

**University of California, Davis 2024-2025 Station Report NCERA-101: Committee on Controlled Environment Technology & Use**

**Reporting Period:** April 2024-March 2025

Shamim Ahamed, Assistant Professor, Department of Biological and Agricultural Engineering, UC Davis.  
Email: [mahamed@ucdavis.edu](mailto:mahamed@ucdavis.edu)

Laura Cammarisano, Assistant Professor, Department of Plant Sciences, University of California, Davis,  
email: [lcammarisano@ucdavis.edu](mailto:lcammarisano@ucdavis.edu)

**✚ New Equipment and Facilities (sensors, instruments, and control systems purchased/installed)**

- **Controlled Environment Engineering (CEE) Lab:** We have bought several sensors for measurement of solar radiation, net radiometers, EC and pH meters, Campbell Scientific data loggers, Hobo sensors for temperature and RH, CO<sub>2</sub> sensors, and Guardian Sensors.

**✚ Accomplishment Summaries**

1. CEE Lab investigated the potential of ground source heat pumps and their hybrid configuration for combined heating and cooling of greenhouses under various climates.
2. We have conducted a study on the impact of far-red light on cilantro growth in an indoor vertical farming system under LED lighting.
3. We have also worked on global-scale modeling of greenhouse hydroponic lettuce production compared to open field production.
4. We have worked with local nursery greenhouse growers in California to provide technical assistance to improve their energy and water use efficiency.
5. Controlled Environment Horticulture (CEHO) Lab initiated an AES project to use CEA to develop nursery management practices for high-quality tomato transplants.
6. In addition, side projects are being performed to study water use in greenhouses, fertilizer concentration in closed-loop systems, and dynamic light applications in indoor farming.

**✚ Impact Statement**

1. The CEE lab organized several webinars on workforce development related to water and nutrient use efficiency in hydroponic production.
2. Dr. Ahamed presented activities related to indoor farming for high school students and educators to familiarize them with it.
3. Dr. Ahamed also presented the fundamentals of indoor farming for the summer workshop organized by CITRIS at UC Davis.
4. The CEHO Lab's projects propose precise management of the CEA technologies a) to develop optimized nursery practices for producing high-quality transplants, supporting more resilient and productive farming systems, b) to improve water use efficiency in greenhouses and the sustainable use of fertilizers and light in indoor farming, advancing the overall sustainability and resource efficiency of CEA systems.

 **Published written works**

**Refereed Journal Articles and Book Chapters**

○ **Journal Articles:**

**Controlled Environment Engineering Lab (Md Shamim Ahamed)**

1. Ahsan, T. A., Rahman, M. S., & Ahamed, M. S. (2025). Geothermal energy application for greenhouse microclimate management: A review. *Geothermics*, 127, 103209.
2. Meskher, H., Thakur, A., Hazra, S. K., Ahamed, M. S., Saleque, A. M., Alsahy, Q. F., ... & Lynch, I. (2025). Recent advances in applications of MXenes for desalination, water purification and as an antibacterial: a review. *Environmental Science: Nano*.
3. Akter, N., Cammarisano, L., Taylor, G., Naznin, M. T., Verdonk, J. C., & Ahamed, M. S. (2024). Impact of light spectral combinations on morphology, yield, and quality of indoor-grown cilantro. *Frontiers in Sustainable Food Systems*, 8, 1499954.
4. Thakur, A. K., Hazra, S. K., Saleque, A. M., Bhattarai, S., Hwang, J. Y., & Ahamed, M. S. (2024). Toward Sustainable Water Solutions: A Review of Nanomaterials for Solar-Driven Water Harvesting. *ACS ES&T Water*, 4(11), 4741-4757.

**Protected Horticulture Lab (Laura Cammarisano)**

1. Akter, N., Cammarisano, L., Taylor, G., Naznin, M. T., Verdonk, J. C., & Ahamed, M. S. (2024). Impact of light spectral combinations on morphology, yield, and quality of indoor-grown cilantro. *Frontiers in Sustainable Food Systems*, 8, 1499954.
2. Cammarisano, L., Frede, K., Graefe, J., Schreiner, M., Baldermann, S., & Körner, O. (2024, May). Pigment time-course of two lettuce cultivars in response to end-of-production blue-enhanced white light treatment. In X International Symposium on Light in Horticulture 1423 (pp. 47-54).

○ **Theses and Dissertations**

1. Omar Samara (2024). Evaluation of Agrivoltaic Systems for Enhanced Agricultural Resource Sustainability. PhD Thesis. (Co-Supervised, Shamim Ahamed)
2. Abir Ahsan (2024): Resource Use and Environmental Impacts of Stand-alone Geothermal Heat Pumps for Greenhouse Climate Control. MS Thesis. (Supervised, Shamim Ahamed)

○ **Book Chapters and Editorial**

Nothing in the last report period

○ **Symposium Proceedings, Oral and Poster Presentation**

1. Syed, S.; **Ahamed, M. S** (2024): Hybrid Model for Forecasting Lettuce Yield in Indoor Vertical Farming. ASHS Annual Meeting, September 27, 2024, Honolulu, Hawaii.
2. Islam, M. N., Inam, A. S., Thakur, A. K., **Ahamed, M. S.**, Ott, B., & Tabassum, S. (2024). A Cost-Effective Electrochemical Sensor for Real-Time Nitrate Monitoring in Hydroponics. *LPI Contributions*, 3065, 5102.
3. Kashif, M.; **Ahamed, M. S.** (2024). Potential of Climate-Smart PV Shade Screen Impact on Greenhouse Thermal Loads. ASABE Annual Meeting 2024, July 28-31, Anaheim, California.

4. Ahsan, T. M. A; **Ahamed, M. S.** (2024). Exploring Trade-offs in Thermal and Economic Performance Across Different Collector Technologies for Solar-Thermally Cooled Greenhouses. ASABE Annual Meeting 2024, July 28-31, Anaheim, California.
5. Ahamed, H.; Ahsan, T. M. A., M.; **Ahamed, M. S.** (2024). Evaluating the Energy Requirement of Indoor Container Farming across Diverse USA Climate Zones. ASABE Annual Meeting 2024, July 28-31, Anaheim, California.
6. Li, Z; Karimzadeh, S.; Ahamed, M. S. (2024). Detection of Calcium Deficiency in the Growing Stage of Lettuce Using Computer Vision. ASABE Annual Meeting 2024, July 28-31, Anaheim, California.
7. Ahsan, T.M.A; Ahamed, M. S. (2024). Hybrid Ground Source Heat Pump for Effectively Cooling and Dehumidifying Greenhouse Indoor Climate. ASABE Annual Meeting 2024, July 28-31, Anaheim, California.
8. Cammarisano L., Frede K., Graefe J., Schreiner M., Baldermann S., Körner O. (2025) Pigment time-course of two lettuce cultivars in response to end-of-production blue-enhanced white light treatment. Acta Horti - LightSym – 19-22 May 2024 – Seoul, Korea.