AMPLIFY: Agrosphere Modeling for Producing Large Increases in Food Yield
An Interdisciplinary Research Platform for High Yield Agriculture

Our Vision

AMPLIFY is a strategic public-private research platform designed to propel innovation and resource-efficient methods to increase crop yields. By creating a critical mass of expertise from academia, industry, and the public sector, AMPLIFY conducts leading-edge basic and applied research that employs new and emerging tools and technologies to solve complex issues in agriculture.

Knowledge and insights gained from these studies fuel applied research at AMPLIFY's technology-rich flagship research/learning/demonstration site at the NC Department of Agriculture and Consumer Services Cunningham Research Station in Kinston. Our robust statewide network of NCSU-NCDA&CS partner research stations and our Grower Network of crop-producing partners afford additional opportunities for testing under a broad range of soil and climate conditions representative of major agricultural regions worldwide.

AMPLIFY research teams are multidisciplinary, dynamic, and project specific. Current teams members reside in three colleges and nine departments: the College of Agriculture and Life Sciences (CALS): Department of Plant Pathology, Plant & Microbial Biology, Soil Science, Crop Science, Biological and Agricultural Engineering, Molecular and Structural Biochemistry, and Agricultural and Extension Education; the College of Engineering's Department of Electrical & Computer Engineering; and the CALS/College of Sciences Department of Statistics.

Some AMPLIFY team members "Outstanding in Their Fields" at the flagship site Cunningham Research Station, Kinston.

Ongoing AMPLIFY projects:

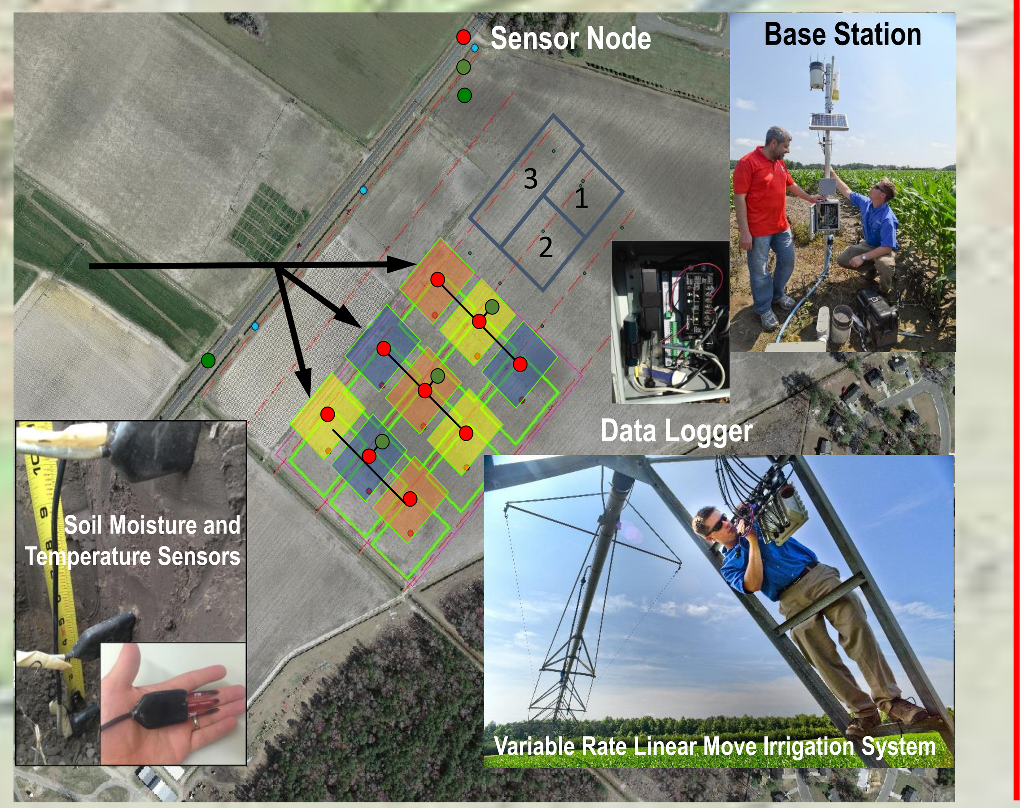
- Integrated Water and Crop Models Development for Smart Irrigation
- Custom Sensor Development, Deployment, and Analytics for Crop Phenotyping
- Remote Sensing Data Fusion to Quantify Crop Phenology, Biomass, Nutrient Status
- Multivariate Integrated Modeling to Identify Yield Traits, Improve Management Strategies and Create Decision Support Tools

Water-Crop Modeling and Smart Irrigation

Rationale and Significance: Irrigated agriculture is rapidly increasing in the U.S. Southeastern Coastal Plain, including North Carolina, in response to variable rainfall and frequent short-term droughts during growing seasons. The variability of rainfall poses challenges for irrigation management. This could lead to excess irrigation, which wastes water, increases production costs, and causes water logging and yield loss.

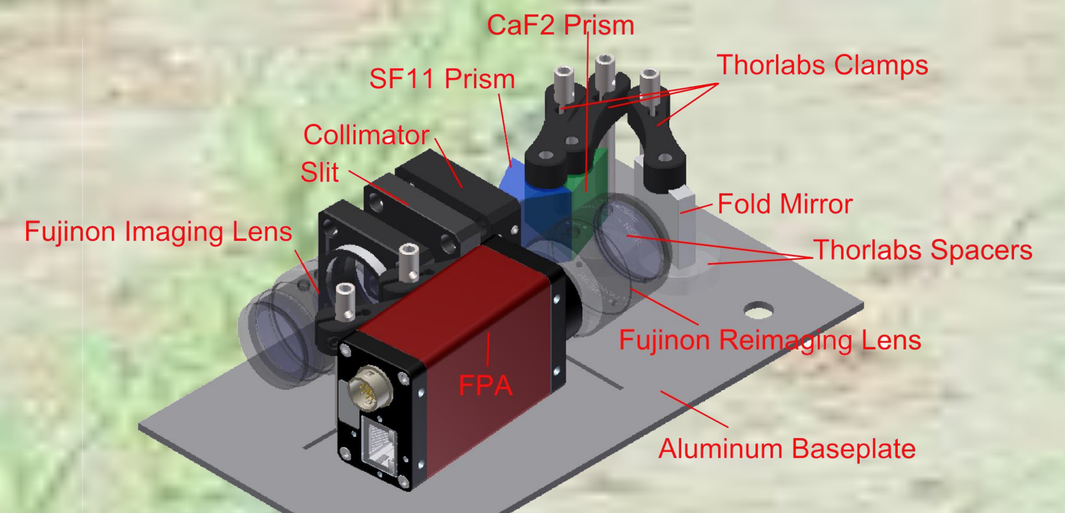
Research Goal: Develop and deploy a "smart irrigation" system for agricultural land in humid areas such as the Coastal Plain of North Carolina. Smart irrigation technology regulates irrigation based on feedback from soil moisture sensors, weather forecasts, and predicted crop phenology. The system is currently being tested at the AMPLIFY research site using three experimental treatments: smart irrigation, standard irrigation, and non-irrigated.

Potential Impacts: This system was designed to increase crop yields and profits, conserve water, and improve water quality.

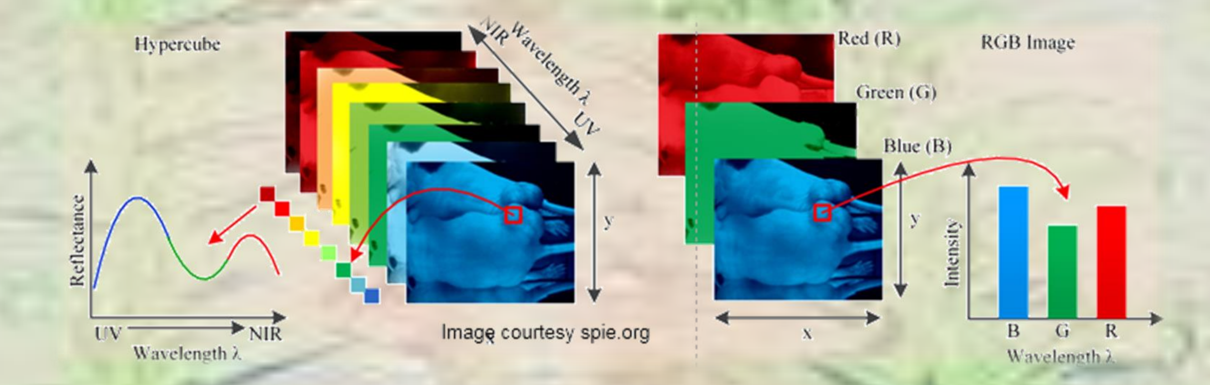


Analytics and Custom Sensor Development

Hyperspectral Imaging System

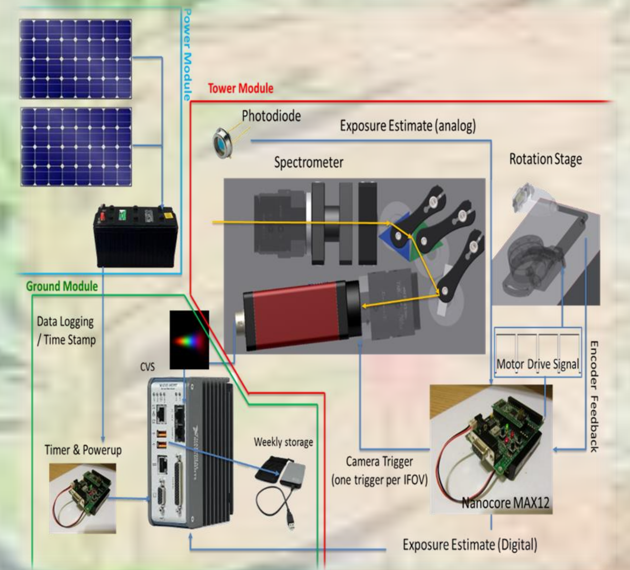


3D CAD model of the imaging camera

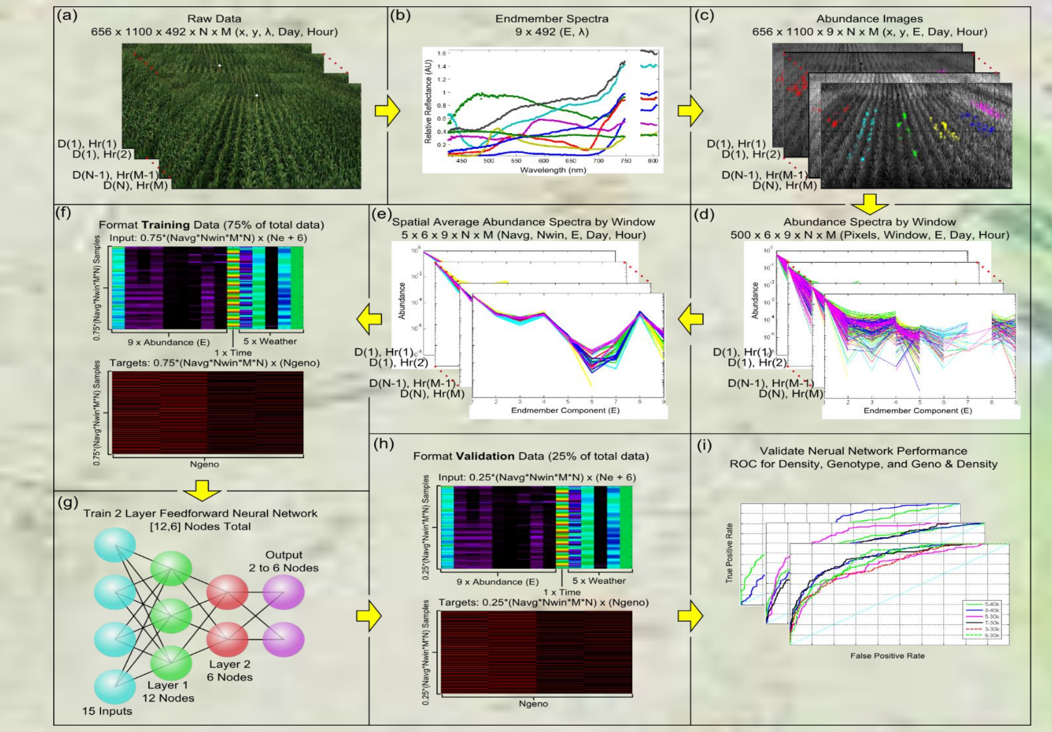


For each pixel, hyperspectral imaging provides a full reflectance spectrum divided into hundreds of narrow-wavelength bands compared to digital color imaging, which uses only the three bands red, green, and blue.

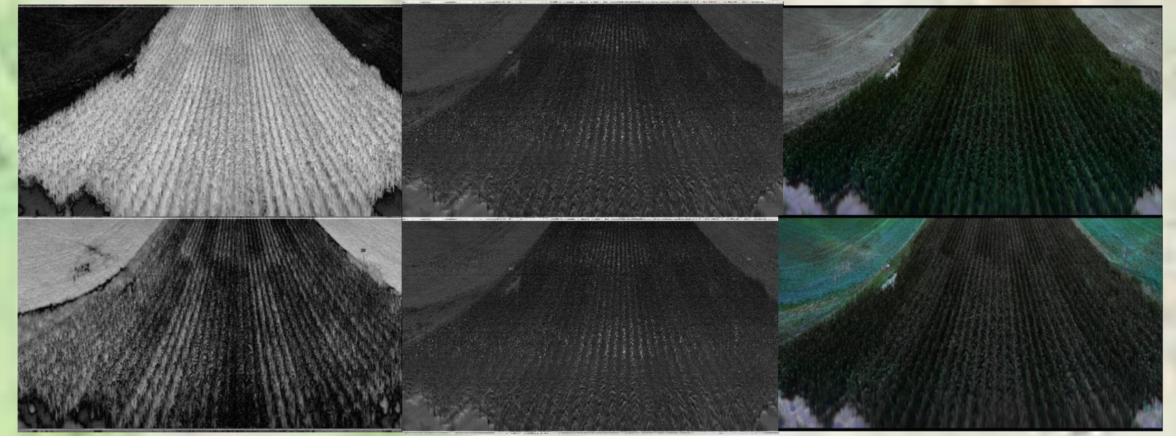
- Camera incorporates power and control modules to create an automatic scanning system
- Scans the corn field every hour from dawn to dusk then hibernates to save power
- Photodiode and thermistor are incorporated into the system to acquire exposure and temperature info while scanning
- Covers both visible and near-infrared spectra range
- Optical components could be altered in future tests to compensate for system aberrations



Left: Schematic of hyperspectral imaging system with control and power components. Right: 50-ft mast on top of which the camera is mounted (inset).

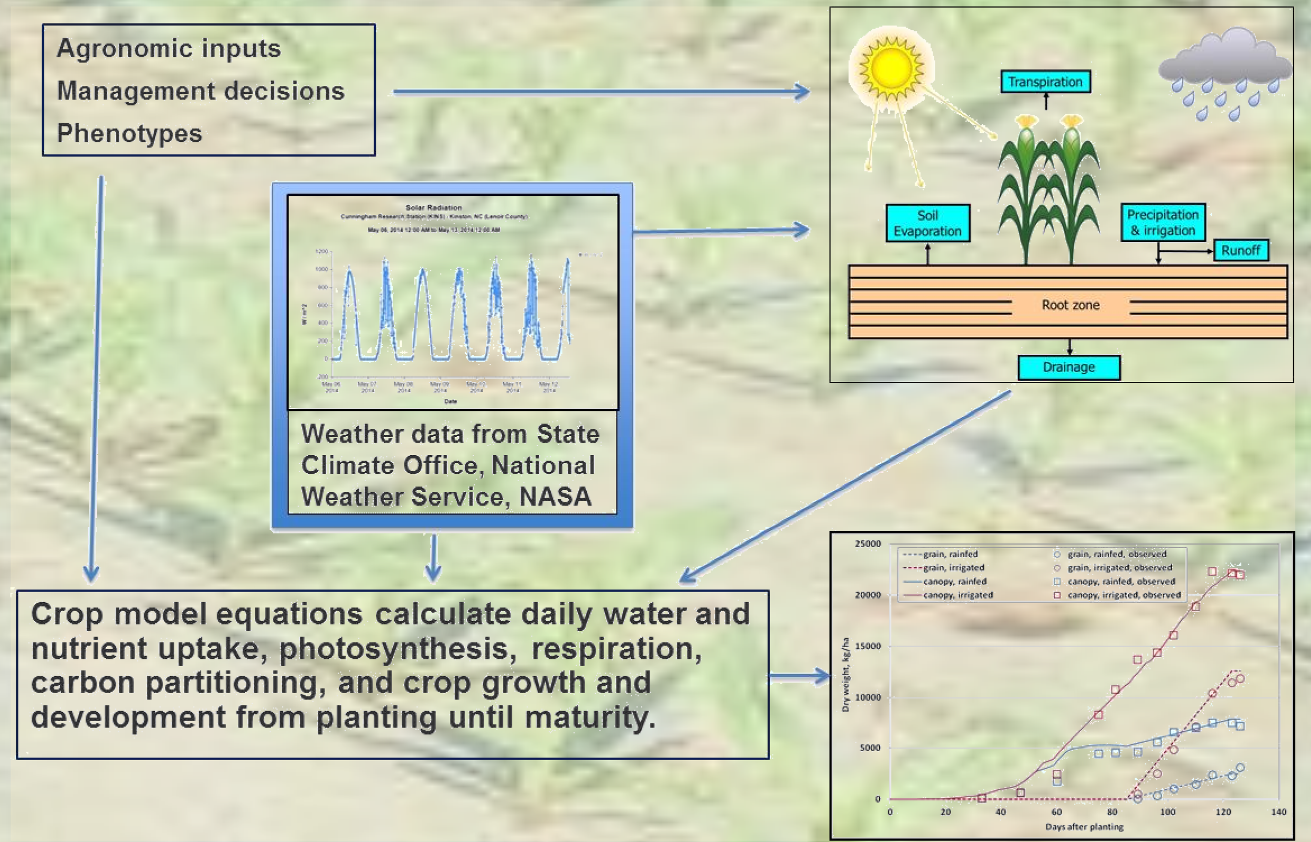


Above: photo-essay of post processing steps to quantify the correlations within the data



Top row, L to R: Corn Normalized Difference Vegetation Index (NDVI) image, Photochemical Reflectance Index (PRI), & false color image showing NDVI & PRI as color, "fused" onto a green single-band image, July 2015. Bottom: August 2015.

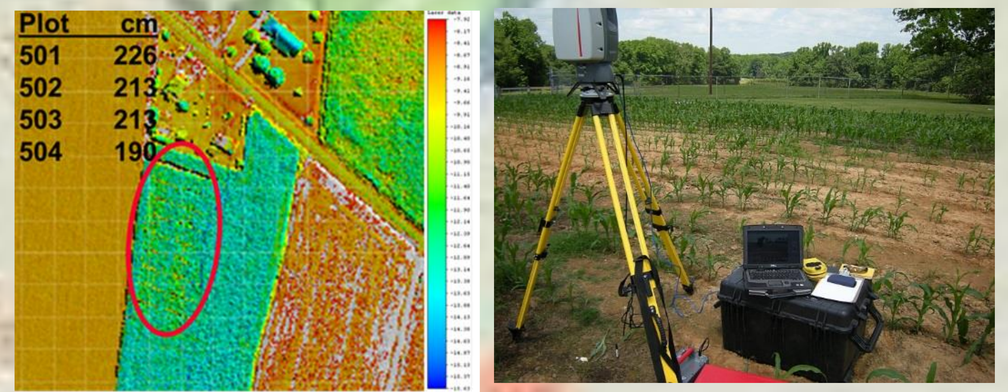
Plant Modeling for Yield Dissection and Management



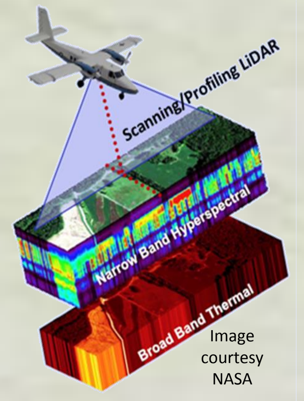
Crop models can serve as a powerful tool for the exploration of the potential benefits of specific phenological traits. They also allow researchers to investigate crop responses across a broad range of environments and management practices, and can help identify appropriate combinations of genetic traits and management practices for specific environments.

Remote Sensing Data Fusion to Quantify Crop Phenology and Nutrient Status

Remote sensing is the gathering of information about materials without contact. By combining data from multiple complimentary remote sensing instruments, we seek more complete understanding of how new crop varieties perform in the field. We are developing and testing novel technologies to quantify crop phenology, i.e. how plants develop during the growing season. This information is essential for developing high performance, resilient crop traits needed to sustain bio-intensive agriculture in the future. Traditionally achieved via laborious manual field measurements, we seek to accelerate field phenotyping using remote sensing. We also use remote sensing to glean information about nutrient status of crops to develop more efficient fertilizer recommendations that minimize nutrient escape to ground and surface waters and protect water quality.



NASA aerial G-LiHT, left, and ground-based 3-D lidar imaging system, right, measures canopy height and architecture, and provides information on plant density and biomass. Thermal imaging assesses crop moisture status and stress.



Scanning LiDAR (Riegl VQ-480)
300 kHz, 1550 nm, onboard waveform processing
Profiling LiDAR (Riegl LD-321)
10 kHz, 905 nm, up to 3 returns per laser shot
VNIR imaging spectrometer (Headwall)
0.4 to 1 µm, 1.5 nm resolution
Thermal imager (Gobi, 8 to 14 µm)
Flying altitude: 300 to 900 m AGL
Swath: ~100 to 250 m
Resolution: ≤1 m
Data acquisition rate: ~50 MB/s (1 TB/d)

NASA-Goddard's Scanning Lidar-Hyperspectral Thermal (G-LiHT) Airborne Imager Specifications

Poster content courtesy of Jeffrey White, Michael Kudenov, Mariano Lowenstern, Mohammed Youssef, Robert Walters, Greg Buol, Gail Wilkerson, Robert Vick. Principal AMPLIFY contacts: Gary Payne gary_payne@ncsu.edu and Rebecca Boston rebecca_boston@ncsu.edu