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

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

- **Controlled Environment Engineering (CEE) Lab:** We have developed two small prototype greenhouses to study smart greenhouse coverings and their impact on plants, as well as a pilot test bed for agrivoltaic research.

Accomplishment Summaries

1. CEE Lab investigated the fundamental concept of various solar technologies for energy harvesting, energy storage, and integration in CEA facilities. We also investigated the water harvesting fundamental for potential applications for water harvesting in CEA.
2. We have also worked for precision control and monitoring of aerial and rootzone environments with advancing sensing and artificial intelligence.
3. The watercress breeding program improves crop chemical composition and higher yield potential under artificial lighting conditions.

Impact Statement

1. The research outcomes for solar cell technology development will impact future research and technology adaptation for energy harvesting in greenhouses. The water harvesting research will enhance the circular economy concept by re-circulating the water within the CEA systems. The precision control and monitoring system will help reduce water and nutrient waste in hydroponic production.
2. Studying plant physiology and breeding for watercress will create a new dimension for growing medicinal and high-value crops in indoor facilities like vertical farming.

Published written works

Refereed Journal Articles and Book Chapters

Journal Articles:

Controlled Environment Engineering Lab

1. Saleque, A. M., Thakur, A. K., Saidur, R., Hossain, M. I., Qarony, W., Ahamed, M. S., ... & Tsang, Y. H. (2024). rGO coated cotton fabric and thermoelectric module arrays for efficient solar desalination and electricity generation. *Journal of Materials Chemistry A*, *12*(1), 405-418.

2. Nasrin, T., Mottakin, M., Selvanathan, V., Hossain, M. I., Shahiduzzaman, M., Islam, M. A., ... & Akhtaruzzaman, M. (2023). Performance optimization and defect studies of Pb-free CsSnBr3-based perovskite solar cells. *Materials Today Communications*, *37*, 107000.
3. Qarony, W., Hossain, M. I., Tamang, A., Jovanov, V., Shahiduzzaman, M., Ahamed, M. S., ... & Knipp, D. (2023). On the Potential of Optical Nanoantennas for Visibly Transparent Solar Cells. *ACS Photonics*, *10*(12), 4205-4214.
4. Rahman, M. S., Han, J., Ge, G., Ahamed, M. S., & Guo, H. (2023). Experimental evaluation of three different dehumidifiers for greenhouses in cold regions. *Applied Thermal Engineering*, *234*, 121324.
5. Chowdhury, M., Ahsan, T. A., & Ahamed, M. S. (2023). Assessment of health hazards of greenhouse workers considering UV exposure and thermal comfort. *Smart Agricultural Technology*, *5*, 100319.
6. Ahamed, M. S., Sultan, M., Monfet, D., Rahman, M. S., Zhang, Y., Zahid, A., ... & Achour, Y. (2023). A critical review on efficient thermal environment controls in indoor vertical farming. *Journal of Cleaner Production*, 138923.
7. Hosseini Monjezi, P., Taki, M., Abdanan Mehdizadeh, S., Rohani, A., & Ahamed, M. S. (2023). Prediction of Greenhouse Indoor Air Temperature Using Artificial Intelligence (AI) Combined with Sensitivity Analysis. *horticulturae*, *9*(8), 853.
8. Aleem, M., Sultan, M., Farooq, M., Riaz, F., Yakout, S. M., Ahamed, M. S., ... & Shahzad, M. W. (2023). Evaluating the emerging adsorbents for water production potential and thermodynamic limits of adsorption-based atmospheric water harvesting systems. *International Communications in Heat and Mass Transfer*, *145*, 106863.
9. Asfahan, H. M., Sultan, M., Farooq, M., Riaz, F., Ibrahim, S. M., Ahamed, M. S., & Imran, M. (2023). Performance Evaluation of Phenol-Resin-Based Adsorbents for Heat Transformation Applications. *Materials*, *16*(15), 5262.

Taylor Lab

10. Hibbert, L. E., Qian, Y., Smith, H. K., Milner, S., Katz, E., Kliebenstein, D. J., & Taylor, G. (2023). Making watercress (Nasturtium officinale) cropping sustainable: genomic insights into enhanced phosphorus use efficiency in an aquatic crop. *Frontiers in Plant Science*, *14*, 1279823.
11. Qian, Y., Hibbert, L. E., Katz, E., Smith, H. K., Kliebenstein, D. J., & Taylor, G. (2023). Watercress yield and quality vary depending on both genotype and environment: Results from highly contrasting growing systems of California and UK. *Scientia Horticulturae*, *319*, 112154.
12. Nikol, V., Hancock, R. D., Becerra-Sanchez, F., Qian, Y., & Taylor, G. (2023). Characterization of a new dwarf watercress (Nasturtium officinale R Br.)'Boldrewood'in commercial trials reveals a consistent increase in chemopreventive properties in a longer-grown crop.
13. Dehnavi, M. M., Damerum, A., Taheri, S., Ebadi, A., Panahi, S., Hodgin, G., ... & Taylor, G. (2024). Population genomics of a natural Cannabis sativa L. collection from Iran identifies novel gen

Book Chapters and Editorial:

1. Asif, M., Sultan, M., Khan, Z. M., Ahmad, S., Khan, M. U., Ahamed, M. S., & Shamshiri, R. R. (2023). Disaster Risk Reduction Through Agricultural Engineering Technologies. In *Disaster Risk Reduction in Agriculture* (pp. 489-507). Singapore: Springer Nature Singapore.

Symposium Proceedings, Oral and Poster Presentation

1. Ahsan, T.M.A.; Karimzdeh, S.; Kashif, M.; **Ahamed, M. S**. (2023). Geothermal heating and cooling for sustainable nursery production in greenhouses. ASABE Annual Meeting, July 9-12, Omaha, Nebraska.
2. Karimzdeh, S.; Chowdhury, M.; **Ahamed, M. S.** (2023). Fault Detection and Diagnosis of Hydroponic System using Intelligent Computational Model. ASABE Annual Meeting, July 9-12, Omaha, Nebraska.