

**Project No and Title:** NCERA-101 Controlled Environment Technology and Use

**Period Covered:** 04-2011 to 04-2012

**Date Reporting:** October 14, 2012

**Annual Meeting:** September 10, 2012, Cambridge UK

**Meeting Program** is accessible though [http://www.controlledenvironments.org/meetings\\_past.htm](http://www.controlledenvironments.org/meetings_past.htm)

**Participants:**

George Adamson (Ontario Scientific), Lou Albright (Cornell), Tony Agostino (CSIRO Canberra, Australia), A.J. Both (Rutgers Univ.), Keri Bouchard (Conviron), David Brault (Quebec), Bruce Bugbee (Utah State Univ.), Jason Fatten (Ball Horticultural), Marc Ferguson (Illumitex), Julian Franklin (Rothamsted Research, UK), Gary Gardner (Univ. Minn.), Gene Giacomelli (Univ. Arizona), Richard Gladon (Iowa St. Univ.), Paul Gray (Illumitex), Dennis Greer (Charles Sturt University, Australia), William Healy (Ball Horticultural), Lynn Hummel (Univ. Wisconsin-Madison), Henry Imberti (Percival Scientific), Ramesh Kanwar (Iowa State Univ.), Bjorn Karlsson (Univ. Wisconsin-Madison), Rob Kerslake (Kerslake Assoc., Australia), Bruce Kettner (Biochambers), Yoshiaki Kitaya (Osaka University, Japan), Steven Kroft (Conviron), Mark Lefsrud (McGill Univ.), Peter Ling (Ohio State Univ.), Alec Mackenzie (Argus Controls), Gioia Massa (NASA Kennedy), Cary Mitchell (Purdue Univ.), Bill Mukanik (Conviron), Lisa Newman (Pioneer), Derrick Oosterhuis (Univ. of Arkansas), Devin Overly (Apogee Instruments), Nicolas Pelletier (Univ. Laval), Reg Quiring (Conviron), Sharon Reid (Conviron), Mark Romer (McGill Univ.), Erik Runkle (Mich. State Univ.), John Sager (EGC), Carole Saravitz (NCSU Phytotron), Flip Sheridan (Cycloptics), Gary Stutte (QinetiQ-NA-KSC), Garry Taylor (Weiss-Gallencamp), Marc Theroux (Biochambers), Marc van Iersel (Univ. Georgia), Nicole Waterland (West Virginia Univ.), John Wierzchowski (EGC), Dave Wilson (Stanford University), Youbin Zheng (Univ. of Guelph)

Executive Officers:

Chair: Marc van Iersel (Univ. Georgia), Vice Chair: Peter Ling (The Ohio State University), Secretary: Henry Imberti (Percival Scientific)

**Brief summary of annual meeting**

The NCERA-101 committee met in conjunction with the UK-CEUG (Controlled Environment Users Group) and the ACEWG (Australasian Controlled Environment Working Group) at Downing College, Cambridge, UK. This meeting represents the fourth international gathering of these CE groups. The meeting program and speaker abstracts are available at:

[http://www.controlledenvironments.org/meetings\\_past.htm](http://www.controlledenvironments.org/meetings_past.htm)

Marc van Iersel called the business meeting to order at 8:20 pm and asked the members for any announcements

Announcements:

- Gary Gardner announced two meetings:
  - International Plant Photobiological symposium will be held in early June in Edinburgh, Scotland.
  - International plant growth substance meeting will be held at Shanghai in late June.
- Marc van Iersel reminded the group that the meeting on challenges of vertical farming is coming soon. The meeting will be held in Maryland. Gary Stutte informed the group that registration is full but the meeting will be available via webcast.

- Marc van Iersel announced that the ISHS lighting conference, International Symposium on Light in Horticulture 2012, will be held at Wageningen, The Netherlands, October 15-18, 2012.

#### Administrator advisory report (Ramesh Kanwar)

- As far as the project is concern everything is in order and there are no pending issues to resolve.
- Report is due sixty days from today (Nov 10, 2012)
- Possibility the National Science Foundation and the European Union have a collaborative project for exploration.
- As known by many members Ramesh took a year off and went to India.
  - He is the Chairman and organizing an International conference. It is the 3<sup>rd</sup> Bhartiya Vigyan Sammelean and expo. If you like to attend after you get to Delhi he will be able to take care of the accommodations and travel expenses but he will not be able to take care of the expenses from North America to India and vice versa. This will be a wonderful opportunity especially for the Industry people.
  - The theme of the conference is Science for Global Development.
  - The Date: October 11 - 14, 2012.
  - The Location: LPU campus (Lovely Professional University Phagwara, Punjab , India)
  - Joint Organizers: Vijnana Bharati, Punjab Technical University Jalandhar (PTU) and Lovely Professional University Phagwara (LPU), in collaboration with Punjab State Council of Science and Technology.

#### Tony Agostino

- Proposed to have the next international meeting in Canberra, Australia in 2016. He yet needs the support of the host institution but he is getting closer to finalizing the details.
- Tony proposed a three day meeting with one day organized by each society. There will be a common theme around the meeting.
- There will be a post meeting tour of CE facilities in Canberra and possibly a visit to the Plant Accelerator in Adelaide.
- Proposed meeting dates would be September or as an alternative March/April.
- Mark Romer moved to accept the offer and it was second By Richard Gladon. The motion was accepted unanimously.

#### 2011 minutes report

Peter Ling reported that last year's meeting minutes are posted in the website and he asked the group for any inputs or comments. Richard Gladon moved to accept the minutes, no opposition to the motion.

#### Membership Report (Mark Romer)

The membership total remains constant at 152 members representing 106 institutions in 8 countries. (Appendix 1). Of note this year, we report the passing in February of our friend and colleague Dr Lynton Incoll (Univ of Leeds, UK). Lynton made significant contributions to our group, most notably by directing the preparation and publication of 3 sets of Reporting Guidelines and in his role as the principal organizer of the first International CE meeting in Norwich in Sept 2001. The UK meeting led

to subsequent international meetings in Australia (2004) and USA (2008). In 2008, the NCERA-101 group awarded Lynton the “Significant Contributor” award, an honour he greatly appreciated. In the past year we have had many new requests to join our group, particularly from industry organizations. The flurry of forum activity on Vertical farming brought many requests as well as the arrival in the marketplace of numerous LED manufacturers who are hunting for a new markets and exposure for their products. Our historical policy has been to allow any interested individual or corporation to join the group. This past year, I have begun insisting that interested parties attend at least one annual meeting before requesting to join. On the flip side, quite a few member companies & individuals do not participate at our meetings – some have never attended a meeting or have not attended in more than 5 years. I would like the membership to discuss the issue of criteria for adding and removing members at the next annual meeting in Purdue (March 2013).

The following points will be considered for discussion:

- What criteria are needed for joining NCERA-101.
- Must prospective members attend at least one meeting?
- Should graduate students be added to the roster?
  
- Do we include any and all industry members who wish to join?  
or do we select companies whose products are linked to CE research?
- Should industry members be assigned a liaison within the group to guide them
  
- Under what criteria should members be removed from the membership list?  
(Non-attendance at meetings; No submission of annual reports or funding support)  
and after how many years ?

Ramesh asked to consider showing the USDA that this is a growing group. Mark understands Ramesh point but agrees with Carole’s input that we do not want industries to use our group and web-site as a source of free advertising.

#### New member introduction

- Nicole Waterland, West Virginia University. Nicole previously attended in 2008 as a graduate student. Works on stress physiology.
- Bjorn Karlsson, University of Wisconsin Madison. Bjorn represents the Biotron.

#### Web-site report (Carole Saravitz)

- Carole reported that it has been a quiet year for the website.
- For general knowledge the website is:
  - Hosted by NC State without commercials or any advertisement on the sides
  - Main site is: [controlledenvironments.org](http://controlledenvironments.org) but also if you type NCR-101 or NCERA-101 will pop-up to the same site
  - Space: we have 2100 Mbyte.
  - At the bottom it says that NC State hosts the site which is the closest thing to advertisement that we have.

- Some of the things we are doing lately are advertising the current positions. Please remind Carole when the position is filled so she can remove it.
- Upcoming meeting information is also in the website.
- What do we want to do in the future with regards to Biotronics Journals sent by Jonathan? She was going to put a link to access them.
- Carole asked if there are any suggestions of things we would like to see?
  - Erik Runkle asked if we track the number of visitors, number of users and number of countries visiting our site. Carole agrees that it is a good idea and asked the group for a good counter. Marc recommended Google analytics.
  - Ramesh suggested adding to the site new things happening in this area, new technologies and new publications. Mark Romer says that in order to accomplish the task we will need a volunteer because once the message spreads out it may become a large task.
  - Alec Mackenzie asked if Carole has a current list for posting conference information.
  - At the moment Carole asks to send an e-mail with a please post with all the complete information of the conference.
  - Gary Stutte expressed that he is personally very happy with the website the way it is. It has exactly what he needs and it serves his needs very well.
- Marc van Iersel thanked Carole for her job and the group showed appreciation for her job with the website. Carole acknowledged Mark Romer's help.

#### Future meetings

Marc van Iersel asked Cary Mitchell for the 2013 meeting update, which will be held at Purdue University during the spring break. March 9-12, 2013. Cary mentioned that Roberto Lopez is helping to organize the meeting as well as the University conferences. At the moment they have in the agenda a tour of Dow Agro.

2014 meeting is tentative in Alaska but Meriam Karlsson asked for a back-up plan just in case. Marc van Iersel volunteered to be the back-up if Meriam can not pull it off.

Marc van Iersel asked if anybody is interested in organizing the 2015 meeting, Mark Romer talked about the possibility of having a joint meeting with the AERGC since they expressed interest and they have a lot of common talent with our group and we also share the same ideas and some of the same people. The only challenge is the schedule coordination. Mark says it is a natural fit, the meeting attracts 70 to 80 people. Carole thinks it is a great idea, Marc van Iersel said that we do not need to make a decision at this meeting but it should be discussed at the Purdue meeting. Marc van Iersel asked the members again to consider the organization of the meeting if you are at a location that hasn't held the event for a while.

#### Report on the past meeting at ISU (Richard Gladon)

There were 73 members attending the meeting. Final financial report showed a total net income of \$8761 which will go to the NCERA-101 instrument account. The point that Richard makes is that of the net income, which was \$6800, was from contributions of our friends, the exhibitors. Richard expressed his gratitude to the exhibitors for the financial contributions that allows the group to enjoy things otherwise not possible.

Gary Gardner suggested using those funds to pay for the attendance of graduate students. Marc van Iersel pointed out that the discussion with regards to the funds in the account could be a very lengthy one and suggested we talk about this subject at the Purdue meeting.

Mark Romer mentioned that the policy for meeting organizers has been to try to break even but also reminded the attendees that portion of the money is used for the Poster competition.

Final comment from Richard is that he will be retiring June 30<sup>th</sup> 2013 and the Purdue meeting will be his last meeting.

#### Election of new secretary

Marc van Iersel presented the Nominating Committee's recommendation of Meriam Karlsson as the incoming secretary candidate and solicited other nominations from the floor. With no other nomination Gary Stutte motioned to accept the nomination, Gioia Massa seconded, and was accepted unanimously. Marc van Iersel asked the floor for any new business and since there were no responses to the floor he proceeded with his last duty as a Chair. At 9:18 pm Marc passed the gavel to Peter Ling and congratulated him for becoming the new Chair. Peter thanked Marc for his leadership and hard work and asked the floor for a round of applause.

Bruce Bugbee motioned to adjourn the meeting at 9:20 pm Gary Stutte seconded, and approved by the attendees.

## Appendix A

### NCERA-101 Membership Summary - June 2012 Mark Romer, *List Curator*

<u>Membership Number</u> .....	March 2011 .....	150
	June 2012 .....	152
• Additions .....		13
• Deletions.....		11
• Net Gain(Loss) .....		2

<u>Membership Composition</u>	<u>Institutions</u>	<u>Members</u>
• Phytotrons & Controlled Environment Facilities.....	12.....	18
• University Departments, Agr. Exp. Stations.....	53.....	77
• Government Organizations & Contractors .....	13.....	14
• Industry Representatives .....	28.....	42
• Independent .....		1
Total Number of Institutions .....	106	
Total Number of Members .....		152

#### New Institutions

##### USA

- C2 Development
- DuPont Pioneer
- Harvard University, Department of Organismic and Evolutionary Biology
- Illumitex Inc.
- Lumigrow Inc.

## **NCERA-101 Accomplishments and Impacts**

(Complete station reports can be viewed on the NCERA-101 website)

At the University of Georgia wireless soil moisture sensors networks have been installed in two commercial nurseries. These sensor networks provide growers with real-time data on substrate water content and environmental conditions in their nursery. In addition, the accompanying software allows growers to automate irrigation based on substrate water content measurements. To date, this automated irrigation has resulted in significant time savings, reduced disease pressure, better plants, and, in one case, a much shorter production cycle. When sensor-controlled irrigation was used to grow a crop of *Gardenia jasminoides* 'Heaven Scent', the production period was shortened from the normal 14 months to only 9 months. In addition, no plants were lost due to root diseases, which typically results in losses of 20 – 30% of the crop (and in some cases 90%). The shorter production cycle and reduced plants losses resulted in an increase in profit of approximately \$1/ft<sup>2</sup>.

University of Arizona (Dr. Kacira) developed multi-camera based computer vision guided crop sensing and monitoring system for crop diagnostics. The monitoring system uses a color, NIR and thermal camera to acquire and process canopy images ultimately providing both greenhouse aerial and canopy based information in a web based decision support platform to help grower for improved production management. The system is currently being evaluated with experiments. They also have developed a complete computational fluid dynamics model including turbulence model for air flow, porous media model for canopy existence, evapotranspiration model for canopy-greenhouse mass and energy exchange, phase change model for high pressure fogging to evaluate climate uniformity for naturally vented greenhouse equipped with high pressure fogging. The model can be used for providing recommendations for various installations and operational characteristics of high pressure fogging systems in greenhouse for cooling.

As previously reported in 2010, Maryland is leading a Specialty Crops Research Initiative (SCRI) Grant to investigate Precision Irrigation and Nutrient Management for Nursery, Greenhouse and Green Roof Systems, using Wireless Sensor Networks. The SCRI-MINDS project is a 5-year project funded by USDA-NIFA and brings together scientists, engineers and economists from five universities (Maryland, Carnegie Mellon, Georgia, Colorado State and Cornell) and two companies (Decagon Devices and Antir Software), to develop and deploy smart sensor networks for specialty crop growers, and provide producers with real-time information to make better irrigation decisions every day. Full activity reports for years 1 and 2 can be accessed from <http://smart-farms.net/impacts>.

McGill University, located in Quebec, Canada, has been researching in two target areas with the first focusing on identifying the potential of greenhouse heating using wood pellets and the second investigating light emitting diodes for plant production. Projects were completed in both areas with the construction and testing of a wood pellet furnace and a full greenhouse scale LED supplemental lighting experiment on hydroponic tomato.

Research has continued at the University of Arkansas to study the effects of high temperature and drought stress on reproductive development in cotton in controlled environment conditions. These studies have shown the extreme sensitivity of pollen tube growth to high temperature, and the manner in which the cotton flower is buffered from water deficit compared to the adjacent leaves. These results have helped explained the yield losses and yield variability experienced by Arkansas farmers.

The USDA-ARS in Toledo, Ohio released the Virtual Grower 3.0 software to be compatible with Mac, Linux, and 64-bit processors; it includes plant scheduling, and dual heating systems. Over 12,000 copies have been distributed since the original release of the software.

The University of Guelph in Ontario, Canada filed a patent for rapid production of plants for green roof installation and erosion control, suggests that Aqueous ozone can be applied directly to plants (tomato) in drip irrigation, has evidence to suggest that liverwort control can be achieved using aqueous ozone in irrigation solution and developed a green roof research website (<http://www.ces.uoguelph.ca/greenroof/>)

Kennedy Space Center reports a small plant growth chamber called “VEGGIE”, for growing vegetables on the International Space Station is being built by ORBITEC, Madison, WI and is scheduled for a space flight demonstration beginning in Aug 2013. KSC and ORBITEC will team up to conduct a verification experiment to grow lettuce on the International Space Station.

Cornell University has continued a series of workshops and student internships to train potential employees, managers, and owners of Controlled Environment Agriculture facilities. Three workshops have been presented to secondary school teachers, six to the general public, three for current greenhouse operators, and three for students. Two students completed internships in hydroponics during the summer of 2012. Cornell University has also continued to field test (beta test) controller in a commercial greenhouse that implements the daily light integral control algorithm patented by Cornell. Control suitability will continue to be monitored and quantified during the coming year. Lastly, the Cornell CEA website ([www.cornellcea.com](http://www.cornellcea.com)) has been significantly updated and continues to receive positive responses from users.

Rutgers New Jersey Agricultural Experiment Station continues to work through operating and maintenance challenges associated with their landfill gas fired microturbine installation at the 1-acre NJ EcoComplex Research and Demonstration Greenhouse. A doctoral student is developing an operational decision support system to manage the electricity generated: use onsite (supplemental lighting for greenhouse tomatoes), export to the utility grid (additional income), or a combination of the two.

## **Publications:**

### NCERA 101 Member Publications

In addition to their efforts above, the NCERA 101 group had over 170 reports either published or accepted for publication since the last meeting. The following publication list of NCERA-101 contributors compiled for station reports and does not include publications from non-reporting stations.



- Adams, C., J. Frantz, and B. Bugbee. 2012. Macro- and micro-nutrient release characteristics of three polymer-coated fertilizer technologies: theory and measurement. *J. Plant Nutr. Soil Sci.* In press.
- Albright, L.D. 2012. Vertical Greenhouses. Presented at the 2012 annual meeting of the AERGC, Toronto, Canada.
- Andiru, G., C.C. Pasian, J.M. Frantz, and M.L. Jones. 2012. Greenhouse production of impatiens wallerana using a controlled release fertilizer produces quality finished plants with enhanced garden performance. *J. Hort. Sci. & Biotech.* In press.
- Andiru, G., C. Pasian, J. Frantz, and M. Jones. 2011. How much water and nitrogen is wasted when a hose is used? *OFA Bulletin.* 930:17-18.
- Astacio, M.G. and M.W. van Iersel. 2011. Concentrated exogenous abscisic acid drenches reduce root hydraulic conductance and cause wilting in tomato. *HortScience* 46:1640-1645.
- Astacio, M.G. and M.W. van Iersel. 2011. Determining the effects of abscisic acid drenches on evapotranspiration and leaf gas exchange of tomato. *HortScience* 46:1512-1517.
- Astacio M.G. and M. van Iersel. 2011. Unexplained wilting of tomatoes after exposure to large doses of exogenous abscisic acid (ABA). *Proceedings of the SNA research conference* 56:28-34.
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- Barnes, J., B.E. Whipker, I. McCall, and J. Frantz. 2011. Characterization of nutrient disorders of *Primula acaulis* 'Danova Rose.' *Acta Hort.* 891:77-83.
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- Bayer, A. J.M. Ruter, M. Chappell, and M. van Iersel. 2011. Growth of *Hibiscus acetosella* 'Panama red' in response to sensor controlled irrigation in two outdoor nursery settings. 2011 Annual conference of the American Society for Horticultural Science. Waikoloa, HI.
- Blanchard, M.G., E.S. Runkle, and J.M. Frantz. 2011. Energy-efficient greenhouse production of *Petunia* and *Tagetes* by manipulation of temperature and photosynthetic daily light integral. *Acta Hort.* 893:857-864.
- Blanchard, M.G., E.S. Runkle, A.J. Both, and H. Shimizu. 2012. Greenhouse energy curtains influence shoot-tip temperature of new guinea impatiens. *HortScience* 47(4):483-488.

- Boscheri, G., M. Kacira, L. Patterson, G. Giacomelli, P. Sadler, R. Furfaro, C. Lobascio, M. Lamantea, L. Grizzaffi. 2012. Modified energy cascade model adapted for a multicrop lunar greenhouse prototype. *Advances in Space Research*, 50: 941-951.
- Both, A.J., R. Hansen, and M. Kacira. 2012. Hydroponics give growers control. Article is part of the Water Wisely series in *Greenhouse Grower Magazine*. May issue.
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