Driven by the Future!

Training our students to build sustainable solutions that create resilience among society, the environment, and the economy!

Students waving in greenhouse hydroponics class laboratory

Building!

Growing!

Internships and Management jobs

"FARMERS WANTED"

Student crop production

College of Agriculture & Life Sciences
Agricultural & Biosystems Engineering
Urban Agric. Vertical Farm System for CEA Research, Education an Outreach (UAg Farm)

The University of Arizona’s Controlled Environment Agriculture Center (UA-CEAC) and technology/industry collaborators have come together to launch a new multi-tier vertical farm (VF) based research, education, and outreach facility (UAgFarm) at the UA-CEAC. The UAgFarm facility was developed for engineering and science based research to address challenges and help advancing technology and crop production applications with indoor growing under artificial lighting, to provide experiential educational opportunities for students, and to educate and inform growers and public on indoor growing systems.

University of Arizona UAg VF facility located at Controlled Environment Agriculture Center (http://ceac.arizona.edu) has 770 ft² floor space, with two independently climate controlled rooms, each room with 2 racks consisting of 3 deep-flow hydroponics beds (each 4ft wide x 8 ft length) with adjustable height between growing bed and lighting. Sole source lighting in UAg Farm utilizes LED modules (with blue and red channels) with remotely and independently controlled light intensity at each growing shelve. A custom designed and built data acquisition and graphical user interface system enables real-time monitoring of air temperature, relative humidity, CO₂, light intensity from aerial environment and pH, electrical conductivity, dissolved oxygen from nutrient solution as well as monitoring of resource use (i.e. energy, water, CO₂), while controlling CO₂ injections.

Rebakah Waller and KC Shasteen (Grad. Student and UAg Farm Managers), Ying Zhang (Grad. Student)
Dr. Murat Kacira, PI (mkacira@email.arizona.edu)
Solar Powered Off-the-Grid Greenhouse

Sustainable production systems can help to reduce agricultural production impact, and also make farming systems less susceptible to climate changes. The world's resources such as water, land, fertilizers and energy are becoming scarcer, especially in semi-arid and arid regions. Innovative technology must go beyond increasing yields, it should include integrated and appropriate production systems & strategies, resource recycling, and alternative energy integration in CEA food production systems.

Communities all over the world are interested in growing safe, local and fresh produce. However, this is more difficult to do in remote locations, challenged regions, and disastrous zones where immediate access to resources for sustainable crop production is limited.

This solar photovoltaic integrated greenhouse system can offer the potential to alleviate food and energy problems without having to connect to the city grid for communities in remote, challenged, and semi-arid locations.

<table>
<thead>
<tr>
<th>Crop Produced</th>
<th>Cherry Tomato (variety Fertility)</th>
</tr>
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<tbody>
<tr>
<td>4 plants/m² crop density</td>
<td></td>
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<tr>
<th>Production Period</th>
<th>April-November</th>
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<tr>
<th>Resource Input</th>
<th>PV Integrated</th>
<th>Grid-Connected</th>
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<tbody>
<tr>
<td>Energy Consumed (MJ/m³)</td>
<td>18.3</td>
<td>48.0</td>
</tr>
<tr>
<td>Irrigation Water Use (L/m³/day)</td>
<td>5.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Wet Pad Water Use (L/m³/day)</td>
<td>7.4</td>
<td>9.1</td>
</tr>
<tr>
<td>Labor (hr/day)</td>
<td>5.3</td>
<td>5.1</td>
</tr>
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<table>
<thead>
<tr>
<th>System Outputs</th>
</tr>
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<tbody>
<tr>
<td>Produce Yield (kg/m³)/week</td>
</tr>
<tr>
<td>Energy Produced (MJ/m³)</td>
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<table>
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<tr>
<th>Average Labor Hours per Task</th>
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<tbody>
<tr>
<td>Overall Plant Maintenance (hr/week)</td>
</tr>
<tr>
<td>Fruit Harvesting and Sorting (hr/week)</td>
</tr>
<tr>
<td>Greenhouse Maintenance/other (hr/week)</td>
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</tbody>
</table>

Greenhouse: 2x134 m² GHs, diffuse PE glazing, dosmatic/drip tape based fertigation, evaporative cooling, climate monitoring/control.

PV System: 27x110 W, Photovoltaic Array, 1xMPPT charge controller, 4xDeep cycle solar batteries, automated energy monitoring.

Project Objectives
- Study technical and economical feasibility of PV Integrated greenhouse
- Determine resource usage and integrated system production outputs
- Analyze effect of climate on efficiency of PV system
- Determine limitations and capabilities of system and make recommendations

Research
(X. Juang, Cal Poly Student)

Hands on education
(A. Playford & M. Ben-It, Under Grad Students)

Outreach

Contact:
Dr. Murat Kacira
mkacira@calpoly.edu
www.ag.arizona.edu/research/kacira
HOW DID WE GET A GREENHOUSE ON THE ROOF OF THE STUDENT UNION?
In Spring, 2017, the Student Union held a Rooftop Garden Design Competition. Students were challenged to design a rooftop garden to supply the Campus Food Pantry and Pangea with fresh produce. This greenhouse was the winning team's design.

The winning team was Bryan Caplan, Dan Gillespie, Raul Moraga, Robert Melvin and Nicholas Tritz.

The competition sponsors are Coca-Cola, Shamrock Farms, UA Student Services Fees Grant, UA Green Funds Grant, UA Student Union.

The greenhouse companies and sponsors are Autogrow, Formflex, Grodan, Wadsworth Control Systems, and Polytext Inc.

WHO RUNS THE GREENHOUSE?
The greenhouse is owned by the Student Union. The Biosystems Engineering Department and Controlled Environment Agriculture Center helped refine the design and construction of the greenhouse and its systems and run the day-to-day operations of the greenhouse.

Dr. Stacy Tollefson (BE Dept) is the Project and Production Manager. She oversees three students who work in the greenhouse, taking care of the plants, environmental conditions, and growing systems.

CONTINUED ON THE BACK
WHAT IS CURRENTLY BEING GROWN IN THE GREENHOUSE?
Cherry tomatoes, slicing tomatoes (commercially called ‘truss’ or ‘cluster’ tomatoes because they are grown as a cluster in the flower truss), mini cucumbers, and colored bell peppers.

HOW MUCH PRODUCE IS BEING GROWN AND WHERE DOES IT GO?
All produce goes to the Campus Pantry located at the SUMC, which currently supplies food to over 550 students and staff per week! It is anticipated that the pantry will receive 70lbs of mini cucumbers, 20lbs of cherry tomatoes, 30lbs of slicing tomatoes, and 10lbs of bell peppers each week.

This amounts to about 3,000lbs of cucumbers, 800lbs of cherry tomatoes, 1,200lbs of slicing tomatoes, and 250lbs of peppers each year.

HOW ARE THE VEGETABLES GROWN?
They are grown hydroponically, without soil. Plants are grown in a soilless media called rockwool. Rockwool is spun volcanic rock that acts to anchor the plant roots and as a sponge to hold water, but it does not provide any fertilizer for plant nutrition. This allows us to feed the plants just the right amount of fertilizer and water they need. Using hydroponics and a controlled aerial environment inside a greenhouse results in maximum plant yields and product quality.

ARE THE VEGETABLES ORGANIC AND PESTICIDE-FREE?
The vegetables are not certified organic. We use mineral fertilizers rather than organic fertilizers.

Hydroponic growing is a sustainable agriculture technique in that requires only 5% of the water and less fertilizer and 10% of the land space than comparable field grown crops, because its yearly productivity can be 10 times that of open-field agriculture, which is affected by weather/climate conditions.

We do not use synthetic pesticides in this greenhouse, instead employ techniques of Integrated Pest Management (IPM). This includes organic pest management approaches, such as using good bugs to kill the bad bugs and using natural botanicals to control pests. We help to exclude pests by our location which has few other plants nearby, and take care not to transport pests from our home gardens or other greenhouses prior to entering the Rooftop Greenhouse.

HOW CAN I GET INVOLVED WITH HYDROPONIC GROWING IN CONTROLLED ENVIRONMENT GREENHOUSES?
Dr. Tollefson runs a Sustainable Urban Agriculture Internship Program where students can gain experience with hydroponic crop production. Some interns will work on the Student Union Rooftop Greenhouse, others will work in the hydroponic greenhouses at the Controlled Environment Agriculture Center.

You can learn about hydroponic growing through the Sustainable Plant Systems, Agricultural Technology Management, Agricultural Education, and Biosystems Engineering degree programs.

Contact Neysha Aguilar for more information at neyshar@email.arizona.edu