

# GROWERTALKS

## Technology

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### Don't Worry, Growers, Your Job is Safe

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The term “autonomous greenhouse” refers to a fully automated indoor farming system where artificial intelligence (AI), machine learning, algorithms and sensors control all aspects of crop growth and management without ongoing human intervention.



However, those of us with any practical greenhouse experience know that, for all practical purposes, that's impossible—the “without ongoing human intervention” part, that is. Humans study the market and decide which crops to grow. Humans order the inputs, negotiate the prices and make the sales. Humans fix the heaters that fail at the worst possible moment. Humans even write the computer algorithm that the greenhouse requires to be “autonomous.” Case in point: In the four Autonomous Greenhouse Challenges (AGC) that have been organized by Wageningen University & Research in the Netherlands, there have been 20 teams in the finals and

anywhere from 120 to 150 total team members involved ... all to create a greenhouse that doesn't require people!

Perhaps we should not be so literal with our definition. After all, WUR's goal with their competition is not to eliminate human growers, but to make their jobs easier, more efficient and more profitable in the face of labor shortages and a changing climate.

Dr. Silke Hemming, head of the Greenhouse Technology Scientific Research Team at WUR, said they are getting closer to meeting those goals.

“Letting an algorithm take control of a greenhouse and achieving a full harvest after a few months doesn't yet exist in practice,” she stated after the conclusion of the most recent competition last winter. “No grower has fully automated this process. However, specific aspects, such as autonomous temperature control, are already in use. We've demonstrated that cultivation ... can be fully autonomous. Of course, there are still many challenges and areas for improvement, but we now have proof that it's possible to complete a growing cycle with an algorithm.”

#### The real challenges

Silke used the word “challenges” in a context beyond the title of the AGC, revealing the truth that creating an autonomous greenhouse is fraught with difficulties, only one of which is creating a computer algorithm that’s “smarter” than a human grower. Granted, that has been achieved in the competition and even proven in commercial trials. For instance, two greenhouse vegetable growers in Ontario, Canada—DC Farms and Great Lakes Greenhouse—have trialed an AI system from the company Koidra (whose founder, Dr. Kenneth Tran, is a two-time AGC winner), and they have seen impressive results: a 5% increase in eggplants at DC and a nearly 20% increase in cucumbers at Great Lakes.



**Dwarf tomatoes grown without human intervention during the most recent Autonomous Greenhouse Challenge. | Photo credit: WUR**

But there are other challenges facing the developers of autonomous greenhouse systems. The first is biology. There is a reason the computer programmers invite plant experts to be part of these AGC teams, and that’s because plants are living biological systems and they don’t respond in a predictable way like widgets in a factory. Said Dr. Neil Mattson of Cornell University and a member of one of the winning AGC teams with Kenneth, “In these biological systems, we can add the same inputs, but sometimes we get different outcomes. That can be due to pests or disease or even the lot of seeds that we’re growing.”

Another challenge is data quality. We all know the old computer adage “GIGO”—garbage in, garbage out. That’s something Neil said he took away from his time in the AGC, where they were given only one practice crop cycle in which to gather data for their algorithm before the actual competition began. “AI is only as good as its training data sets,” he said. “So that means if the algorithm doesn’t have any information about your system and how it has functioned in the past, it’s not going to do a very good job of predicting what’s going to happen in the future.”

Yet another challenge is whether greenhouse operations will be willing to share their historical data with others in order to expand the pool of available knowledge. After all, growers may view their data as a competitive advantage. But Dr. A.J. Both of Rutgers, who was on that winning AGC team with Neil, hopes not. “I’m a firm believer in the saying that a rising tide lifts all boats, and that if the growers were more willing ... They can share a certain amount of data without really revealing specific details about their operation, I think then we would all benefit from that. I think we need to work harder as researchers to convince growers that that is, indeed, a benefit to them.”

But possibly the greatest challenge facing the autonomous greenhouse is economics: Is the cost of the technology worth the benefits it might deliver? Right now, that’s unclear. In the AGC, the teams strive to produce the most yield with the least inputs, as a commercial grower might, but they’re producing less than 100 m<sup>2</sup> of plants, not hectares of them. Systems such as Koidra’s will almost certainly be offered on a subscription basis, and one can only hope they know the profit margins of the produce they are helping grow and are factoring that into their pricing models. But at least for now, autonomous greenhouse technology is the purview of high-value monoculture crops such as produce, medicinals/pharmaceuticals and perhaps young plants.

And that’s an autonomous greenhouse with the aforementioned “ongoing human intervention.” What about true autonomy—a greenhouse where computers do everything, from planting to harvest? “I suspect if we threw enough money at this problem—if we put a billion dollars in—we could probably develop, at least within bounds for specific crops, an AI greenhouse that worked pretty well,” Neil speculated.

But would that make sense for a crop that sells for \$2 a pound? In other words, just because you can doesn’t mean

you should.

“That’s right,” he agreed. “When I hear folks talk about automation, they’re like, well, which processes does it pay to automate? Which ones are more labor intensive? And which can we easily automate? And then which things are not as labor intensive or are not easily automated? So currently the thought is you don’t automate everything, you automate things where they make economic sense.”

## Enter your “digital twin”

The best way around these challenges is to use autonomous growing technology as a tool to help the human grower—a “digital twin.”

That term was coined in 2002 to describe a “digital equivalent to a physical system”—a virtual model that mirrors a physical system’s properties, behaviors and lifecycle using historical and real-time data. In horticulture, the digital twin would be a virtual version of your greenhouse, which the AI algorithm uses to process real-time and historic weather, climate and crop growth data to come up with the best climate control settings to achieve a desired outcome. It can even include data from outside the greenhouse, such as energy costs or market prices. Combine that with machine learning—where the computer gets “smarter” the more data it has—and you get more optimized decisions as time goes on.

Neil takes the concept a step further, imagining a digital twin of the human grower. Say you manage a 10-acre range and your boss wants to add a second location. Wouldn’t it be nice to have a twin to run it? With AI you can, analyzing the data and making recommendations. You oversee the process remotely, establishing goals and watching for problems—almost like a head grower overseeing section growers. Over time, thanks to machine learning, the more the algorithm does, the better it gets—just like a human grower—leaving you time for more important tasks.

## Why your job is secure

As “smart” as AI is getting with every iteration, the one thing it may never be able to calculate is the elusive why behind our human decision-making. Why should we select this new cultivar over that one? Why should we grow grape tomatoes for this particular customer?

As Neil said, “AI needs to know what the objective is, what are you trying to optimize—you as the user has to program that in, be it yield, quality, energy savings, profitability” or a combination of them. That’s a key reason experienced human growers will always be necessary in the greenhouse, no matter how smart our environmental controls get.

That, and to fix the heaters. **IG**