RUTGERS
New Jersey Agricultural Experiment Station

REPORT FOR THE NCERA-101 MEETING, September 11-14, 2022

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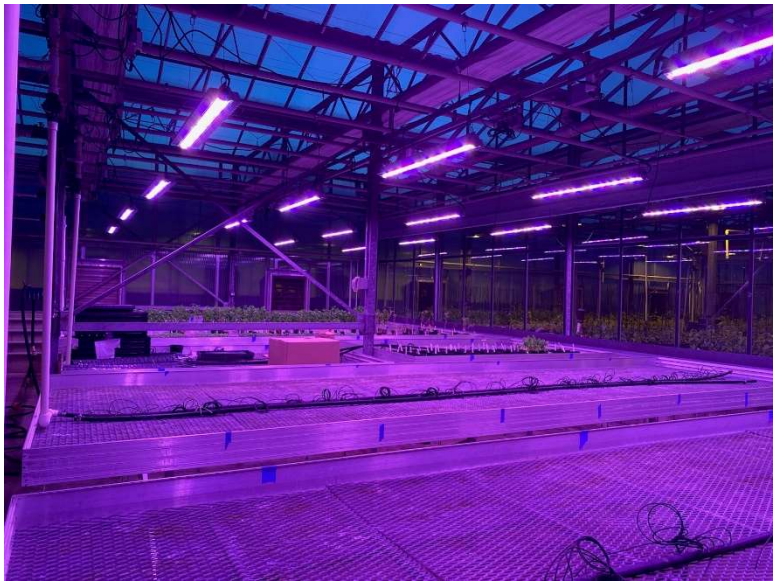
1. New Facilities and Equipment



The first sections of the NJ Experiment Station Research Greenhouse were outfitted with LED fixtures (GE Arize Element L1000, PKB spectrum: 15.5% Blue, 15% Green, 69.5% Red). These 600 W LED fixtures are replacing 400 W mogul base HPS fixtures. The average PAR intensity across the benches shown (564 ft^2) was 220 µmol/(m^2s), n = 564, St. dev. = 32, min = 132, max = 266). The calculated uniformity metric for the installation shown was 0.85 (1 – St. dev./average).

2. Unique Plant Responses
None.

3. Accomplishment Summary
We continue to evaluate a variety of lamp fixtures for light output, light distribution and power consumption using our 2-meter integrating sphere and a small darkroom. We are continuing to work on a comprehensive evaluation of ventilation strategies for high tunnel crop production (David Lewus). We are continuing our work using life cycle assessment tools to assess the environmental impacts of switching from high-pressure sodium lighting to LED lighting (Farzana Afrose Lubna).

4. Impact Statement
Nationwide, Extension and NRCS personnel and commercial greenhouse growers have been exposed to research and outreach efforts through various presentations and publications. It is estimated that this information has led to proper designs of controlled environment plant production facilities and to updated operational strategies that saved an average sized (1-acre) business a total of $25,000 in operating and maintenance costs annually. Crop lighting presentations and written materials on controlled environment crop production techniques have been prepared and delivered to local and regional audiences. Greenhouse growers who implemented the information resulting from our research and outreach materials have been able to realize energy savings between 5 and 30%.

5. Published Written Works

Book chapters:

Both, A.J. 2022. Greenhouse energy efficiency and management, Chapter 11. In *Regional Perspectives on Farm Energy* (D. Ciolkosz, Ed.). Springer, Switzerland. pp. 85-93. https://link.springer.com/book/10.1007/978-3-030-90831-7

Both, A.J. 2022. On-farm energy production – Solar, wind, geothermal, Chapter 12. In *Regional Perspectives on Farm Energy* (D. Ciolkosz, Ed.). Springer, Switzerland. pp. 95-105. https://link.springer.com/book/10.1007/978-3-030-90831-7

Refereed journal articles:

Lewus, D.C. and A.J. Both. 2022. Using computational fluid dynamics to evaluate high tunnel roof vent designs. AgriEngineering 4(3), 719-734; https://doi.org/10.3390/agriengineering4030046

Lubna, F.A., D.C. Lewus, T.J. Shelford, and A.J. Both. 2022. What you may not realize about vertical farming. Horticulturae 8(4), 322. https://doi.org/10.3390/horticulturae8040322

Shelford, T.J. and A.J. Both. 2021. On the technical performance characteristics of horticultural lamps. AgriEngineering 3:716-727. https://doi.org/10.3390/agriengineering3040046

Refereed conference proceedings articles:

Llewellyn, D., T.J. Shelford, Y. Zheng, and A.J. Both. 2022. Measuring and reporting lighting characteristics important for controlled environment plant production. Acta Horticulturae 1337:255-264. https://doi.org/10.17660/ActaHortic.2022.1337.34

Shelford, T., A.J. Both, and N. Mattson. 2022. A greenhouse daily light integral control algorithm that takes advantage of day ahead market electricity pricing. Acta Horticulturae 1337:277-282. https://doi.org/10.17660/ActaHortic.2022.1337.37

Published abstracts of presentations delivered at professional meetings:

Brumfield, R.G., S. Arumugam, A.J. Both, M. Flahive Di Nardo, R. Govindasamy, D. Greenwood, J. Heckman, N. Polanin, A.A. Rouff, A. Rowe, and R. VanVranken. 2021. A successful educational program for women producers, beginning farmers, and military veterans that helped address farm risks during the COVID-19 pandemic. Presented at the 2021 Annual Conference of the American Society for Horticultural Science (ASHS), Hybrid, Denver, CO, August 5-9. HortScience 56(9) Supplement, S61. https://doi.org/10.21273/HORTSCI.56.9S.S1

Trade journal article:

Both, A.J. 2022. A quick look into LEDs. GrowerTalks. April Issue. pp. 50-51.

6. Scientific and Outreach Oral Presentations

Both, A.J. and N. Mattson. 2022. What to expect when you're selecting? Light systems and economics. Presentation at Cultivate'22, Columbus, OH. July 19.

Both, A.J. 2022. Agrivoltaics. Online presentation for members of Sustainable South Jersey. May 31.

Both, A.J. 2022. Review of greenhouse energy issues. Online presentation for the Greenhouse Grower School (Cornell Cooperative Extension of Orange County). February 9.

Both, A.J. 2022. Hydroponics. Online presentation for students at the Sojourner Truth Middle School, East Orange, NJ. January 28.

Both, A.J. 2022. Greenhouse design. Online presentation for the 5th Annual Urban Farmer Winter Meeting (University of Maryland Cooperative Extension). January 24.

Both, A.J. 2021. Sustainable crop production. Online presentation for students at Delaware Valley University. December 7.

Both, A.J. 2021. Energy conservation strategies for greenhouse crop production. Presentation at the Northeast Greenhouse Conference and Expo. Boxborough, MA. November 4.

Both, A.J. 2021. Focusing on sustainability: Crop production, soils and energy (Agrivoltaics as a solution?). Presentation for Annie's Project New Jersey: 10 Years of Empowering New Jersey Farmers. New Brunswick, NJ. November 4.

Both, A.J. 2021. Are LED lamps better for crop production in greenhouses? Narrated PowerPoint presentation for the Energy Answers for the Beginning Farmer and Rancher Project. Available at: https://farm-energy.extension.org/energy-answers-for-the-beginning-farmer-and-rancher/

Both, A.J. 2021. How can we improve energy efficiency in greenhouses? Narrated PowerPoint presentation for the Energy Answers for the Beginning Farmer and Rancher Project. Available at: https://farm-energy.extension.org/energy-answers-for-the-beginning-farmer-and-rancher/

Both, A.J. 2021. What alternative energy systems can be used in the greenhouse industry? Narrated PowerPoint presentation for the Energy Answers for the Beginning Farmer and Rancher Project. Available at: https://farm-energy.extension.org/energy-answers-for-the-beginning-farmer-and-rancher/

7. Other Relevant Accomplishments and Activities

Autonomous Greenhouse Challenge (Wageningen University and Research, the Netherlands)
Team Koala (led by Ken Tran, Koidra, Inc.) won the third edition of the Autonomous Greenhouse Challenge that focused on hydroponic lettuce production. The team received advice from Neil Mattson (Cornell University) and A.J. Both (Rutgers University). For a press release, see: https://www.wur.nl/en/newsarticle/familiar-face-leads-team-koala-to-win-the-autonomous-greenhouse-challenge-for-a-second-time.htm

ADVANCEA
A grant proposal submitted to the USDA-NIFA Specialty Crop Research Initiative program was recommended for funding and is scheduled to start in the fall of 2022. The 4-year project is led by Chieri Kubota (The Ohio State University) and the team consists of researchers from The Ohio State University, Rutgers University, Cornell University, and the University of Arizona. Commercial team members include Koidra, Inc. and Hort Americas. The full title of the project is: *Advancing controlled environment agriculture through data-driven decision making and workforce development*.

Agrivoltaics
NJ has ambitious renewable energy goals and has a history of promoting photovoltaics. A logical option would be to allow for more solar farming. However, solar farming typically takes the land out of agricultural production. In a small and densely populated state like NJ, that is a less attractive option. Raising the photovoltaic panels on taller posts and reducing their density would allow for a combination of agricultural production and electricity generation with photovoltaic panels. The NJ Agricultural Experiment Station and the state legislature have provided over $2M of funding to a team of researchers to develop a number of research and demonstration facilities at various university farms across the state. The team is planning to construct these facilities over the next year and will conduct experiments involving field and forage crop trials.