

BY PETER KONJOIAN AND MICHELLE KLIEGER

# Greenhouse and Vertical Farm Food Production: Cultivar Selection, Plant Breeding and Seed Quality



*Peter Konjoian is president of Konjoian's Horticulture Education Services Inc. His career spans four decades as a commercial grower, researcher and consultant. Michelle Klieger is founder and president of Stratagerm Consulting, an agricultural consulting firm serving the global seed industry. Konjoian can be reached at peterkfes@comcast.net.*

**M**y guest today is Michelle Klieger, founder and president of Stratagerm Consulting, an agricultural consulting firm serving the global seed industry. She has worked with indoor and vertical growers on their seed selection processes. Michelle earned her bachelor's degree from the University of Maryland in 2008 in Animal Science, her master's degree in Agricultural Economics from Purdue University in 2015 and an MBA from Indiana University's Kelley School of Business in 2015.

**Peter:** Thanks for joining us, Michelle. Cultivar selection is the focus of one of my messages to greenhouse growers and vertical farm operators. Your perspective in this area runs deeper than mine; how are you educating growers regarding plant breeding and cultivar selection?

**Michelle:** The growers I'm working with tend to view all seeds as the same. They purchase one from a catalog

and plant it. On the other side, plant breeders work hard so that each new variety is an advancement — sometimes a huge advancement. It must be. In many countries there is a registration process to prove the seed is better than other products on the market. In the United States, we believe that customers will only purchase a new variety if it's better than what they used last year.

**Peter:** Drawing from my years as an ornamental crop grower and researcher, we have a handful of seed and cutting cultivars that, after decades of market presence, continue to lead the pack. And on the other side, we need to be vigilant in keeping pace to identify another handful of new introductions that may ascend to market leader status. In between there's a whole lot of trialing, testing, and thinning of scores of other new introductions every year. Comment further on the point you made that if it's new then it must be better.

**Michelle:** We need to take a step backward here. Better means different things to different growers. A better flower might have a more vibrant color. A better tomato plant might have a higher yield. There are millions of characteristics that breeders consider when selecting new varieties. They might be looking for disease resistance, early harvest or even a specific flavor. I've also participated in melon

trials where we tried different cantaloupe. The sweeter melons are for U.S. markets and the less sweet melons are grown in Asian markets. As a grower, you are considering all of these features and purchasing the seed that best fit your needs.

**Peter:** Help us understand from a breeding perspective the challenges indoor and vertical production bring to the table. I've heard you say what's better for traditional outdoor production systems is not necessarily what's better for indoor and greenhouse high-density controlled environment agriculture (CEA) production systems.

**Michelle:** Better for outdoor agriculture means a better disease resistance package, more drought tolerance or earlier maturity. Better for indoor agriculture means something completely different and this is the conversation I want to be having. Seed companies have thousands of varieties in their research portfolios. These are all varieties that didn't make the cut for outdoor agriculture, most likely because they lacked disease resistance. Indoors, you don't need that same coverage, so many of these varieties might be a great option. Additionally, they might taste better, have different coloring, or grow well in a different/controlled environment.

**Peter:** I believe these distinctions are pretty easy for growers in either traditional or CEA production to grasp.

However, some frustration exists over the gap in breeding effort to support CEA production. We've been told this is market driven and because the cost of bringing a new cultivar to market is high the economics are such that we have a chicken or egg dilemma. It can't be bred until the market can support it. Can you provide additional insight?

**Michelle:** There are two levels of effort here. Commercializing a totally new variety takes about seven years and a lot of investment. At this level, plant breeders have a hard time justifying the cost for a small market, especially one that is not uniform. Each vertical agriculture system is different, making it hard to breed for. However, there are enough similarities across greenhouses that there are entire brands dedicated to greenhouse product.

The other level is to test current cultivars in CEA production. This means take all the varieties that are not commercially available right now and start growing them under specific CEA conditions. Do any of these do better than what is currently available? Running trials with seeds that already exist has a much lower R&D cost than breeding new varieties. This could help solve the chicken and egg problem.

**Peter:** That's a great point, Michelle; it brings to mind that saying ... One man's trash is another man's treasure. Figure 1 shows two Pak Choi cultivars I grew in plug trays



**Figure 1. Trial of pak choi showing traditional cultivar on left and compact cultivar on right.**

using a flood and drain system. Depending on the plug tray density choosing one cultivar over the other has consequences in terms of disease control, crop time and harvest quality. Another message you have for growers focuses on the impact seed quality has on their day to day production and operational profitability. What is the challenge you see growers wrestling with?

**Michelle:** I work with a lot of reputable seed companies. These companies follow legal requirements for seed in the United States. When you purchase seed, they come in a bag with a seed tag. That tag is regulated by the Federal Seed Act. It requires that companies provide accurate information about the kind of seed, the lot number, the purity, the germination rate, the amount of hard seed, inert seed, weed seed and when the seed was tested. If the information provided is not accurate, then the grower has legal ramifications.

Seeds are an important input into any farming system. They are what turn into the plants you sell. High-quality seeds will result in high-quality plants. Low-quality seeds could result in minor problems, like lower quality produce. But there is also risk of serious problems.

Seeds can carry and transmit diseases and pathogens. They can lower the quality of produce that comes from your farm, but they can also have longer lasting and

more expensive impacts. Infected seed could contaminate an entire system. The seed could bring a disease into your operation, but if it is mechanically transmitted as well, you could keep re-infecting the operation with contaminated equipment. This could require shutting down the entire operation and disinfecting it before starting over with new seeds.

Also, when you purchase seed online from an unfamiliar company and you don't know the source you don't know where the seed is coming from. It may or may not meet the legal requirements spelled out in the Federal Seed Act.

**Peter:** You raise several valid points that are not tied to any particular production system. Agronomic crops, vegetable crops, outdoor, greenhouse, indoor vertical farm ... as far as seed quality goes, most of the growers reading this understand that we get what we pay for.

You mentioned above that you work with reputable seed companies. Traditional greenhouse growers, growers I've worked with for many years, for the most part get what you're saying. I'm finding a new group of growers, those entering CEA production with no horticultural experience, who are vulnerable to the pitfalls we're discussing.

Next, I understand one of your recurring observations is poor design and execution of grower trials. This topic hits close to home for me, several of my colleagues

and I have been sounding this alarm for some time. Tell us more about your experience.

**Michelle:** I work primarily with controlled environment agriculture, more specifically with vertical farmers that operate plant factories that mostly grow leafy greens. They are largely focused on the sensors and the technology that make these operations run. With the right tools, many think that farming can be automated, especially when the environment is controlled.

I was drawn to this space because of my seed background and the fact that the environments are fixed. If nature and nurture both affect the final product that comes out of these systems and the nurture (the environment) is fixed, then the power of nature (genetics) is much higher. By helping farmers pick the right genetics the growers can obtain higher yields or better produce at harvest.

**Peter:** I'm with you but need to share an observation. I've been involved with several CEA projects in recent years, all led by individuals coming from the tech sector you cite. To date, I've been disappointed by their lack of appreciation for general crop culture, daily farm management and basic plant physiology. What I'm saying is that the nurture side of the equation, in my experience, extends beyond just the environment to include its management as well. I am confident that those who embrace the plant as well as tech will play key roles in leading us into the future. Proceed, how are you helping your growers understand trial design and execution?

**Michelle:** To capitalize on the fixed environment, you need to run variety trials to figure out what works and what doesn't. Before you can start the trials, growers must understand their systems. They should ask: how far apart are the trays, is it a deep-water culture or an NFT channel, how much blue light is there, and what is the temperature inside? All of these will impact what can grow. Then you need

to decide what the most important characteristics are. Do you want to maximize yield? Do you want to maximize flavor? Do you want to harvest as quickly as possible?


As growers answer these questions, they can try different seeds and see how they perform in the system. Good data is key. What was the germination rate? How long did germination take? What did the leaves look like? How tall did the plants grow? Without setting goals and collecting data, it's impossible to objectively compare different varieties. The beauty of an indoor system is the amount of control you have. Many farmers don't leverage this by running controlled experiments and collecting data to feed into future trials. Every detail that you can capture is helpful. For example, growers report that growing kale on the bottom racks and basil on the top has higher yields than a full stack of either crop.

**Peter:** Amen to a grower's version of the scientific method. Ask good questions, run a good, controlled trial, collect good data and make informed decisions that will contribute to profitability. Michelle, thanks again for spending this time with us. [gpn](#)

Quick Lead Time!

## RELIABLE VENTILATION EQUIPMENT

Family-Owned  
Since 1937



**Quietaire's Angle Flow:**  
Aluminum or Galvanized.  
Designed to maximize efficiency.




**Quietaire's Stainless Steel Evaporative Cooling System:**  
No sump required.  
Replacement cooling pads also available.



**Quietaire's HAF18:** Affordable option to move air through your greenhouse.

Serving the greenhouse industry for over **75 years** with prompt service and durable, low maintenance and quality ventilation products.



www.quietaire.com info@quietaire.com  
866-228-9421 Fax 713-228-9425  
505 North Hutcheson Houston, TX 77003