this, the greenhouse sector can grow equally fast. Technology can make an immense difference in sustainable and efficient cultivation. I think that survival in the horticultural sector is entirely dependent on using novel technologies."

"e-Gro helps growers take smarter, more efficient decisions.

Chapter 3
Why data-driven cultivation is relevant

With *Silke Hemming*



As a researcher at Wageningen University & Research and organiser of the Autonomous Greenhouse Challenge, Silke Hemming closely follows developments in the field of data-driven growing. There are still many hurdles ahead, but the whole world is looking over our shoulder and helping us to bring remote growing closer. Fifteen years ago, nobody had any faith in the initiative, but things have changed since then."

Not new, but innovative

Data-driven growing is not a new development. After all, for quite some time growers have based their decisions on climate data measured inside and outside the greenhouse . This data was compared with historical data, or benchmarked against data from other growers. So why all this sudden interest in data-driven growing? "It's all due to the current radical evolutions in technology enabling us to zoom in on plants and in models that accurately predict how plants will respond to setpoints. This allows the future to be predicted too, and growers to be supported in their growth strategies," says Silke Hemming "Tech companies have long been working on data platforms for food. The emergence of new revenue models in plant-based production – such as vertical farming concepts and intensive cultivation using LED light – is intensifying the need for control methods and accelerating developments in data-driven growing. The Challenge is a great way of gaining more knowledge and experience, testing new technology and learning from the results."

From reactive to proactive

At present, a crop's development is still mainly managed based on personal observation and instinct. According to the researcher, even more traditional growers are slowly starting to realise that green fingers are all very well, but not the be-all and end-all. "There is still a strong tendency towards reactive crop management," continues Hemming. "By adjusting setpoints to curb vegetative or generative growth. But in actual fact, your crop has been performing suboptimally for some time by that point. Sensors are now becoming available that enable real-time monitoring of developments, for example conditions in a plant's root zone environment, the microclimate and even photosynthesis. That allows a faster response and intervention. Combined with advanced growth models you can anticipate to prevent a suboptimal performance. The outcome will be higher yields, better product quality, greater resistance and more efficient use of energy, CO2, water and nutrients."

Work in progress

The researcher explains that the supply industry is already busy developing platforms to facilitate data-driven growing and make it accessible for practical applications. "Your e-Gro concept is a good example of this," she says. "I'm certain these kinds of initiatives help move horticulture forwards. I see it as work in progress, because there's still a long way to go before we actually have truly autonomous systems that cover the entire spectrum of observation, data processing and optimising growing." One of the difficulties to be overcome is that data relating to crops, growing conditions, climate, water and nutrients come from different sources - some of them handwritten, others digital - and that some data is generated per minute (climate), others daily (harvests), and yet others two weekly (nutrient analyses). Analysing, combining and interpreting all those data is no mean feat. And then there will still be observations that are not (yet) digitally recorded, such as growers' observations as they walk through their greenhouses to inspect their crops.

Relevance

Hemming: "We must also ask ourselves whether everything we can and could measure is indeed relevant for what we actually want to know, i.e. how plants are feeling and whether they are performing to the best of their ability. The answer to this question is, of course, no. What's more, not all the data that are now measured can be easily interpreted or translated into concrete actions. We can't yet look as deeply into a plant as we'd like to, but we're certainly making progress." So what can growers do once they have the desired relevant data? Control production, quality and moment of harvest of course, but to truly maximise their profits they'd also need market information.

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My expectation is that development will be accelerated in the next five years and that autonomous cultivation platforms will become standard equipment for a new generation of cultivation managers.

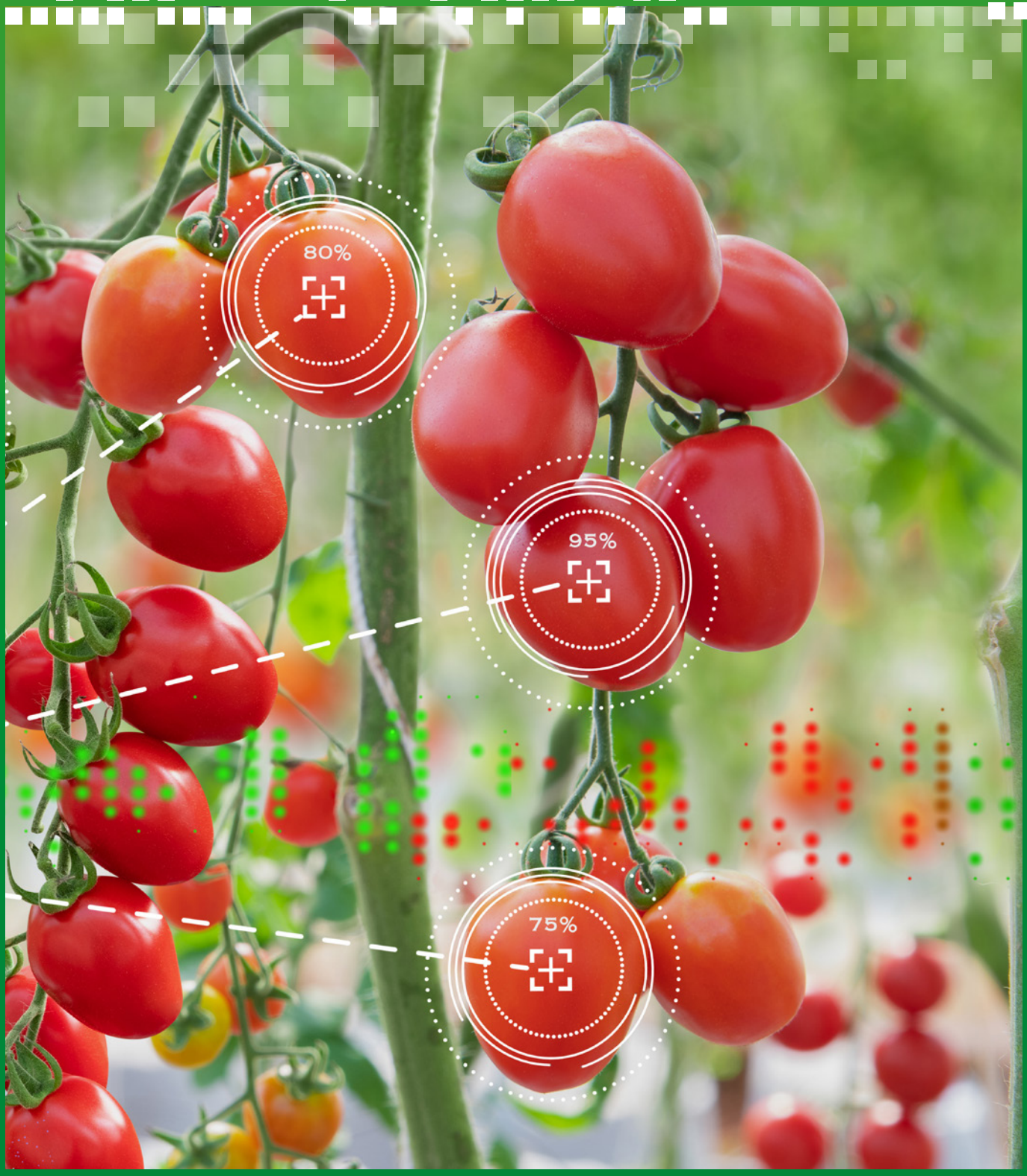
New generation

The Wageningen researcher expects that eventually, platforms will be created that unite all relevant information and support growers in their decision-making processes. They certainly won't make growers superfluous, but they will greatly expand their scope of control. And that is indeed necessary because the number of capable and skilled growers is steadily declining worldwide. Another favourable aspect of new technology such as e-Gro is that it may reawaken interest in the green sector among young people who have grown up with interactive games and apps. New cultivation concepts such as vertical farming, which is attracting great international interest, are also making a contribution. The same holds for other developments based on technology and artificial intelligence-based developments, such as robotisation and remote sensing, whether or not combined with drones.

"We can safely say that data-driven cultivation has never been so relevant," concludes Hemming. "That wasn't yet the case in 2006, when my colleagues were relatively successful in using computer models to manage a crop of sweet peppers in our greenhouses in Naaldwijk. Their efforts weren't greeted with much enthusiasm then. I expect developments to really gain momentum in the next five years, and that autonomous cultivation platforms will become part and parcel of the toolkit of a new generation of cultivation managers."

Chapter 4
Horticulture 4.0 is imminent

With *Harrij Schmeitz*



The fourth industrial revolution is driving a fundamental shift in our familiar processes. Concepts such as the Internet of Things, data mining, artificial intelligence and robotisation are staples on innovation agendas. In the horticultural sector, innovator and independent project manager Harrij Schmeitz has long been a pioneer on the crest of the digitisation wave. He predicts radical changes in growing technology, chain processes and organisations.

"Autonomous, data-driven growing systems will become an undeniable reality. The concept is being widely experimented with and developments such as vertical farming are propelling it forward. Those changes are imperative. The urgency to gain full control over cultivation systems is growing and there are fewer physical hands available to secure continuity in food supplies. Which is not to say that human intervention will be surplus to requirements. Human labour will still be necessary. Maybe more intensively for some tasks than for others, but not a single sector can function properly without the input of man. New knowledge domains and skill sets will also be involved. Greenhouse horticulture in the future will be organised, staffed and managed in a totally different way. And that process is already beginning to take shape."

Now is the time

Harrij Schmeitz has a clear vision of the future. He believes now is the time for data-driven platforms that combine numerous data and information flows (business and market information) process the data integrally and translate it into setpoints for crop growth. Much of the necessary knowledge and technology is already available in the IT world and some other sectors. It is now the turn of the high-tech horticulture sector. Thanks to measuring instruments and imaging technology, growers are increasingly able to establish the current status of their crop performance real-time. Heating and cooling systems, fans,CO2 shot, customised dosing of fertilisers and nutrients and accurately adjustable grow light installations are the ingredients needed to steer growth in the desired direction and maintain crop balance.

"An optimal growing system reduces the stress on plants, so they are less susceptible to diseases and stay vigorous and productive for longer," says Schmeitz. "Our understanding of what this requires is growing. It is now up to us to integrate the separate components and focus on the best practices in global greenhouse horticulture."

Phased approach

Thanks to initiatives such as the Autonomous Greenhouse Challenge, increasing investments in vertical farming and innovations such as Grodan's e-Gro, the momentum behind the development of data-driven concepts is growing. As manager of the Greenhouse 4.0 programme (see box) Harrij also uses these tools. "It's happening in phases," he says about this development. "Initially, the output will consist of well-founded recommendations for the crop manager. Once the value of this advice has been proven, and there is greater confidence in technology, there will be room for self-learning, fully autonomous steering platforms. Links to market information systems could be a logical next step, guided by better harmonisation of supply and demand. In parallel, a new wave of innovation is playing out in the field of robotisation. In the long run, tasks such as crop care, harvesting and scouting for the presence of pests and diseases will be predominantly done by machines."

Smaller zones

Schmeitz comments that large, adjacent growing zones and irrigation sections can be a hindrance to precision growing systems. "The bigger individual zones in a greenhouse are, the more complicated it is to create a uniform climate," he says. "When you can measure and make setpoints to behind the decimal point at plant level, it's not a particularly good idea to configure the space in the greenhouse in a way you know will disrupt precision control in advance. This implies that, alongside the technological innovations that have now been initiated, innovations to the actual structures need to be put in place to do full justice to the functionalities of this new technology. Growers and greenhouse construction companies will soon acknowledge that need. The large expanses under glass and defined irrigation zones that are now common practice, will gradually make way for compact, individually controllable zones in the greenhouse. Adopting this new approach doesn't necessarily have to limit any expansion plans of companies. In addition, automated harvesting and crop care using robots will also impact on greenhouse design. Taking all these factors into account, these disruptive developments are set to revolutionise the shape of greenhouse horticulture as we know it."

Initially, the output will consist of well-founded recommendations for the crop manager.

Structural investment in R&D

The innovator hopes that primary producers will not sit and wait, but proactively make focussed investments instead. "Compared with other sectors, agricultural and horticultural companies devote

relatively little funding to R&D. R&D is rarely a cost item in the operating budget and when new technology is acquired and applied, it is mainly because of new construction and expansion projects."

The small group of companies with a clear R&D policy and funding earmarked for innovation, are usually found blazing the trail that others follow. However, innovation involves more than money alone. According to Schmeitz, it revolves around having the right mind set; a willingness to push the envelope, critically scrutinise operating processes and optimise them by applying disruptive technology. "These pioneering companies are defined by innovation embedded in their culture, providing fertile ground for new concepts and knowledge to take root and flourish. They are most likely to be early adopters of data-driven growing.

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Grodan supplies innovative, sustainable stone wool media solutions for the professional horticulture sector, based on Precision Growing principles. These solutions are applied for the cultivation of vegetables and flowers, such as tomatoes, cucumbers, sweet peppers, aubergines, roses and gerberas. Grodan offers stone wool substrates together with tailor-made advice and innovative tools to support Precision Growing and therefore facilitate the sustainable production of healthy and safe and tasty fresh food and products for consumers.

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