## USDA-NIFA:

# Multimodal Sensing for Early Detection and Real-Time Correction of Water Stress and Nutritional Needs in Plants

Michael Daniele, Alper Bozkurt, Thomas Rufty, Edgar Lobaton

## Challenge:

- By correlating multiple phenotypic expressions, we will be able to identify and quantify the underlying stressor (water stress and/or nutrient deficiency), such that the quantity and timing of water and fertilizer delivered can be continuously optimized.

- Develop hardware that is non-destructive to the "plants-under-test" to provide reliable, longitudinal data for analysis.
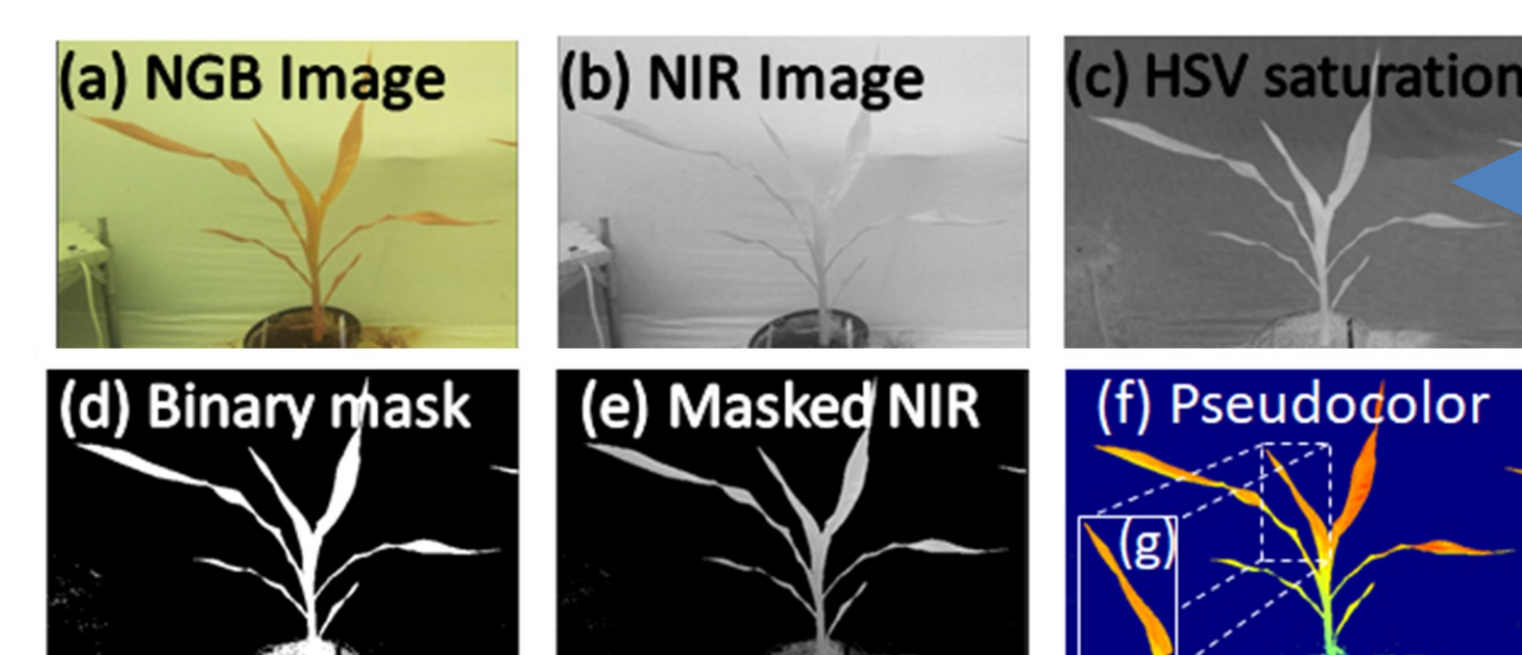
## Solution:

- A combination of novel and low-cost electrochemical (impedance), mechanical (growth) and optical (plant color) sensors placed on or near a plant for continuous monitoring of its growth to close the loop.

- Developed "safe-on-plant" electrodes, new algorithms for multispectral imaging, fully-integrated microsystems for remote plant electrophysiology.
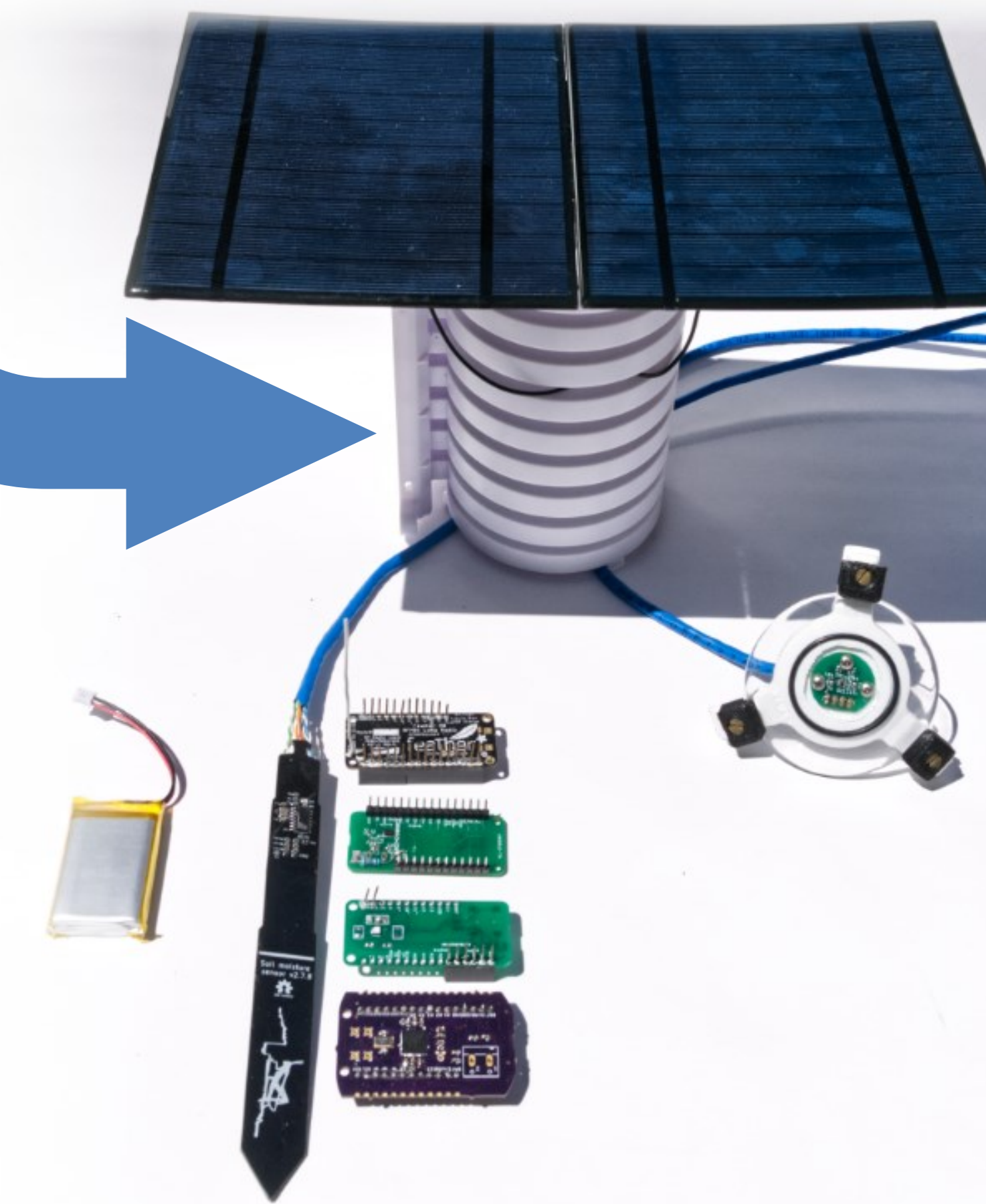
USDA-NIFA Project.
North Carolina State University
Michael Daniele, mdaniel6@ncsu.edu
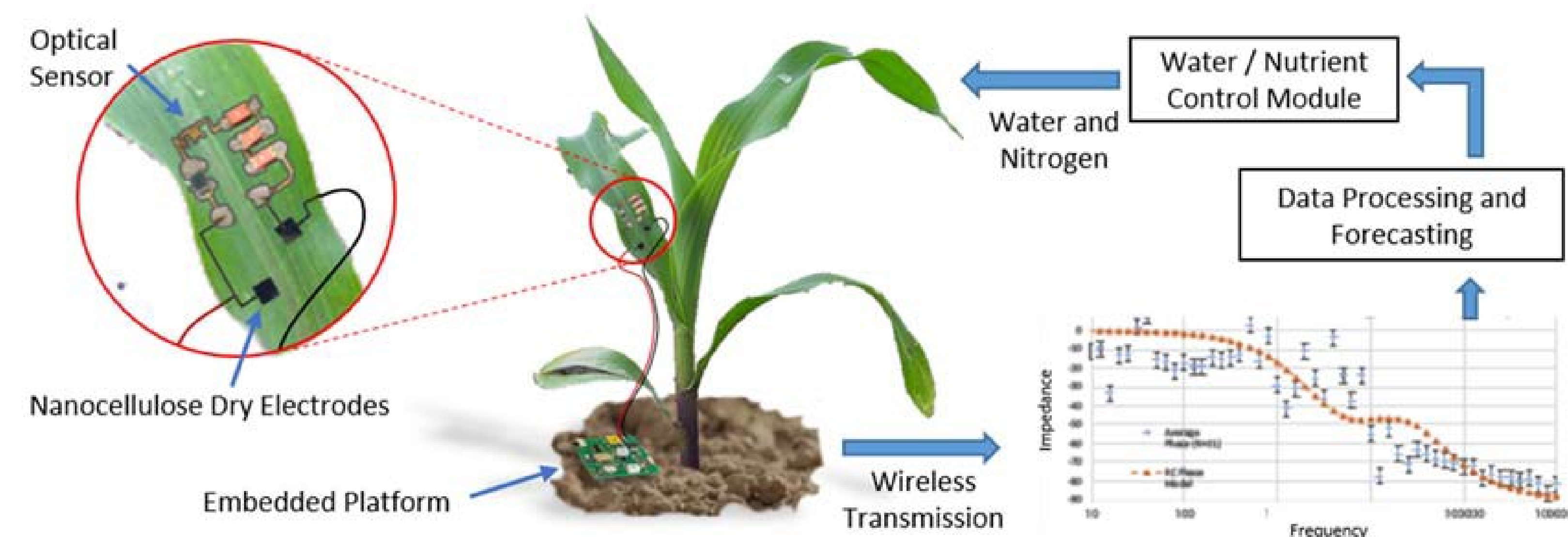


Simple Circuits for Remote Growth Monitoring

Non-Contact Detection of Water Stress

(a) NGB Image  (b) NIR Image  (c) HSV saturation
(d) Binary mask  (e) Masked NIR  (f) Pseudocolor

Environmental Station with Bioimpedance Capabilities

## Scientific Impact:

- Transform our understanding of the dynamic phenotypic expression of water stress and nutritional needs; furthermore, the tools developed for this research will provide a CPS based methodology that can be translated to the general area of plant phenotyping to analyze environmental effect, optimize growth parameters, and reduce production cost.

## Broader Impacts:

- Ensuring Crop and Resource Security and Sustainability.

- Protecting and Enhancing Water Resources.

- IoT would ultimately constitute a standard component of the U.S. food production and marketing network and assist the U.S. agriculture remain globally competitive.