

New facilities and equipment

- Sixteen small form factor (300 x 300 x 500mm) multispectral LED grow boxes were designed and built in-house and have been deployed in one of our walk-in plant growth chambers
- A Bambu Lab X1 Carbon 3D printer was added to our 3D printer collection
- Acquired four California Analytical Instruments Inc Model 702LX NDIR Gas Analyzers (CO₂ and O₂) to replace our now ancient California Analytical Model 300 gas analyzers

Activities and accomplishment summaries

- A collaboration between the Canadian Space Agency, Canadensys Aerospace, McGill University, and the CESRF resulted in the development of a prototype lunar lander for plant production. Plant production was successfully tested under reduced atmospheric pressure (57 kPa) for a period of one lunar day/night cycle (28 Earth days)
- Over the past year, the CESRF has been collaborating with McGill University, the Canadian and German space agencies, and aerospace company Canadensys to develop the next generation ground test demonstration system for a Lunar greenhouse known as the LAM-GTD (Lunar Agricultural Module Ground Test Demonstrator). The system is being designed to operate at a reduced atmospheric pressure of 57 kPa, the proposed atmospheric pressure for Lunar base operations.

Published written works since our last report

Theses and dissertations

Brockett, R. 2023. Ostrich Fern Fiddlehead (*Matteuccia struthiopteris* L. Todaro) Cultivation: Controlled Environment Requirements and Growth Cycle Compression. MSc. School of Environmental Sciences, University of Guelph, Guelph, Ontario

Silver, J. 2025. Application of an Algae-based Biopolymer in Deep Water Culture of Lettuce (*Lactuca sativa*). MSc. School of Environmental Sciences, University of Guelph, Guelph, Ontario

Stochnoff, J. 2023. Lighting for Bush Bean (*Phaseolus vulgaris*) Production in a Controlled Environment. PhD. School of Environmental Sciences, University of Guelph, Guelph, Ontario

Terlizzese, D. 2024. Characterizing and Improving the Light Environment in Greenhouse Fruiting Vegetable Crops. MSc. School of Environmental Sciences, University of Guelph, Guelph, Ontario

Wake, M. 2024. Refining Environmental Parameters for Wheat (*Triticum aestivum* L.) Production in Vertical Farms. MSc. School of Environmental Sciences, University of Guelph, Guelph, Ontario

Scientific manuscripts

- Ahrens, A. 2024. Photoperiod and Fertigation Strategies for Controlled Environment Cannabis Production. MSc. School of Environmental Sciences, University of Guelph, Guelph, Ontario
- Ahrens, A., Llewellyn, D. & Zheng, Y. 2024. Longer photoperiod substantially increases indoor-grown cannabis' yield and quality: A study of two high-THC cultivars grown under 12 h vs. 13 h days. *Plants*, 13(3), 433; <https://doi.org/10.3390/plants13030433>.
- Dsouza, A., Dixon, M., Shukla, M., & Graham, T. 2025. Harnessing controlled-environment systems for enhanced production of medicinal plants, *Journal of Experimental Botany*, 76:76–93, <https://doi.org/10.1093/jxb/erae248>
- Dsouza*, A., Newman, L., Graham, T., Fraser, E.D.G., 2023. Exploring the landscape of controlled environment agriculture research: A systematic scoping review of trends and topics. *Agric. Syst.* 209, 103673.
- Kong, Yun, and Youbin Zheng. 2024. "Diverse Flowering Response to Blue Light Manipulation: Application of Electric Lighting in Controlled-Environment Plant Production" *Horticulturae* 10, no. 6: 578. <https://doi.org/10.3390/horticulturae10060578>
- Kong, Y., & Zheng, Y. 2023. Magic blue light: A versatile mediator of plant elongation. *Plants*, 13(1), 115.
- Ly, V. & Zheng, Y. 2025. Alleviation of Chilling Injury in Postharvest Sweet Basil (*Ocimum basilicum* L.) with Silicon and Abscisic Acid Applications. *Agriculture* 2025, 15(6), 643; <https://doi.org/10.3390/agriculture15060643>
- Marie, T. R., Leonardos, E. D., Rana, N., & Grodzinski, B. 2024. Tomato and mini-cucumber tolerance to photoperiodic injury involves photorespiration and the engagement of nighttime cyclic electron flow from dynamic LEDs. *Frontiers in Plant Science*, 15, 1-21. DOI 10.3389/fpls.2024.1384518
- Moher, M., Llewellyn, D., Golem, S., Foley, E., Dinka, S., Jones, M., & Zheng, Y. 2023. Light Spectra Have Minimal Effects on Rooting and Vegetative Growth Responses of Clonal Cannabis Cuttings. *HortScience*, 58(2), 215-221. <https://doi.org/10.21273/HORTSCI16752-22>
- Qingming Li, David Llewellyn, Yun Kong, and Youbin Zheng. 2025. Narrowband blue LEDs with different peak wavelengths similarly promote seedling elongation and have greater promotion effects than ultraviolet A and far-red in two species of Brassicaceae. *Canadian Journal of Plant Science*. 105: 1-13. <https://doi.org/10.1139/cjps-2024-0108>
- Terlizzese, D., Lanoue, J., Hao, X., & Zheng, Y. 2024. Light Environment and Photosynthetic Capacities of Leaves at Different Locations within Eggplant Canopies in a Greenhouse in Ontario, Canada. *HortScience*, 59(5), 678-683. <https://doi.org/10.21273/HORTSCI17642-23>

Book chapters

- Graham, T. 2024. The promise and pitfalls of controlled environment agriculture (CEA) - technological, biological, and societal considerations for an evolving agricultural landscape. In *Future Food Systems: Exploring Global Production, Processing, Distribution and Consumption*. Editor(s): Rickey Y. Yada, Rene

Van Acker, Martin Scanlon, David Gray. Academic Press, Pages 43-54 <https://doi.org/10.1016/B978-0-443-15690-8.00023-0>

Leonardos, E.D., Marie, T.R., & Grodzinski, B. (2024). Quantifying Daily Growth Patterns Non-destructively Using Whole-Plant CO₂ and H₂O Exchange Is a Powerful Tool for Phenotyping. In Handbook of Photosynthesis. Chapter 24: pp 474-497; edit M Pessarklia. Published, CRC Press, Boca Raton, FL., USA

Marie, T. R., Leonardos, E. D., & Grodzinski, B. (2024) Using Whole-Plant Diurnal Transpiration and Remotely Sensed Thermal Indices to Phenotype Circadian Rhythm Traits. In Handbook of Photosynthesis. Editor; Pessarklia, M. Chapter 25: pp. 498-509. CRC Press, Boca Raton, FL., USA14. Lopez, R.G. 2023. Photoperiod management- Flower induction of specialty cut flowers. Greenhouse Product News 33(10): 6–8.