

insideGROWER

May 2020

CONTROLLED ENVIRONMENT AGRICULTURE

20 Years of CEA Innovation

University of Arizona's CEAC
celebrates two decades
of multi-disciplinary research
and hands-on collaboration



PAGE 14

What to consider for
CEA strawberries



PAGE 18

Mastering the
root zone



PAGE 22

Pests in the
greenhouse for
field hemp



Essential Business

It's a phrase that, as of press time, was the difference between business as usual (well, 6 feet away as usual) and shutting down indefinitely.

Any state that issued business closures and Sheltering in Place-type orders made provisions for agriculture businesses of all kinds (some states even included cannabis), allowing our CEA growers to keep working. Of primary concern is the safety of our food supply, and while nothing is an exact science, CEA growing when done right seems to be just what we need right now.

At the vast majority of growers I've visited, there are sanitation measures in place, from the use of gloves and hair nets to strict hand-washing protocols and foot baths, depending on the crop. Depending on the location, it seems rather easy to work at least 6 feet apart in the greenhouse and many operations use automation to bring hydroponic leafy greens from rafts to harvest and into clamshells or bags. It often has few middle men, going from the growing operation right to the grocery store and bypassing more links in the chain. It's something that consumers (like myself) would love to hear

more about via social media channels and direct communication. The more we can all be reassured about the essentials, the better.

It's an advantage that I talked with Dr. Murat Kacira about (along with many other topics) when we connected for this month's cover story on the Controlled Environment Agriculture Center (CEAC) at the University of Arizona.

"CEA can significantly contribute to the resiliency with local food production capabilities not only during disaster-free times, but most importantly, during times when under the pressures of severe disasters and pandemics," he says. "When the food supply and chain is disrupted due to limited availability of resources, labor and transportation capabilities."

Murat, as the current director of CEAC, has had a hand in educating members of the CEA community to help improve their operations in matters of safety, efficiency and crop production. As they celebrate 20 years of CEAC, we take a look at its impact on the industry on page 10.

One of the central themes of CEAC is partnership and collaboration. Other universities have been practicing the same and this month we feature research from GLASE, a public-private consortium focused on advanced lighting and controls. On page 14, you can read about optimizing CEA strawberry production, a crop that's gaining more interest from growers.

Part of utilizing controls properly is understanding how plants function to provide the proper environment. For a better understanding of plant root zone needs in hydroponic production, turn to page 18.

And finally, in this issue you can find ways to combat pests for both hemp and cannabis crops on pages 22 and 30, respectively.

This last bit isn't relative to operating a growing facility, but I do hope when you receive this publication it finds you in good health and spirits. Please stay safe and take care.

Jennifer Polanz
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CONTROLLED ENVIRONMENT AGRICULTURE

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A Friend Remembered
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ON THE COVER

As the University of Arizona's Controlled Environment Agriculture Center (CEAC) marks its 20th anniversary, we caught up with current Director Dr. Murat Kacira (left) and past Director Dr. Gene Giacomelli (right), as well as others, to understand the impact the center has had, and where it's heading in the future. Turn to page 10 for the full story.

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20 Years of Innovation and Collaboration

As the Controlled Environment Agriculture Center at the University of Arizona celebrates 20 years this year, we take a look at its impact on CEA now and in the future.

Dr. Nadia Sabeh, known to the controlled environment agriculture industry as “Dr. Greenhouse,” will never forget a note she received from Dr. Chieri Kubota when Nadia was considering attending the University of Arizona for her doctorate degree. It was late 2002 and Nadia had recently toured the campus and the relatively new Controlled Environment Agriculture Center (CEAC).

“In that email she wrote that this is a new program, and we’re really looking for people who can basically launch this program and who will be leaders in the field for the future in the industry,” she said. “I remember reading that and thinking, ‘That’s me. I want to be one of the people who really kickstarts this industry to push it into the next generation and iteration of what CEA could be.’”

Now Nadia, who graduated with a Ph.D. in Agricultural Engineering, is the founder and owner of Dr. Greenhouse, an agricultural and mechanical engineering firm that specializes in the design of HVAC systems for indoor growing systems. She is one of those people, using what she learned at CEAC (pronounced “sea-ack” by those who are part of the program) to help forward the CEA indus-



Dr. Murat Kacira began teaching at University of Arizona at CEAC in 2007 and took over as director in 2018.

try at a time when the world is looking for more safe food production options. In fact, she’s one of many graduates out in the industry, whether it’s as a grower or principal in a growing operation, an allied trade member or in research.

According to CEAC Director Dr. Murat Kacira, more than 2,000 people have gone through the hands-on short courses and intensive workshops taught multiple times a year, and about 100 to 150 undergraduate and graduate students are taking credit-bearing courses and are involved in research activities each year at CEAC.

A UNIQUE, MULTI-DISCIPLINARY, HANDS-ON APPROACH

Let’s step back in time to the years approaching the turn of the century, when CEA growing started taking off thanks in part to the expansions of the Arizona greenhouse tomato operation EuroFresh, which was eventually bought by NatureSweet.

“Dr. Merle Jensen [Associate Dean of the College of Agriculture] was really the person who pushed to get the funding from the state of Arizona to make this happen, and has always been a supporter and cheerleader in many, many ways,” said Dr. Gene Giacomelli, who was the center’s founding director and led CEAC from 2000 until 2018. “It was Merle’s vision that made the center

happen and made it happen here.”

It was because of that increasing demand for research that Merle was able to convince the state of Arizona to invest \$600,000 a year to support the burgeoning industry.

“It was unheard of, even at that time,” Gene adds. “Every five or 10 years you might get one of these initiatives that’s so critically important that the state legislature would make a permanent budget for support.”

What set CEAC apart, and still does somewhat to this day, is its unique blend of biosystems and agriculture engineering and plant sciences. It’s faculty from multiple disciplines working together within the confines of CEAC that’s helped forward innovative research in controlled environments, from urban agriculture and vertical farms to greenhouse hydroponics, and even growing on other planets and in microgravity. It was that blend of multi-disciplinary research for today’s industry that attracted both Nadia and Chieri to CEAC.

“We learned how to collaborate across disciplines,” Nadia said. “We got to work across the aisle so we’re not siloed. And what the faculty and people at CEAC do, we lived and breathed that.”

Chieri came to CEAC from a horticulture engineering program in Japan, where they were doing research for the



Dr. Gene Giacomelli served as director of CEAC from its beginning in 2000 until 2018. He continues to teach at the university and conduct research. Here he's seen with the Lunar-Mars Greenhouse prototype.

future, not necessarily for the industry's immediate needs.

"As soon as I joined Arizona I knew I would work closely with growers and change my problem-solving type from futuristic to today," she said.

It was that unique perspective from multiple angles that helped students who studied there become the pioneers and innovators of today's CEA businesses.

"The CEAC, because of its history, starting very early on with multi-disciplinary educational and cutting-edge research programs, has been ahead of the curve," Murat said. "We just need to continue to make sure we are also not only maintaining the extent and the quality of the program—we want to grow, too, in the future."

We'll talk about those future plans in a minute, but first, let's look back on some of the exciting concepts and research that have come out of CEAC.

RESEARCH AND COLLABORATION

There have been too many research projects over the years at CEAC to mention them all, but there have been a couple of concepts that have stood out. Much of the research over time has helped growers improve the efficiency of inputs for indoor growing to reduce costs and energy usage.

For example, Murat and Gene, with their research conducted in Vertical Farm (UAg Farm) and the Lunar-Mars Greenhouse prototype system, developed a metric for comparing indoor lighted production systems so growers could better figure their costs. The metric is "grams of edible biomass produced per kWh electrical power required." More metrics can be utilized for other input efficiencies, like how much water is being used per kilogram of edible food produced. The more water recaptured and reused the more efficient the system, and the same can be said for plant nutrients.

I mentioned Dr. Chieri Kubota at the beginning. During her 16-year career at CEAC she conducted valuable research on greenhouse tomato production that helped improve flavor, taste and quality of hydroponic tomatoes. She also bridged greenhouse work and traditional outdoor tomato production through producing

high-quality seedlings and transplants in the greenhouse for planting outdoors. Her third area of focus was researching hydroponic strawberries to develop production on a larger scale.

"In terms of industry, I think the two ideas out of the three, I can tell the visible impact," said Chieri, who's now heading up a new CEA lab at The Ohio State University. "The vegetable grafting I started working on in 2005 and finally got USDA funding in 2007. During those times we didn't have anyone in the U.S. grafting. Greenhouse growers were using grafting back then, but they had to rely on Canadian capacity. They were buying and importing from Canada.

"The second area, the strawberry production ... I started knowing that was going to be very important. In 2009-2010 no one was doing it on a commercial scale in the U.S. Now multiple states have acres of strawberry production."

THE BEAUTY OF COLLABORATION

Another aspect of CEAC that makes it unique is its partnership with private industry from the get-go. At the time when the center got off the ground, it wasn't always accepted in other research facilities to work with industry, but it's become the norm today.

"I think the center would not have been possible without the support of our industry and CEAC has been really, really integrated with our industry," Murat said. "I would like to acknowledge them and their support in the past, as well as now and looking into the future. I think that's had a huge impact on our success as well."

It hasn't just been a partnership with industry, but also with government. Of course, the state of Arizona has been an invested partner since the beginning, but CEAC also has been awarded funding from the likes of NASA (for the eight-year prototype Lunar-Mars Greenhouse leading to a new initiative for the International Space Station you'll read about momentarily) and the National Science Foundation (for the Food Grow Chamber producing fresh veggies at the South Pole since 2004).

CEAC has collaborated with other universities, as well. One of the larger projects is a recently funded \$2.7 million USDA Specialty Crop Research Initiative ▶



THE UNIVERSITY OF ARIZONA

Reunion Alert

Controlled Environment Agriculture Center (CEAC) is targeting the last weekend in October for a reunion during University of Arizona's Homecoming

Festivities. They would like to invite graduates of all levels, former professors, staff and students who worked or studied at the CEAC to celebrate the 20th anniversary. Find out more about CEAC's activities at ceac.arizona.edu.

grant to study indoor production of leafy greens. An industry match brought total funding to \$5.4 million. That research, labeled Optima for Optimizing Indoor Agriculture, will be documented on the website www.scri-optimia.org.

WHAT'S NEXT?

The arena of controlled environment agriculture is growing by leaps and bounds across the globe, spanning areas with even the harshest climates that were previously thought unable to grow food, like Antarctica and Abu Dhabi, as well as crowded city centers. With the research from CEAC, that has changed, opening up new doors for growing more sustainably and efficiently.

"Because of that, we started a program on Urban Ag and Vertical Farming the past few years onward where we have connected with our industry," Murat says of collaborations with large-scale farms, where they've developed new environmental control applications to optimize production and resource usage. He's particularly interested in the integration of Artificial Intelligence (AI), automation and robotics, as well as in-

novative agrivoltaics, wavelength selective covering materials and renewable systems integration into CEA systems.

CEAC was one of five teams to receive new funding from NASA to design a prototype system to deliver water and nutrients more efficiently for crop production and microgravity for the International Space Station. Phase 1 is design and Phase 2, which will likely be narrowed down to two teams, will involve building the system. One team will be selected for Phase 3 deployment to the ISS. The CEAC team includes researchers from across the globe in collaboration.


"I think the impact of the CEAC really has been working on some cutting-edge research and CEA systems and design concepts to help the industry," Murat notes. "And produce graduates who are now and will continue to be the leaders of the future."

Those types of cutting-edge projects also help attract interest, resulting in more students of a variety of disciplines learning through CEAC. Murat sees more students interested in sustainability, food production and urban agriculture.

"Because of that we see an influx of students coming from other disciplines," he adds. "It is a perfect example where you can really integrate when it comes to water, energy and food components, and sustainability interests."

CEAC also has been working with commercial operations to place their students in internships so they have a working understanding of what's needed. Students also get a taste of that in CEAC greenhouses and indoor agriculture facilities, and through helping, lead talks at CEAC's short courses and intensive workshops. It's that kind of hands-on experience and collaborative work that helps CEAC continue to lead in the field of controlled environment research.

"People would flock to CEAC from other countries," recalls Nadia. "It was the only place this was happening with multiple disciplines. They were able to address industry needs that were immediate, as well as long-term needs."

"I think people still look to University of Arizona for those resources and guidance." 

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