

Table of Contents

Education and Outreach	
<i>Dr. Tadashi Takakura Recognized</i>	1
<i>Controlled Environment Scientists and Engineers to meet at UA</i>	1
<i>2009 Greenhouse Short Course</i>	2
New Faces	2
<i>Sustainable resource management and year round production of fresh green salad crops with automated and remotely monitored controlled environment plant production systems</i>	3
<i>Aquaponics Food Production System</i>	4
Out and About	5
<i>Reaching Out Around the Globe</i>	6
CEAC Visitors	7
CEAC Volunteers	7
<i>CEAC Summer Retreat</i>	8
Director's Opinion	9
<i>It was an Exceptional Summer!</i> <i>By Gene Giacomelli</i>	

Dr. Tadashi Takakura Recognized

Dr. Tadashi Takakura was honored July 10th, 2008 for his 20 years of teaching at UA. Dr. Takakura is a world renowned



Dr. Tadashi Takakura and
Dr. Don Slack, ABE Dept. Head

expert in controlled environment systems for agriculture, and a long-time friend and colleague. As a Professor of Agricultural Engineering and head of the Laboratory of Environmental Control at the University of Tokyo, he has gone on

to serve as Dean of the College of Environmental Science at Nagasaki University and President of Fukuoka International University and Fukuoka Women's Junior College. Since 1988, Dr. Takakura has been teaching a graduate course each summer in the Agriculture & Biosystems Engineering (ABE) department at UA entitled, "Simulation of Biological Systems". In 1994, Dr. Takakura became an adjunct professor in ABE, and he has faithfully taught this course to engineers and plant scientists during summer session ever since. Dr. Takakura was named a fellow in the American Society of Agricultural and Biological Engineers in 1987 and was the first, and at that time, the only, Japanese Engineer elected to Fellow. He has also served as a member of the ASAE Foundation. We wish him well and will welcome him to ABE and CEA in future years.

Controlled Environment Scientists and Engineers to meet at UA-CEAC

The ISHS International Workshop on Greenhouse Environmental Control and Crop Production in Semi-Arid Regions will convene October 20 – 24, 2008. More than 100 researchers and educators in greenhouse controlled environment and crop production from 24 countries will meet in Tucson, Arizona for scientific presentations, commercial and research greenhouse facility tours, and to enter the closed environment of Biosphere2, and to remotely visit the robotic Phoenix Lander, currently sampling the extreme environment of its landing site on Mars. This event is organized and hosted by the CEAC at the University of Arizona. For registration go to: www.GHWorkshopAridRegions2008.org. (Also see workshop invited keynote speakers on page 2)

2009 Greenhouse Short Course

On April 26-29, 2009, we will proudly host the **9th Annual Greenhouse Crop Production and Engineering Design Short Course**. The new venue – the Sheraton Hotel Tucson, will offer enhanced facilities, while a new cast of invited speakers will help participants gain valuable knowledge about managing and designing greenhouses and producing hydroponic food crops. More information, registration procedures, and hotel reservations information will be provided in the near future at www.ag.arizona.edu/ceac.

New Faces



Student Workers

Evan LaBrant is a freshman from Vancouver, Washington who is seeking a degree in Plant Sciences, with a possible double major in Agricultural & Biosystems Engineering. He will be working for **Dr. Pat Rorabaugh** in the teaching laboratory caring for the tomatoes, sweet peppers and cucumber crops.

Heidi Hawkins is a senior focused on a degree in Agriculture Technology Management. She has returned to school after 8 years of real world experiences and will complete her degree in the plant production area, something she loves. Upon graduation she hopes to pursue a career in something to do with, yes you guessed it,...plants. She will be working for **Dr. Pat Rorabaugh**.



New students workers not pictured are **Chris Federici**, **Case Giacomelli**, and **Erynn Dunn**. Erynn is a student worker for **Dr. Roger Huber** and will be our scout for insects and disease infestation within the CEAC greenhouses for this year. Case and Chris will work for **Dr. Pat Rorabaugh**.

In addition, **Fernando Rojano** from Vera Cruz, Mexico is a new graduate student in ABE who has an interest in biofuels and CEA.



Featured Speakers



Stefania De Pascale
The University
of Naples Federico II
Naples, Italy



Nicholas Castilla
CIDA, Granada, Spain



Guy A. Cardineau
Arizona State University
Arizona, U.S.A.



Sadanori Sase
National Institute
for Rural Engineering,
Tsukuba, Japan

ISHS International Workshop on Greenhouse Environmental Control and Crop Production in Semi-Arid Regions

October 20-24, 2008

Omni Tucson National Golf Resort & Spa, Tucson, Arizona USA

Greenhouse plant production is extending beyond the traditional areas to harsher climates, including arid and semiarid regions. Along with this rapid development and "migration" of greenhouse controlled environment agriculture (CEA), new technologies must evolve, and supportive operational information must be developed. Achieving sustainable greenhouse applications will require an interdisciplinary and multi-dimensional approach to solutions, which combines both engineering and horticultural expertise. CEA applications are no longer limited to traditional food and floral crop production, but are now poised to capitalize on plant processes for biopharmaceuticals, bioactive compounds, bioremediation, and bio-energy. It is therefore a critical time for researchers, educators, developers, and the industry to work together for the enhancement of society with CEA-based technologies.

Come for a magnificent change of scenery. Tucson is the authentic Southwestern destination. Mile after mile of pristine desert, cactus like nowhere else on Earth, spectacular mountains in every direction. The views and climate are absolutely incredible. Our workshop resort is nestled in the foothills of the Santa Catalina Mountains in Tucson, Arizona USA. The resort provides top-class sleeping rooms, world-class service, gourmet and casual restaurants for a professional educational experience within a relaxed atmosphere.

Sponsored by:



Desert Glory

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**FOR MORE INFORMATION AND TO REGISTER:
WWW.GHWORKSHOPARIDREGIONS2008.ORG**

International Workshop organized by:



Under the aegis of:



Sustainable resource management and year round production of fresh green salad crops with automated and remotely monitored controlled environment plant production systems

By Murat Kacira, Associate Professor, ABE

Water usage and energy consumption as it relates to agriculture continues to be a very important topic of discussion. Water is the most vital natural resource for sustainable economic development in Arizona. Even though Arizona suffers from limited water supply and drought, the majority of Arizonans are not aware of the severity of future challenges. One of the most



Fig 1. One of four separate (4 x 8 foot) DFHS research units at CEAC used for several investigations, including: (1) lettuce variety trials; (2) determining the effect of a commercial product to prevent Pythium in lettuce; (3) stimulating the production of plant phytochemicals.

important components of sustainable water management is the development of mechanisms to reduce and reuse existing resources.

The Deep Flow Hydroponic System (DFHS) is a technique with plants that float on a body of water and completely cover the surface. With such a design, it is possible to limit water use to precisely the amount which is used by the plants. Along with precision control of the root and aerial environment of the plants, this alternative production system may help to make agriculture sustainable within semi-arid regions in the future.

As energy and fuel prices rise, fresh foods will increase in price due to their shipment from distant production locations. With concern for food safety and food for healthy lifestyle, locally grown produce is gaining popularity. In order to determine the feasibility of such a venture in the desert Southwest, preliminary

research is being conducted, using a scaled version of a DFHS which will provide information such as yields and operating costs for the Southwest. This data when combined within a business and financial plan can then be used to aid new agricultural businesses in Arizona.

Automated and remotely monitored, the deep flow hydroponic system was designed and constructed (Fig. 1 & 2) at the CEAC. A Professional Science Master student **Myles Lewis** is working under the supervision of **Dr. Gene Giacomelli** and **Dr. Murat Kacira** (Agricultural & Biosystems Engineering) and the advising of **Dr. Merle Jensen**, Emeritus Professor, Plant Sciences, to determine the economic feasibility of commercial greenhouse lettuce production within a deep flow hydroponic system in the Southwest. We will study the potential of sustainable management of water/fertilization and year-round production of high quality and nutritional fresh salad vegetables with reduced water and fertilizer applications compared to field production.

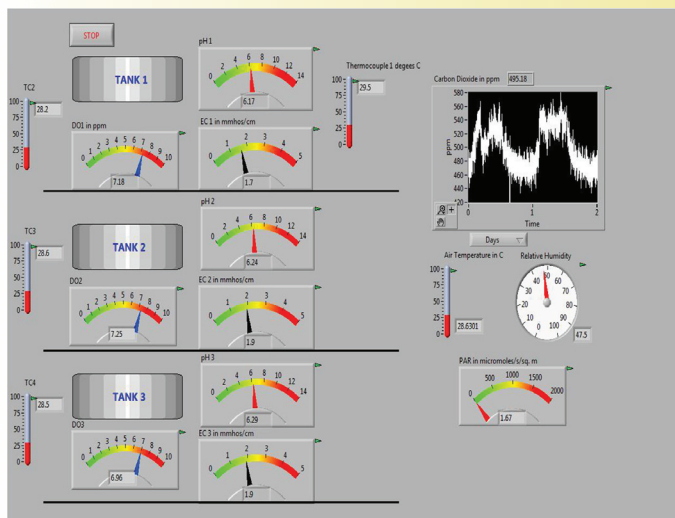


Fig 2. The automated DFHS units are continuously and remotely monitored through the Internet using LabView software for environmental parameters including EC, pH, dissolved oxygen and nutrient temperature in root zone; and air temperature, relative humidity, light intensity, and CO2 concentration in the aerial environment.

(Continued on page 4)

(Continued from Page 3)

In addition, **Dr. Joel Cuello** (Agricultural & Biosystems Engineering) in collaborative research with **Dr. Murat Kacira** is evaluating the effect of stimulating plants with low power levels of electrical current to induce the leafy greens and pharmaceutical crops to enhance phytochemical production. Future research will include the studies of the dynamics of the system, and the effects of electrical conductivity (EC), pH and water temperature on plant growth, quality and phytochemical yield.

Aquaponics Food Production System

Graduate student **Jason Licamele** was joined by **Peter Considine** this summer to work on the Aquaponics project. Jason is a doctoral student in the ABE program studying under the tutelage of **Dr. Giacomelli** and **Dr. Kevin Fitzsimmons** (Soil Water & Environmental Sciences). Peter is a Chemistry major and completing his senior year. The multi-disciplinary project combines the hydroponic, aquaculture and aquatic engineering fields. Project facilities construction, supported by the Premier Organic Farms grant, will begin lettuce production trials in September. Currently the fish system is operational and supporting two types of tilapia; Nile Tilapia (*Oreochromis niloticus*) and a Florida Red Hybrid (*O. niloticus* x *O.*

spp.). The Aquaponics system is a recirculating design producing both tilapia and lettuce, which share common waters. The initial goal is to demonstrate the operations of the aquaponics system, while monitoring the nitrogen dynamics and biomass production.



Tilapia fish tanks (left) and common nutrient water sump (right) for the Aquaponics system. Deep Flow Hydroponic System lettuce is grown in the adjacent bay (background)

Out and About

Specialty Crops Funding from USDA Farm Bill Calls for Industry Action

The USDA, through the tax-supported Farm Bill, has included vegetable/flower crop systems for federal research support. Although termed “Specialty Crops” within the legislation this includes the floriculture industry and greenhouse crop production. The Specialty Crops Research Initiative will provide upwards of 30 million dollars each year for the next 5 years to allow competitive research support for the vegetable and floral specialty crops industry. There will be great competition for the funds from other agricultural groups such as fruit industry, wine industry, field vegetable industry, etc, which are also considered specialty crops. Seems to me that greenhouse crops must be the “specialty crops” of specialty crops!!

The potential is there to help the industry. The academic community cannot succeed alone!

There is a very clear expectation of the USDA that a strong participation of the targeted industry be included in the planning of the grant proposal, or there would be no funding awarded to that grant proposal. Here is the opportunity for research, development and outreach funds targeted to your industry. Funding and subsequent R&D results will be very much in your control. Therefore if you are called upon by your favorite research facility/university for documented support for their proposal, please heartily respond to help assure success in obtaining the grant.

Jensen Speaks to 1,000 Farmers

Dr. Merle Jensen, Professor Emeritus, Plant Sciences, was invited to attend and speak at the 2008 International Tomato Congress in Leon, Mexico, July 23-25. His presentations were “Hydroponic Production in Mexico: An Alternative or Necessity?” and “Designing a Successful Greenhouse Vegetable Operation - Ten

Critical Factors.” The Tomato Congress is organized and sponsored by Meister Media Worldwide, and has quickly become established in Mexico as a significant educational source of production and marketing information for CEA crops.

ICES Conference – San Francisco

In June, Agricultural and Biosystems Engineering masters student, **Lane Patterson** and small business collaborator, **Phil Sadler** of Sadler Machine Company, each reported R&D efforts at the 39th International Conference on Environmental Systems (ICES) held in San Francisco California. Lane presented a “Resource and Production Model for the South Pole Food Growth Chamber”, and Mr. Sadler presented the “Prototype BLSS Lunar Habitat” to an audience of professionals in the fields of Space Exploration and Advanced Life Support. Those in attendance included representatives from NASA, Boeing, the Italian Space Agency and various universities and research Centers.

The complete papers are published at the SAE International website under the session: Bioregenerative Life Support. See the Patterson paper at: <http://www.sae.org/technical/papers/2008-01-2011>; and the Sadler paper at: <http://www.sae.org/technical/papers/2008-01-2186>.

Selena (Qian Li) gave a presentation at the Annual conference of American Society for Horticultural Science (ASHS) in Orlando, Florida July 21-25, 2008. Her paper was on “Effects of Supplemental Light Quality on Growth and Phytochemicals of Baby Leaf Lettuce Grown under White Light” by **Qian Li** and **Dr. Chieri Kubota**.

Reaching Out Around the Globe

First annual South Pole food growth chamber's "farmers market"

The First Annual South Pole Food Growth Chamber Farmers Market was held on August 31, 2008. It was organized by **Ms. Terry Eddington**, operator/manager of the chamber that is currently producing fresh vegetables during the cold, dark winter at the Amundsen-Scott South Pole Station in Antarctica. The market featured home-made (well, "pole-made") Pickles, Baguettes, and dips for hydroponically grown cucumbers, as well as, complementary food items prepared (but not grown) locally, including Yogurt, Cheese Platter, Olive Spread, Pesto, and Three Bean Salad. The celebration was planned to thank everyone who had volunteered this current winter at the South Pole to help care for the crops in the 250 square foot chamber, which achieved a recent harvest of 167 pounds in one week...an all-time record! Terry wrote, "I was actually surprised how many people were afraid to harvest a big salad, as I roved the growth chamber identifying plants and varieties, I found myself helping to educate my colleagues about hand harvesting. I suppose picking or eating something so precious right off the vine may be a little intimidating. It certainly proves that the SPFGC is a morale booster to so many that have the extraordinary once in a life time experience at the South Pole." Terry reminds us that we should recognize the importance of fresh, high quality, locally-grown food products in our daily lives, and that a celebration of this occurs, in part, because of the ability to grow plants

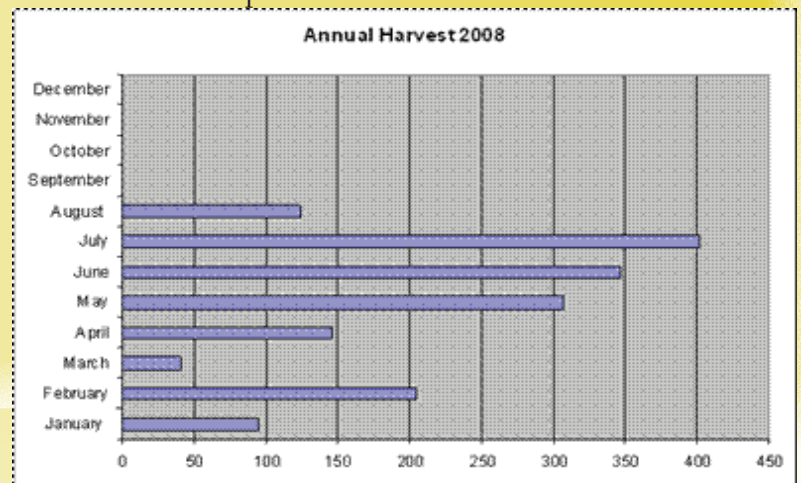


"Pole-made" Pickles.
(Photo by Teresa Eddington)



Food Growth Chamber, South Pole, August 25 2008. Lettuce, cucumbers, and swiss chard, kale, chives and onions (out of view)
(Photo by Teresa Eddington)

hydroponically in controlled environments even in remote locations. CEAC, in collaboration with Sadler Machine Co., is proud to have helped develop the chamber vegetable production system. **Lane Patterson** can be contacted with questions about the design (lane12345@rocketmail.com). Terry can be contacted at South Pole Food Growth Chamber teresa.eddington@usap.gov until November when she departs northward.



Monthly harvest (pounds per month)
at SPFGC, South Pole, Antarctica.
(Graphic by Teresa Eddington)

CEAC Visitors

Asahi Glass Green-Tech, LTD

On July 3rd, **Seiji Matsuda**, Division Manager of overseas division, and **Ichiro Yasui**, President and GM of overseas division, Asahi Glass Green-Tech, LTD of Japan presented a special seminar, entitled “F-clean™ ETFE Copolymer Technology for Greenhouse Glazing – Current Use, Future, and Collaborative Opportunities” at CEAC. The F-clean glazing was compared and contrasted to other flexible film greenhouse covers, and the versatility of application was clearly emphasized when it was described that the Olympic swimming building in China was covered with the material. F-clean technical information can be found at <http://www.fluon.jp/fluon/english/products/fclean/index.shtml>

Moonbase Greenhouse for Food and Life Support



Illuminated by water cooled lighting technology developed for NASA, as a CEAC collaborative project with Sadler Machine Co. (Tempe, AZ), **Phil Sadler** describes the progress made on a 21 cubic meter (18 foot long by 7 foot diameter deployable greenhouse designed for a lunar habitat, to **Giacomo Giovangros**, an engineer from Aero Sekur, an Italian supplier of advanced materials for aerospace.

Giacomo visited the CEAC Extreme Climate lab at the UA-ARC to develop future collaborative project plans. The life size laboratory will demonstrate air and water revitalization once its aluminum “skeleton” is covered by an air tight skin that encloses the plants within a semi-closed environment which will produce oxygen from carbon dioxide via plant photosynthesis, as well as, potable water from plant transpiration.

CEAC Volunteers

The CEAC Volunteers weathered the long hot summer, by caring for the plants and systems in the demonstration greenhouse. Their harvest of greenhouse produced figs and bananas continue to amaze and help us to further conclude that anything can be grown in a greenhouse! To be sure we do not forget, **Leo Pullara** created a CD montage of images of all the crops recently produced by the Volunteers.

CEAC Summer Retreat

On August 22nd, all the CEAC research group of students, faculty and staff met for the First Annual CEAC Research Retreat organized by **Dr. Chieri Kubota**. Twenty-one people attended and most provided a 10-minute summary of their accomplishments of this past summer period. The event offered opportunity for sharing experiences and to give perspective to some of the CEA research program activities.

Representative titles from each of the presenters are listed below (in no special order):

- Nitrogen Balance and Biomass Production in Aquaponics (Tilapia/Lettuce)
- Importance of Variety Trials of Tomato, Sweet Pepper, and Strawberry
- Automated Monitoring of Plant Health and Growth with Remote Sensing
- Improved Control of Natural Ventilation and Evaporative Cooling
- Machine Vision Guided System for Monitoring Plant Health and Growth
- Differential Pressure as Control Strategy for Natural Ventilation
- Feasibility of Commercially Produced Greenhouse Lettuce in the Southwest
- Developing a Closed CEA Plant Production System for Fresh Green Salad Production
- Evaluation of Commercial Fungicide in a Deep Flow Hydroponic System
- Yield Prediction and Growth Mode Characterization of Greenhouse Tomatoes Using Neural Networks and Fuzzy logic
- Low Air Temperature Storage of Grafted Melon Seedlings
- Characterization of Root Zone Media for Irrigation Control of Greenhouse Tomatoes
- Evaluation of Foamed Glass as a Root Zone Substrate
- Plant-Made-Pharmaceuticals with Transgenic Tomato Plants
- Effect of Supplemental Light Quality on Phytochemical Production in Plants
- Food for Health – Dose Response of Vegetable Consumption Feeding Study
- Grafting of Vegetable Seedlings for Improved Crop Performance
- Lunar Greenhouse Prototype for Bioregenerative Life Support
- Inflatable Greenhouse Algae Growing System for Production of Biodiesel
- Developing a Greenhouse Strawberry Crop Production System
- Operations Support of South Pole Food Growth Chamber
- CE-based Support of UA Biofuels Institute
- Vertical Farms for Food Production in Urban Areas
- Evaluation of Slow Sand Filtration for Recycling Greenhouse Hydroponic Nutrients and Water
- Determining the Role of Environmental Factors on Nutritional Content and Post-Harvest Quality of Leafy Greens

Director's Thoughts

It was an Exceptional Summer! ***By Gene Giacomelli***

Several momentous events manifested themselves during this past summer season. I do not refer to the pageantry of the China Olympics, or the engineering marvel of the safe arrival of the Phoenix Lander Mission to Mars. However, just as these events required development for many years, so too have three timely CEA-related events, which came to my attention this summer. These events resulted from a USDA Program, a University Faculty Search, and an International Workshop. These three are discussed below:

USDA Funding More Applied Production Research

The new farm bill (the Food, Conservation, and Energy Act of 2008) established a "Specialty Crop Research Initiative" to fund research including controlled environment agriculture. Also the USDA-NRI program, traditionally funding fundamental molecular or genomics research, changed its name to USDA Agriculture and Food Research Initiative, which will now allocate funds toward applied research in agriculture. This is exactly what is needed to help resolve the food production issues in the US. A stakeholder input meeting is organized for September 12th in Washington DC. For more information on SCRI and AFRI, see the following websites:

http://www.csrees.usda.gov/newsroom/news/2008news/07111_specialty_crop_rfa.html
http://www.csrees.usda.gov/business/reporting/stakeholder/an_stakeholder_afri.html

New Academic Position on Controlled Environments

The Horticulture Department at Iowa State University has recently advertised a faculty position for controlled environment specialist. What is especially unique about this position is that they are considering Agricultural Engineering degrees, among others, as prerequisite professional education for a faculty position in Horticulture. To date we know of no other comparable position in the US except for the one at UA-CEAC. We believe that this type of position and demands for hiring with multidisciplinary educational background will increase in the future. Therefore as we continue to develop the CEA program in Arizona for enhancing multi-disciplinary R&D in CEA, we are encouraged that the PhD graduates in CEA may have opportunities for academic positions at major universities in the US. For this we are highly optimistic about the future of CEA, and become even more dedicated to quality and creative work for improved education, research, outreach and economic development in the US and around the world.

The first International Workshop on Semi-arid Greenhouse

Coming to UA-CEAC! www.GHWorkshopAridRegions2008.org

It is a rare opportunity for a meeting to bring together world-class CEA scientists. The timing of the Workshop and its importance to agriculture could not have been better. Concerns for quality, nutritious, safe and abundant vegetable crop food products at low cost are now on the minds of many US consumers (and the USDA!). CEA is a supplementary food producing agricultural technology which has been competitive within the food production systems around the world for many decades, and more recently within North America.

(continued on page 10)

This Workshop will be a formal debut of the UA-CEA program in the international community! Go to this link for the scientific program:

<http://www.eventinterface.com/clients/ishs/links/Revised%20Scientific%20Program%20081308.pdf>. I thank the organizing committee for all the hard work in planning and presenting the Workshop, and look forward to the opening session on October 20th!

We all should look forward to the future!

CEAC is published quarterly by the Controlled Environment Agriculture Center, The University of Arizona College of Agriculture and Life Sciences.

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The Controlled Environment Agriculture Program is a collaboration among UA College of Agriculture and Life Sciences (CALs) departments, Centers and Institutes. It's programs are supported in part by State funding directed to the Agricultural & Biosystems Engineering, and Plant Sciences Departments.

Program Director: Dr. Gene Giacomelli

For more information or to subscribe, email us at connieh1@email.arizona.edu

Tell us what you want!

CEAC seeks your comments and suggestions for changes, new topics, and features in future editions of CEAC, the quarterly newsletter of the Controlled Environment Agriculture Center.

Contact Connie Hackathorn, Editor, at connieh1@email.arizona.edu or at 520/626-9566.

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