UW College of Agriculture and Natural Resources

# Global Perspectives Grant Program

## Project Report Instructions

**COVER PAGE**

**Trip Date**: **_03/15/2025 – 04/04/2025_____**

**Principle Investigator(s)_____Guadagno_____**

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**Project Title from Application:** Empowering Early Stress Detection with AI: A Global Plant Phenotyping Initiative

**Non-technical summary (max 1500 characters plus spaces):**

This project focuses on improving how we detect when plants, especially cotton, are under water stress. By using advanced imaging tools and artificial intelligence, researchers study plant traits—like color and temperature changes—to spot early signs of drought or water shortage. The work involves collaboration between the University of Wyoming and research partners in Italy, using both real plant measurements and computer analysis. The goal is to better understand how plants respond to limited water, support sustainable farming, and strengthen the University of Wyoming's role in global agricultural research and education.

1. **Main results of activities planned in the proposal.**

Plant water dynamics represent the changes in plant water balance in time and space. Our global project tested the suitability of early detection of plant water limitations via anomaly detection and deep autoencoders. Through the integration of physiological, phenomic, and computer vision approaches we started designing AI (deep learning) to test models aimed at the early detection of drought stress.

In particular, we investigated whether it is possible build an anomaly detector via unsupervised training of deep autoencoders on large number of images from plants watered at field capacity. The knowledge gained from well-watered plants will be used to test anomaly detectors to predict plant response to the onset of water limitations.

We ran replicate water limiting experiments using cotton plants (Gossypium hirsutum L.) at the Plant Growth & Phenotyping Facility at University of Wyoming (UW) and at the Agrobios in Italy to provide the necessary dataset to test the anomaly detectors and test the AI models. Plants were imaged using an RGB and a thermal camera (FLIR, T560) mounted on a gantry system at UW and through a high-throughput system in Italy (Pictures). Ground-truthing of imaging data using leaf-level physiological measurements of leaf absorbance, chlorophyll a fluorescence, and water content on cotton plants was conducted throughout the experiments.

The collected data formed the core data set for future agricultural imaging model implementation across all institutions involved in the consortium. It will also serve for a future publication aiming to crack the physiological code to early detection of plant stress via imaging

techniques. Coupling of high-throughput and physiological phenotyping will allow for a long-needed assessment of correlations between leaf- and canopy-level physiology in plant science

2. **Describe any future plans**

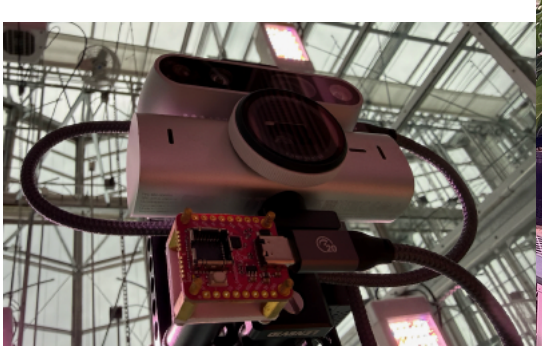
The consortium now hopes to first publish the collected results as it did in 2023 https://par.nsf.gov/servlets/purl/10527951 - when a first global grant was awarded to this same group. Also, we would like to test the models on a variety of different crops to assess the adaptability and accuracy of the AI process developed. For the second year, this consortium showed itself capable of fruitful collaboration and we hope that future support might be possible to sustain long-lasting relationship with the Italian entities.

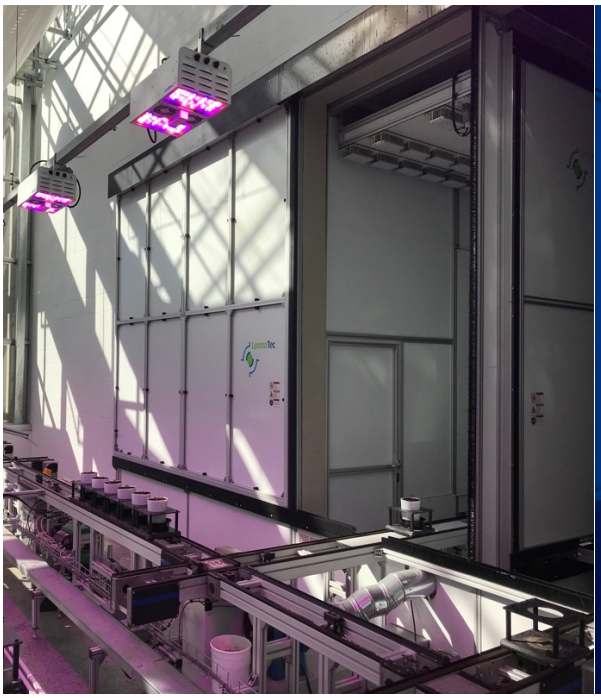
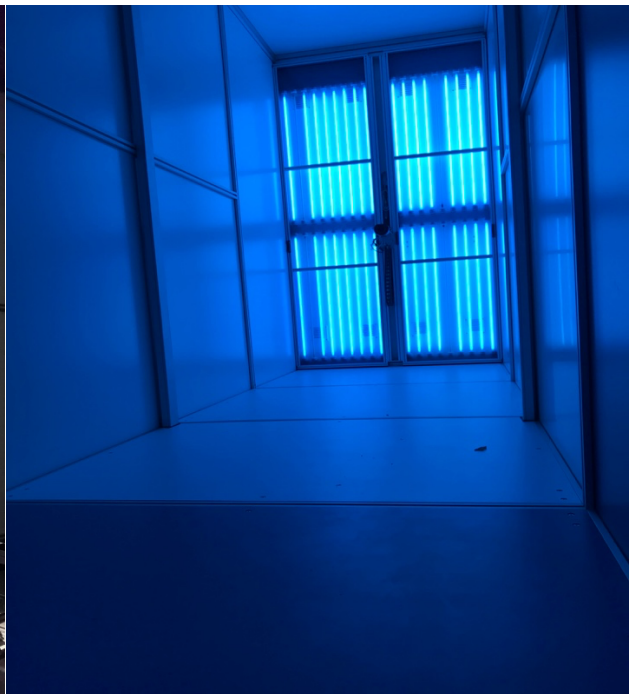
3. **Outline potential impacts to a) the College of Agriculture, Life Sciences and Natural Resources, b) the University of Wyoming, and c) the State of Wyoming**

a) Our project is strategically aligned with CALSNR mission as an essential piece of our land-grant institution, dedicated to proactively fostering a sustainable future for Wyoming's agriculture. It directly supports our latest initiatives in Controlled Environment Agriculture (CEA), addressing critical challenges in the region where approximately 33% of the population resides over a mile from grocery stores, with many rural residents living over 20 miles away.

b) The Science Initiative at UW is poised to enhance world-class research and education, reinforcing the foundations of Wyoming's economy and working synergistically with initiatives like the Wyoming Innovation Partnership, which also aims to cultivate a skilled workforce in CEA. This project not only facilitates the implementation of ongoing phenotyping instrumentation and training at the facility but also enhances international research opportunities and student recruitment.

c) Strengthening international collaborations is critical for stimulating student interest, creating teaching opportunities, and advancing workforce development in agricultural phenomics—an emerging interdisciplinary field that is crucial for building a sustainable future for all agricultural stakeholders, particularly in ensuring an economically viable future for the State of Wyoming.



4. Photos 1) RGB camera on in house gantry system 2) Cotton plants growing in the greenhouse 3) Agrobios high-throughput phenotyping facility 4) Measurement camera 5) PI Guadagno and Italians collaborators on the project after work gathering

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**QUESTIONS?** Contact Tori Henderson in the Agricultural Experiment Station office at aes@uwyo.edu or (307) 766-4223.