THE UNIVERSITY OF ARIZONA
BIOSYSTEMS ENGINEERING
Controlled Environment Agriculture Center

24th Annual

Greenhouse Engineering Design and Crop Production

Short Course

Online and In-Person

March 26th - 28th, 2025

Welcome to the 2025 Greenhouse Crop Production and Engineering Design Short Course

Dear Participants,

Our dedicated faculty, staff, and students at the UA-CEAC, as well as guest speakers along with our sponsors and exhibitors, welcome you to the 24th Greenhouse Crop Production and Engineering Design Short Course!

University of Arizona's Controlled Environment Agriculture Center (UA-CEAC) is a multidisciplinary program with engineers, scientists, students, faculty, volunteers, and industry collaborators sharing the same vision to develop controlled environment agriculture as an economically, environmentally, and socially sustainable agricultural option. The UA-CEAC is dedicated and continues to prepare the controlled environment agriculture (CEA) workforce of the future with its research, educational, and outreach/extension programs.

We put together an excellent three-day program with lectures presented by leaders in academia and the Controlled Environment Agriculture industry and supported by our industry sponsors and exhibitors. The 24th Short Course program consists of experts in their respective fields on plant nutrition, systems, sensors and controls, insects and pests, lighting, fertigation, automation, environmental controls, plant physiology, engineering, artificial intelligence, business development, urban agriculture, mushrooms, aquaponics, microgreens, strawberries and others. They are all here to help you!

There are different kinds of CEA systems and technologies considered for crop production within controlled environments. Therefore, no single silver bullet system or solution fits all. The selection will depend on various factors, with the plants to be grown and their optimal environmental requirement being the central focus, but also including expected yield and quality, consumer expectations, market demand, climate, finances, growers' capabilities, and others. At the end of the program, you will not leave with the full knowledge of CEA aspects. However, you will have the essential information to guide you towards achieving success.

We are excited and looking forward to your active participation in this program.

Murat Kacira
Professor and Director, Controlled Environment Agriculture Center

ARIZONA®

Table of Contents

ARIZONA

Acknowledgments and Thanks

OUR INVITED SPEAKERS:

Dr. Ryan Lefers, Dr. Jose Chen Lopez,
Dr. Yujin Park, and Karla Garcia

OUR 2025 SPONSORS:

DRAMM

TC CONTROL GROUP
CRITICAL ENVIRONMENT SOLUTIONS

VidaWool®

K 1913
we make it grow

Grow beyond.
CONVIRON
ARGUS CONTROLS

CONLEY'S
GREENHOUSE MANUFACTURING & SALES
EST. 1946

bpgrower.com
BEAVER PLASTICS

PREMIER TECH

heliospectra

RAYN
GROWING SYSTEMS

OUR ORGANIZATION AND DEVELOPMENT COMMITTEE:

Dr. Murat Kacira, Dr. Gene Giacomelli, Dr. Barry Pryor, Dr.
Triston Hooks, Dr. Matthew Recsetar, Dr. Goggy Davidowitz,
Barbara Bruno, Aaron Tevik, and David Bogner

ARIZONA


DRAMM
SOLUTIONS FOR GROWERS SINCE 1941
DRAMM water
IRRIGATION
WATER
MANAGEMENT
AIRFLOW
PEST
MANAGEMENT
Contact us to learn how
DRAMM can find a solution
for you.
information@dramm.com
www.dramm.com
920.684.0227

MITRA X

Full modularity and Flexible spectrum

Next generation in LED Grow Lights

Mitra X Offers:

- Comprehensive spectrum portfolio ranging from 40% red to 90% red
- Flexible spectrum alternative
- Efficacy up to 3.7
- Output up to 5700 µmol
- Fully modular with a wattage ranging from 325w to 1500w

Get wireless dimming and full control with Adelphi and helioCORE 2.0

- Precise DLI control with external weather forecasts
- Track your energy consumption
- Organize your light strategies by crop type or production stage.

heliospectra

Visit our website for more info:

SCAN ME


Discover Growcoon
Discover Nygaia
Two solutions that open the door to the horti-culture of tomorrow: Nygaia and Growcoon.
As the use of hydroponic systems has continued to increase, growers are looking for additional solutions that further improve plant cultivation in water. With Nygaia and Growcoon, Klasmann-Deilmann offers you two such solutions. The Growcoon is a biodegradable net pot with a stable but flexible open net structure. Nygaia is a high tech bio-degradable growing medium for more sustainable and controlled cultivation. Both solutions offer you so many advanatges, that you should scan the QR codes right away to learn all the benefits.
www.klasmann-deilmann.com

Connecting Farmers to Research

Research-Backed LED Spectra Customized to Your Crops

rayngrowingsystems.com

RAYN GROWING SYSTEMS

RIDDER

Intelligent Greenhouse Technologies

Formerly HortiMax growing solutions

Climate Screens

Energy-efficient, light, and temperature management

Labor Management

Enhanced workforce efficiency with simplified decision support management

Digital Solutions

Ensuring safe and seamless integration for our equipment

Climate Control

Optimization of climate, irrigation, and energy to maximize growth

Drive Systems

Reliable and precise control over ventilation and screening

Water Treatment

Sustainable irrigation solutions, focused on resource savings

Ridder North America

ridder.com info@na.ridder.com toll-free: +1 (855) 322-1400

TC CONTROL GROUP

CRITICAL ENVIRONMENT SOLUTIONS

OUR MISSION

We believe in growing people into their potential. In everything we do, we are driven by our clients' end results.

We create integrated CEA solutions alongside growers, designing systems that address their unique growing needs.

Our highly skilled team is made of industry-built experts, including growers, engineers, programmers, business experts, electricians, technicians, and project managers.

Our mission and purpose for getting up every day is to see people grow. TC Control Group sees a world where you can grow anything inside, anywhere in the world, and we work to make that a reality.

IRRIGATION & FERTIGATION SERVICES

Work with our irrigation experts to create an irrigation and fertigation system that is specifically tailored to your operation.

Our process involves analyzing the watering requirements of crops, the functions desired by the growers, and the quality of raw water available.

Our irrigation systems automate watering so you don't have to dedicate resources to manually watering, calculating nutrient concentrations, or maintaining a watering schedule.

Together, we can create an irrigation system that reduces your water consumption and operating costs while optimizing the delivery of the nutrients your crops need.

HOOGENDOORN GROWTH MANAGEMENT PARTNERSHIP

We see a world where you can grow anything indoors. With TC Control Group's solutions engineering, you can harness the power of nature to make your growing operation plant-centric. That's why TC Control Group is proudly partnered with Hoogendoorn Growth Management. Hoogendoorn's Intelligent Algorithms and IIVO technology monitor your growing environment to provide crop-specific insights that will unlock your growing potential. Hoogendoorn provides the insight, TC Control Group provides the weather.

hoogendoorn
growth management

(508) 832 5900

solutions@tccontrols.com

24/7 Service and Support

VIDAWOOL® PRODUCTS

Growing Media System

VidaWool® Starter Plugs ›

VidaWool® Blocks ›

VidaWool® Slabs ›

ABOUT VIDAWOOL®

Intelligently Designed for Consistent Commercial Cultivation

Hydro-Xtend™ water dispersion technology

- Even water dispersion and nutrient availability
- Predictable water retention

UV-protection lined blocks

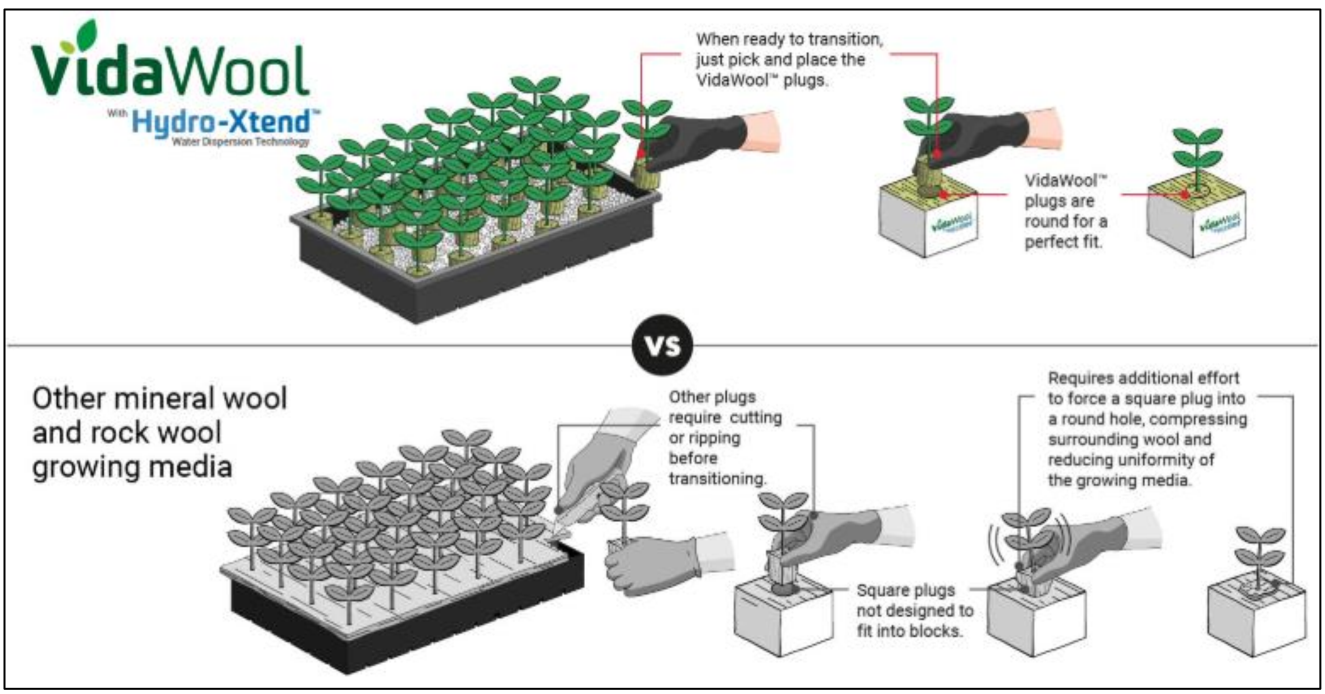
- Reduces exposure to light that can stress and inhibit root growth
- Keeps root zone dark to guard against algae and bacterial growth

Tight-wrapped slabs

- Keeps water and nutrients where you want them
- No dead areas
- Enables lower water consumption

Customizable at commercial scale

- Tailored sizing for your operational needs



Visit us at: owenscorning.com/vidawool

Greenhouse
Engineering Design & Crop Production
Short Course

Circular Controlled Environment Agriculture for Sustainability

THE UNIVERSITY OF ARIZONA BIOSYSTEMS ENGINEERING
Controlled Environment Agriculture Center

Online & In-Person
March 26th - 28th, 2025

Day 1: Fundamentals Of CEA and Hydroponics| Wednesday, March 26th

8:00 am - 8:45 am	**Check-in for on-site participants**
8:45 am - 9:00 am	**Welcome and Introductions** Dr. Murat Kacira - CEAC Director, Interim Head and Professor, Biosystems Engineering Department, The University of Arizona
9:00 am - 9:45 am	**Greenhouse Design Basics** Dr. Gene Giacomelli - Professor, Biosystems Engineering, The University of Arizona
9:45 am - 10:00 am	**Discussion and Q&A**
10:00 am - 10:45 am	**Climate Control** Dr. Murat Kacira - CEAC Director, Interim Head and Professor, Biosystems Engineering Department, The University of Arizona
10:45 am - 11:00 am	**Discussion and Q&A**
11:00 am - 11:30 am	**Break & Exhibitor Networking**
11:30 am - 12:15 pm	**Integrated Pest Management** Dr. Triston Hooks - Assistant Professor, Biosystems Engineering, The University of Arizona
12:15 pm - 12:30 pm	**Discussion and Q&A**
12:30 pm - 1:30 pm	**Lunch**
1:30 pm - 2:15 pm	**Hydroponic Plant Production Basics** Dr. Triston Hooks - Assistant Professor, Biosystems Engineering, The University of Arizona
2:15 pm - 2:30 pm	**Discussion and Q&A**
2:30 pm - 3:00 pm	**Sponsor Presentations**
3:00 pm - 4:30 pm	**CEAC Tour Day 1** Teaching Greenhouse & AdvanCEA Greenhouse

Day 2: Circularity in CEA| Thursday, March 27th

9:00 am - 9:45 am	**Opportunities for Circularity in CEA** Dr. Ryan Lefers- Founder, Iyris
9:45 am - 10:00 am	**Discussion and Q&A**
10:00 am - 10:45 am	**Optimizing Circular Food Systems through the Integration of Diverse CEA Crops** Dr. Goggy Davidowitz - Professor, Department of Entomology, University of Arizona
10:45 am - 11:00 am	**Discussion and Q&A**
11:00 am - 11:30 am	**Break & Exhibitor Networking**
11:30 am - 12:15 pm	**Substrates of the Future: Materials, Performance and Sustainability** Dr. Jose Chen Lopez - Horticulture Specialist, Premier Tech
12:15 pm - 12:30 pm	**Discussion and Q&A**
12:30 pm - 1:30 pm	**Lunch**
1:30 pm - 1:45 pm	**CEAC Mission Award**
1:45 pm - 2:45 pm	**Sustainability Panel**
2:45 pm - 3:15 pm	**Sponsor Presentations CEAC**
3:15 pm - 4:30 pm	**CEAC Tour Day 2** Mushroom Lab Optional: MISAS & Mars Lunar Greenhouse

Day 3: Microgreens, Aquaponics, and Mushrooms Production in CEA| Friday, March 28th

9:00 am - 9:45 am	**Microgreens Production in CEA** Dr.Yujin Park, Assistant Professor , School of Applied Sciences and Arts , Arizona State University
9:45 am - 10:00 am	**Discussion and Q&A**
10:00 am - 10:45 am	**Strawberry Production in CEA** Karla Garcia, Technical Service Specialist, Hort Americas
10:45 am - 11:00 am	**Discussion and Q&A**
11:00 am - 11:30 am	**Break & Exhibitor Networking**
11:30 am - 12:15 pm	**Producing High Value Lions's Mane Mushrooms in Controlled Environment Systems** Dr. Barry Pryor, Professor, School of Plant Sciences, The University of Arizona
12:15 pm - 12:30 pm	**Discussion and Q&A**
12:30 pm - 1:30 pm	**Lunch**
1:30 pm - 2:15pm	**Aquaponics in CEA** Dr. Matthew Recsetar, Assitsant Professor, Biosystems Engineering, The University of Arizona
2:15 pm - 2:30 pm	**Discussion and Q&A**
2:30 pm - 4:00 pm	**CEAC Tour Day 3** Aquaponics Greenhouse & Vertical Farm

1- UA-CEAC CLASSROOM

2- MUSHROOM CULTIVATION DEMONSTRATION

3- TEACHING GREENHOUSE

4- ADVANCEA GREENHOUSE

5- AUTOMATION GREENHOUSE

6- VERTICAL FARM

7- AQUAPONICS GREENHOUSE

8- SPONSOR/EXHIBITOR NETWORKING HALLWAY

Greenhouse Design Basics- Structures, Glazing, & Cooling

Dr. Gene Giacomelli

Professor Emeritus, The University of Arizona Biosystems Engineering, The University of Arizona

Dr. Gene Giacomelli is a faculty member in the University of Arizona's Biosystems Engineering Department. and former & founding director of the CEAC. He received a Ph.D. in Horticultural Engineering from Rutgers University in 1983. He also has a Master's degree in Agricultural Engineering from the University of California-Davis and two bachelor's degrees in Horticultural Science and Biological and Agricultural Engineering from Rutgers University. Here at the University of Arizona,
he teaches Controlled Environment Systems which is an introduction to the technical aspects of greenhouse design, environmental control, nutrient delivery systems, hydroponic crop production, and intensive field production systems. His research interests include controlled environment
plant productions systems (greenhouse and growth chamber) research, design, development and applications, with emphases on: crop production systems, nutrient delivery systems, environmental control, mechanization, and labor productivity.

Greenhouse Design Basics - Structures, Glazing, & Cooling:

Greenhouses are controlled environment crop production systems used to overcome difficulties in climatic conditions to optimize the production. Greenhouses use a free energy source, the sun. The design and structures selected depends on the climate, and depending on your region, you'll want to take advantage of the proper design, glazing or screens, and heating or cooling systems to overcome the limitations of your environment.

The productivity and quality in greenhouse production depends on the level of technology chosen, therefore understanding of the technology and its influences on the production can help investors to make better business plans and lead to success in the operation.

Introductory Thinking

- ***Providing a Production Space***
- ***Selecting a Greenhouse Cover***
- ***Ventilating & Cooling daily***
- ***Heating nightly (& daily)***
- ***Monitoring and Control***

Growing the Crop(s)

Transport, Handling, Packaging, Marketing

ARIZONA

Thought[ful] List for Greenhouse Design Planning
24th CEAC Greenhouse Short Course
Dr. Gene Giacomelli giacomel@ag.arizona.edu
March 2025

Crop[s] to be grown

Environmental needs? Plant physical needs? Labor requirements? Market availability?
Understand every task to meet the plant's demand required in the production process

Climate conditions at the location of the greenhouse

Need climate for the time of year to produce crops
Required: Temperature [minimum night and maximum day]
Optional : cloud cover, wind, body of water, elevation

Grower's production experience

Soilless culture in pots, hydroponics [what specific type], aquaponics

Market

Researched? Established? Neither?---go back, begin again!

Heating

If the outside air temperature at your site during crop production will be significantly less than the minimum night air temperature required for the crop[s]….then a source of heat is required to produce a quality crop in a prescribed timeframe.

Passive solar for high tunnel for portion of the warm seasons - electrical power not required
Controlled fossil fuel heater - electrical service required, or see CEAC off-grid greenhouse
Source: Hot air or hot water heater
Distribution: fan heat exchanger, overhead hot water pipes, under bench or floor heating
Goal: Maintain setpoint air temperatures for day and night

Ventilation

Once a greenhouse structure is covered, a ventilation system is always required [sometimes immediately!].

Ventilation is air exchange from outside into greenhouse for cooling, moisture reduction, and CO2 exchange

Exhaust fans for positive, controlled ventilation. Roof peak and sidewall openings for natural air exchange based on winds, height of roof peak and size & number of openings.

Neither system can control to below [or even equal to] outside air temperature.

Cooling

Evaporative cooling can control to below outside air temperature [5 – 30 ^{o}F cooling], and is limited by the outside air humidity [greater humidity less cooling]

Wet pad wall opposite exhaust fan wall most common

Water cools the air by evaporating within the wet pad of the end wall and humidifies the incoming air which is moved through the greenhouse by the exhaust fan

Fog [or mist] cooling by spray nozzles located overhead throughout the greenhouse. More uniform within greenhouse and efficient cooling than wet pad, but challenging to maintain [water quality will block nozzles] and control [must cycle to prevent wetted plants]

Supplemental Lighting

Photosynthetic lighting and/or photoperiod control to compensate for natural environment.

Shade/Energy Screen

Indoor mechanical system to deploy screen in the night for energy conservation [20 – 40% savings], or for use in day for shading [20 – 30% light reduction] and some cooling [1 or 2 degrees] to reduce plant water stress

Monitoring and Control

Monitor air temperature and humidity, sunlight and CO2 but control mostly based on air temperature [easiest to do]. Computer control can do more complex controls with more types and numbers of sensors, as well as store and analyze data, communicate with operator, and overall provide much valuable information to the grower who can make better decisions for more efficient production.

Structure and Glazing

Structure: Single bay ground-to-ground [high tunnel] or single bay greenhouse, or multiple-bay, gutter connected

Glazing: Glass or plastic [film or rigid], single or double-layers are general choices

Glass is forever, but expensive. Plastic life is 20 – 25 years for double-wall rigids and 2 – 4 years life for the films [except ETFE, Tradename: F-Clean], and less expensive.
Double-layer air-inflated polyethylene film is very cost effective
Various additives in the plastics modify qualities [longevity, heat loss, condensation dripping, light quality change, and heat gain from the sun]

Utilities

Necessary for operations: heating fuel, water source, electrical, communications, transport access, market access, sanitary disposal

Headhouse

Storage, packing, office, restrooms, lunchroom

Plant Nutrient and Water Delivery

Water quality, get a lab test of your water source!

Fertigation – creating nutrient formulation, deliver consistently and on-demand

Delivery to plant roots: top drip, NFT, DWC [or floating rafts], Ebb & Flow [or Flood & Drain], aeroponics. All must provide the same: water, nutrients, oxygen, removing salts, maintaining pH, without light. Match system type to the crop [size, access requirements, opportunity to automate, ease of turnover, sanitation, maintenance, skill of labor required, logistics of plant and materials handling, failsafe!]

Control of irrigation cycle: timer, substrate moisture content, %drainage

Final considerations for the profitable grower

Continually learn about plant care and needs. Share your experiences. Visit trade shows.
Listen to the next generation of growers in your family and business community
Don’t block your future moves for development/expansion. Plan your production space
Attend short courses until becoming board with having more experience than the teachers

Notes

Climate Control

Dr. Murat Kacira
Interim Head and Professor, Biosystems Engineering Department, The University of Arizona

Dr. Murat Kacira is the director of the Controlled Environment Agriculture Center and interim head of the Department of Biosystems Engineering at the University of Arizona. He received his PhD (2000) and MS (1996) degrees in Food, Agricultural and Biological Engineering from The Ohio State University. His BSc degree (1991) is in Agricultural Engineering from Cukurova University in Türkiye. Murat's primary focus is on resource-use efficiency of systems through integrated crop and production system sensing, monitoring, alternative energy, and environmental control applications. He interacts with stake holders through technical consultations, organizing and presenting in crop production and engineering short courses with hands-on educational workshops and grower conferences, and presenting at national and international conferences. He is a member of the American Society of Agricultural and Biological Engineers (ASABE), American Society of Horticultural Sciences (ASHS) and the International Society for Horticultural Science (ISHS).

Climate Control:

Climate control is a critical aspect of Controlled Environment Agriculture (CEA), enabling optimized plant growth and resource efficiency. This presentation explores key environmental variables to monitor and control. We will examine climate control processes, ranging from simple manual adjustments to sophisticated automated systems. Additionally, we will discuss the evolution from basic climate controls to advanced applications leveraging real-time data and automation. Finally, emerging trends in climate control approaches, such as speaking plant, machine learning, IoT integration, and adaptive climate modeling, will be highlighted to discuss the current and future trends in climate control applications in controlled environments.

Notes

ARIZONA

Integrated Pest Management in CEA

Dr. Triston Hooks
Assistant Professor of Practice,
Biosystems Engineering,
The University of Arizona

Dr. Triston Hooks graduated with a Ph.D. in Plant and Environmental Sciences from New Mexico State University in 2020, where he researched rangeland ecology and plant salinity tolerance. Additionally, he has worked as a Research Associate at Texas A&M AgriLife Research Center in Dallas, where his research focused on Urban Agriculture and Controlled Environment Agriculture (CEA) technology, including hydroponic systems and LED lighting. Dr. Hooks has conducted research on organic hydroponic production of lettuce and the application of ultra-violet (UV) light to enhance plant quality in greenhouse production systems. Dr. Hooks now serves as an Assistant Professor of Practice in the Department of Biosystems Engineering at the University of Arizona. He teaches Introduction to Hydroponics, Advanced Hydroponic Crop Production, Integrated Pest Management, and is an instructor for many of our offerings, including our CEAC intensive Workshops.

Integrated Pest Management in CEA:

We know that CEA can use less water and fertilizer, but what about pesticides? Many growers overlook pest management thinking that CEA is invulnerable, but nothing could be further from the truth. This presentation covers the basics of common CEA pests and how to manage them using Integrated Pest Management (IPM) techniques such as cultural, mechanical, biological, and chemical practices so that you can become a more resilient and sustainable grower!

Notes

ARIZONA

Hydroponic Plant Production Basics

Dr. Triston Hooks
Assistant Professor of Practice,
Biosystems Engineering,
The University of Arizona

Dr. Triston Hooks graduated with a Ph.D. in Plant and Environmental Sciences from New Mexico State University in 2020, where he researched rangeland ecology and plant salinity tolerance. Additionally, he has worked as a Research Associate at Texas A&M AgriLife Research Center in Dallas, where his research focused on Urban Agriculture and Controlled Environment Agriculture (CEA) technology, including hydroponic systems and LED lighting. Dr. Hooks has conducted research on organic hydroponic production of lettuce and the application of ultra-violet (UV) light to enhance plant quality in greenhouse production systems. Dr. Hooks now serves as an Assistant Professor of Practice in the Department of Biosystems Engineering at the University of Arizona. He teaches Introduction to Hydroponics, Advanced Hydroponic Crop Production, Integrated Pest Management, and is an instructor for many of our offerings, including our CEAC intensive Workshops.

Hydroponic Plant Production Basics:

Systems, substrates, and nutrient solutions, oh my! Feeling intimidated by hydroponics? This presentation covers the basics for both leafy greens and vine crops and attempts to demystify hydroponic plant production so that you can be a confident and better grower!

Notes

ARIZONA

Opportunities for Circularity in CEA:

Dr. Ryan Lefers
Founder, Iyris

Dr. Ryan Lefers is Founder and Head of Plant Genetics at iyris, a sustainable agtech company creating easy-to-adopt technologies for climate adaptation.

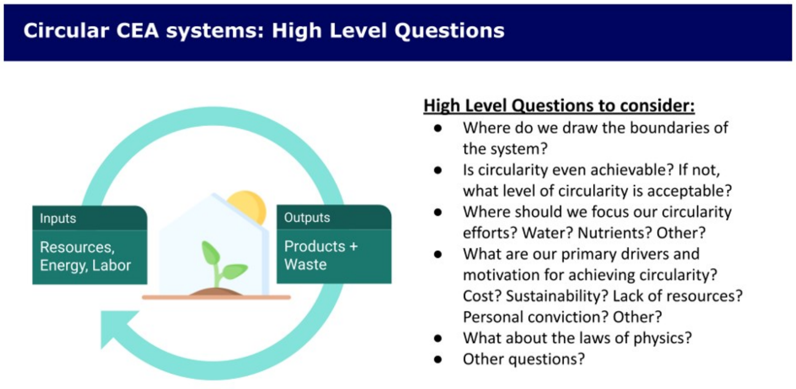
Throughout his career, Ryan has focused his efforts on systems that serve to advance water and food security in a sustainable way. A diverse range of experiences in business, research, agriculture, climate and water has set him apart as a highly sought after speaker and as a global expert in the field. Ryan holds a BS and MS in Agriculture Engineering from South Dakota State University and a PhD in Environmental Engineering from King Abdullah University of Science and Technology (KAUST). He has founded three companies in sustainable agriculture – an aquaponics produce company selling fresh produce in Saudi Arabia, a sustainable agriculture consulting company based in the USA, and his current company – iyris (previously known as Red Sea Farms). Ryan is an expert in covered and open field agriculture systems and the complex interactions between food, water, energy and climate.

Ryan's passion is to serve people and steward the planet through business, research and innovation.

LinkedIn Profile: https://www.linkedin.com/in/ryan-lefers/

Opportunities for Circularity in CEA:

As a self-enclosed system, controlled environment agriculture offers the opportunity for circularity in the reuse/recycling of outputs as inputs. However, the level of circularity that is applied in practice for any given CEA system will depend on many factors, including external influences. In our time together, we will define what circular means for CEA and take a look at an example of one input (water) that has the potential to be circular "inside the box" of a CEA system. We will then break into groups to evaluate and design circularity of other inputs for a CEA system to be built in Arizona, concluding with a short presentation to your peers and wrap-up.



ARIZONA

Notes

Optimizing Circular Food Systems through the Integration of Diverse CEA Crops

Dr. Goggy Davidowitz
Professor, Department of Entomology, University of Arizona

Dr. Goggy Davidowitz is a Professor and University Distinguished Scholar in the Departments of Entomology and Ecology and Evolutionary Biology at the University of Arizona. His research in insect physiology explores how insects adjust their growth and development to changes in the environment. Davidowitz also focuses on repurposing excess fruits and vegetables to grow insects as food and feed. Using CEA methodologies, Davidowitz leads a team to develop an integrated, circular, sustainable food production system from plants, mushrooms, fish and insects in a way that the waste products from any one food system is repurposed as a resource for another food system.

Optimizing Circular Food Systems through the Integration of Diverse CEA Crops:

CEA technologies are typically used to grow crops individually. CEA methodologies can also be used in integrated crop systems. MISAS (Modular, Integrated, Sustainable Agricultural System) is a four-crop CEA system that integrates food production from plants, mushrooms, fish and insects in a way that repurposes the output waste streams of each crop as an input resource for another crop. Integrated CEA systems are modular and can be adapted to a particular communities need, can produce complete diets, particularly important in isolated locations, and are highly sustainable, producing almost no waste.

Notes

ARIZONA

Substrates of the Future: Materials, Performance and Sustainability

Jose Chen Lopez
Horticulture Specialist, Premier Tech

Jose Chen Lopez holds a PhD in Agricultural and Biosystems Engineering with a major in Controlled Environment Agriculture, along with a Master's degree in Soils and Irrigation and a Bachelor's degree in the same field. With a strong academic foundation, Jose has acquired extensive experience working with growers over the years. His expertise in the interrelationship between substrates, water, plants, and the aerial environment allows him to excel in technical demonstrations, coaching sessions, and devising optimal solutions for various agricultural challenges.
Since joining Grower Services in 2013, Jose has leveraged his comprehensive knowledge to provide invaluable insights and support to growers, helping them achieve better results in controlled environment agriculture.

Substrates of the Future: Materials, Performance and Sustainability

The Controlled Environment Agriculture (CEA) industry has been evolving at a fast rate. As crops transition from traditional field production to protected environments there have been important developments in structure materials, sensors, automation and of course substrates. With these advances, there is a stronger emphasis on the plant root environment and on the growing substrate, however physical, chemical, and biological characteristics are often overlooked. In the market, there is a wide range of commercial substrates available, but growers should consider a dependable company that can supply high quality products and consistency to fulfill the needs of the crop and the grower. In terms of substrate circularity, substrate design should start by choosing materials that are readily available and require the least amount of energy to produce. These materials need to provide the proper environment to encourage root growth and form a healthy root microbiome to facilitate the proper use of water and nutrients, promote higher yields and increase the nutritional value of the crops. In addition, they must be able to be reused, recycled, or safely disposed with minimal environmental impact.

Notes

ARIZONA

Microgreens Production in CEA

Dr.Yujin Park
Assistant Professor , School of Applied Sciences and Arts , Arizona State University

Yujin Park is an Assistant Professor of Horticulture at Arizona State University. Her research program at the Indoor Farming Lab aims to better understand how environmental controls, including light, temperature, and nutrients, regulate plant growth and development of horticultural crops for indoor and greenhouse crop production. She holds degrees from Michigan State University (Ph.D.) in the U.S., and Seoul National University (M.S.) and Yonsei University (B.S.) in Korea.

Microgreens Production in CEA:

Microgreens are small, edible plants harvested at an early stage of growth. Their rapid growth makes them a popular choice for urban farming and home gardeners. The physiology of microgreens is crucial for understanding their development, from seed germination to seedling establishment. The process of growing microgreens involves selecting the right seeds, sowing them in optimal conditions, and providing the necessary environment for their rapid growth. Ideal growing conditions, such as temperature, light, and humidity, are key factors for success. Understanding these factors and how to address them will help growers optimize production and ensure high-quality yields.

Notes

Strawberry Production in CEA

Karla Garcia
Technical Service Specialist and Consultant, Hort Americas

Karla Garcia is a passionate plant physiologist with over 12 years of experience in the field. Her journey began in her hometown of Hermosillo, Sonora, Mexico, where she joined an Eco-physiology Lab as an undergraduate student. Karla holds a Master's Degree in Plant Science from The University of Arizona and specializes in plant physiology in controlled environments. She is deeply committed to promoting sustainable horticultural practices for food production.

Throughout her career, Karla has served as a technical adviser and consultant for various companies and has taught short courses in hydroponics, urban farming, and greenhouse design across the Americas. She has also successfully managed a microgreens company for over 7 years. Now, as part of the Hort Americas team, Karla is focused on supporting customers with their horticultural needs, guiding them to successful projects, and leading sales efforts in Mexico.

Strawberry Production in CEA

Strawberry cultivation in controlled environment agriculture (CEA) presents unique opportunities to optimize yield and fruit quality through precise environmental management. This presentation will focus on the latest research applied to greenhouse management for hydroponic strawberry production. Key topics include light management in both greenhouses and plant factories, the link between temperature and fruit quality, and strategies for optimizing photosynthesis. Additionally, we will explore the effects of relative humidity, ventilation, and pollination on fruit development, as well as best practices for substrate selection, irrigation strategies, and nutrient recommendations. Understanding the interactions between these environmental factors is critical for improving productivity and maintaining consistent, high-quality strawberry production in CEA systems.

Notes

Producing High Value Lions's Mane Mushrooms in Controlled Environment Systems

Dr. Barry Pryor
Professor, School of Plant Sciences, The University Of Arizona

Dr. Barry Pryor received an M.S. in Plant Protection and Pest Management, and a PhD in Plant Pathology from the University of California, Davis. In 2001, he began his faculty appointment at the University of Arizona in the School of Plant Sciences. In 2024, Dr. Pryor began a new academic appointment at Oregon State University in the Department of Botany and Plant Pathology. Dr. Pryor's research program focuses on understanding the functional and evolutionary interactions of fungi with their environment. Areas of interest include mechanisms of pathogenesis and management of fungal disease in field, tree, and vegetable crops, evolution and species concepts in asexual fungi, production of toxic secondary fungal metabolites, and environmental mycology. Additional interests include fungal community composition in native and agricultural ecosystems, particularly those in semi-arid and arid zones, effects of fungal aeroallergens on childhood asthma, and the development of gourmet and medicinal mushroom production as components of sustainable food systems. Dr. Pryor's new position in Oregon is focused specifically on commercial mushroom production. Undergraduate and graduate student participation has been central in each of these fields of study and all projects provide rich opportunity for student training and independent research. Over the past 10 years, 73 undergraduates, 16 graduate students, and 4 postdoctoral scholars have contributed to projects objectives at varying degrees, resulting 68 peer-reviewed publications and numerous articles of general public interest.

Producing High Value Lions's Mane Mushrooms in Controlled Environment Systems:

In this presentation, Dr. Pryor will highlight production systems, challenges, and innovations in modern commercial mushroom production and ways in which mushroom production can be integrated into your CEA operations. Commercial production of both button and specialty mushrooms has huge economic potential, especially for controlled environment agriculture, and growth in the industry is averaging 10-20% annually. This growth is fueled by rising consumer awareness of the nutritional value of mushrooms including high protein, fiber, vitamins, and minerals but low in calories, which make mushrooms a great food source in a society that regularly consumes calorie-rich food. Moreover, several species have unique nutraceutical content that promote for health and longevity. One of these species, lion's mane mushroom, has neuroregenerative properties and is a favorite among consumers and producers alike. This presentation will provide an additional focus on the production of this very unique specialty mushroom.

ARIZONA

Notes

Aquaponics in CEA

Dr. Matthew "Rex" Recsetar
Professor, Biosystems Engineering,
The University of Arizona

Dr. Matthew “Rex” Recsetar has over 13 years of hands-on experience with aquaponics systems, excelling in the construction, design and operation of various system setups. His capabilities extends to cultivating a diverse range of plants and fish, alongside imparting his knowledge through teaching and training initiatives. He runs a consulting business called ZonaPonics where he channels his expertise into developing and optimizing commercial aquaponics farms. Dr. Recsetar’s commitment to education is evident as he teaches courses on Aquaponics Design and Aquaponics Engineering at the University of Arizona. In addition, he teaches a class on the Future of Food focusing on food production technologies.Dr. Recsetar’s research ventures delve into diverse aspects of aquaponics, including nutrient dynamics, decoupled aquaponics, sludge mineralization, system optimization, root microbiome and aquaponic feed alternatives. Outside of aquaponics, he has also focused extensively on aquaculture, hydroponics, sustainable food production and wastewater treatment.

In 2019, he developed and patented a phyto-mediated wastewater treatment bio-reactor (PWBR) which demonstrated removal capabilities of 90% or better of nearly all contaminants of emerging concern (CECs) found in tertiary-treated wastewater effluent from a Tucson WRF. He has also examined the potential for aquaculture biosolids to be used as a soil amendment for growing wheat. Recently, he performed research that examined various nutrient management techniques and optimized water-use efficiency in commercial decoupled aquaponics systems growing Cannabis sativa (hemp). His current research topics include the examination of root microbiomes in aquaponics systems and hydroponic systems seeded with aquaculture effluent, optimization of sludge mineralization, and fishmeal replacement in aquaculture feeds that can be tailored to meet nutrient demands of aquaponics systems growing high-value crops.

Aquaponics in CEA:

Aquaponics, a complex method of growing fish and plants together presents a unique approach to sustainable agriculture. While similar in most respects to hydroponics, aquaponics utilizes aquaculture effluent as a natural nutrient source for plants, replacing inorganic salts. This not only facilitates organic plant production, but improves water use efficiency. Initially adopted on a small-scale by hobbyists, schools and individual greenhouse operations, aquaponics has gradually transitioned into large-scale commercial production with increased use of technology and environmental control. Challenges in scaling aquaponics historically impeded large-scale adoption, but ongoing research into nutrient dynamics and management as well other innovations has made this a more desirable endeavor, especially for high-value crops or for growing in arid regions.

Notes

ARIZONA