Facilitating community unoccupied aerial systems (UAS, drone) knowledge, communication, and data processing across agriculture

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Project Goal and Objectives

The overall goal of this USDA-NIFA and AG2PI supported project is to advance phenotyping and phenomic knowledge and activities through advancing UAS data collection, processing, analysis, and community discussions.

1. **Enhance networks and communication of best practices between groups and individuals currently successfully developing and using UAS tools as well as those seeking to use UAS tools in their agricultural research.**
2. **As a case study, process existing Genomes to Fields (G2F) UAS datasets (2017 to 2023) into consistent usable end products for the community to directly use, and make them publicly available.**
3. **Develop a user-friendly webpage that acts as a centralized platform to find necessary resources and information related to UAS based HTP.**

Terminology:

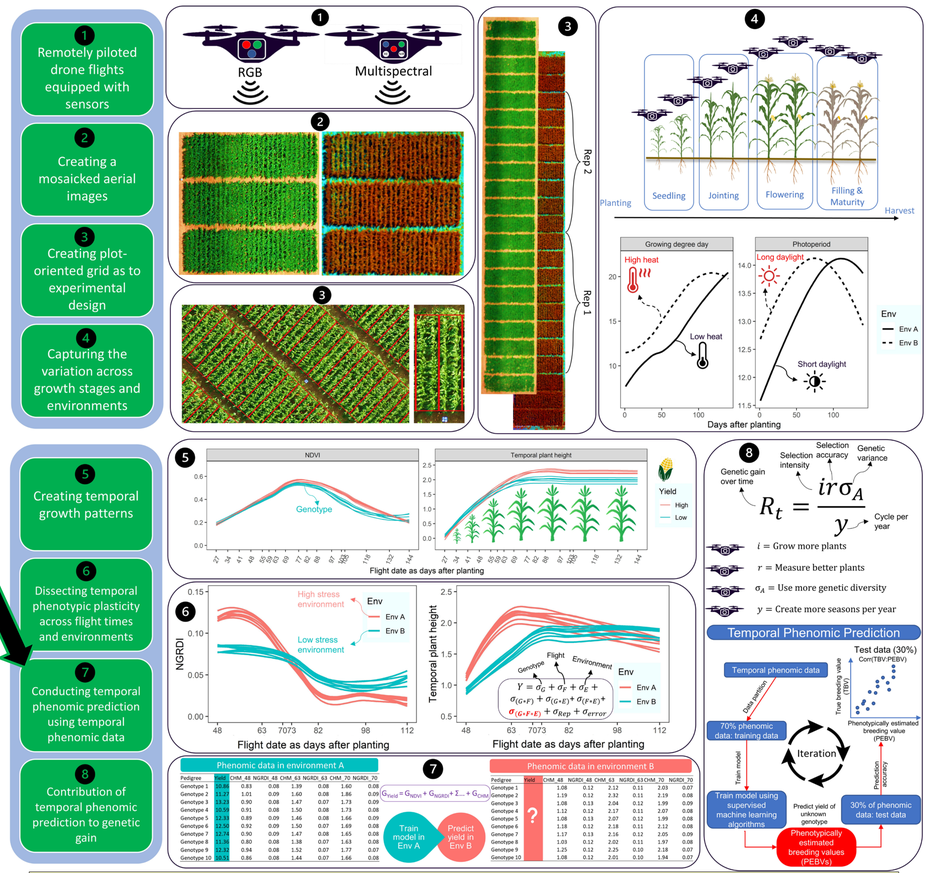
- ***Unoccupied aerial vehicles (UAV) plus sensors creates Unoccupied aerial systems (UAS)***
- ***unoccupied = unmanned = uncrewed***

Why Should Plant Breeders Care About Drones?

1. **Automate routine measurements -** decrease labor or increase plots measured on traits, for example:
   - Plant height
   - Yield estimation (cotton, sorghum, wheat)
   - Foliar disease estimation
2. **Find new signatures of "elite-ness" -** measure things infeasible or impossible previously:
   - Temporal growth patterns / biomass
   - Senescence and grain filling period
3. **Phenomic selection -** Use hundreds or thousands of phenomic "features" in way like genetic markers in genomic selection. (*NOT the same thing as phenotypic selection*)
4. **AI / Deep learning -** Use images directly to predict response variables.

Impacts beyond plant breeding

- **Identify novel stress signatures for farmer management**
- **Identify new phenotypes and mechanisms of biological importance**



1) Enhance communication around UAS in agriculture

Multiple groups and disciplines have developed methods, tutorials, trainings and research around UAS in agriculture. However, these activities often exist in silos and do not necessarily reach the audiences most interested in these topics. A major goal is to enhance visibility and communication between these groups through a coordinator.

SAAESD — S1069: Research and Extension for Unmanned Aircraft Systems (UAS) Applications in U.S. Agriculture and Natural Resources
(Multistate Research Project) Status: Active

NCRA — NC1212: Exploring the Plant Phenome in Controlled and Field Environments
(Multistate Research Project) Status: Active

AI IN AGRICULTURE: INNOVATION AND DISCOVERY TO EQUITABLY MEET PRODUCER NEEDS AND PERCEPTIONS

Wheat CAP Coordinated Agricultural Project

the Genomes to Fields initiative

ODD-PIGG

Livestock?

D2P

SPIE. DEFENSE+ COMMERCIAL SENSING
Conference 12539
Autonomous Air and Ground Sensing Systems for Agricultural Optimization and Phenotyping VIII

FIELDimageR

BREEDBASE

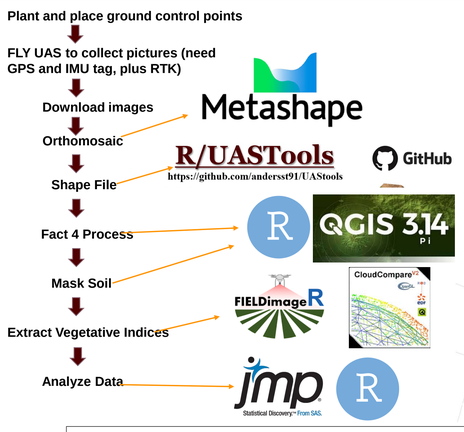
Phenome Force

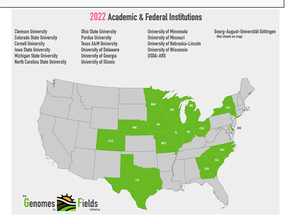
NAPPN
North American Plant Phenotyping Network

The project supported 9 early career participants to discuss UAS in agriculture at the S1069 multistate project; Virginia Tech Tidewater Center June 1-2, 2023 (photo: M. Balota)

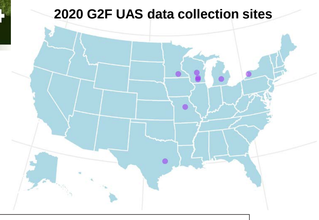
2) Process existing G2F maize UAS datasets

The Genomes to Field GxE project has collected data on over 180,000 corn field plots including 2,500 hybrids and 162 unique environments across 9 years.14 core traits and weather data were measured in each location. Since 2016 some locations have collected UAS images, This project is processing this data into products using the same pipeline and making publicly available. https://www.genomes2fields.org/





2020 G2F UAS data collection sites



Current pipeline workflow and 2020 multi-locational data processed to date.

Year	Environment	RGB vegetation indicies	Multispectral Vegetation Indicies	Plant height elevation models	File size: Orthomosaics and plant height point cloud files	File size: All files including raw image and Agisoft files)
2020	College Station, TX	Yes	na	Working on	534 GB+	976 GB+
2020	Arlington, WI	Yes	na	na	56.7 GB	481 GB
2020	Hancock, WI	Yes	na	na	38.2 GB	231 GB
2020	Madison, WI	Yes	na	na	63 GB	433 GB
2020	Missouri	Yes	na	Yes	707 GB	1.74 TB
2020	Michigan	Yes	Yes	Yes	73.9 GB	404 GB
2020	New York	Yes	Yes	na	39.4 GB	39.4 GB
2020	Minnesota	Working on	na	Working on	43.1 GB+	400 GB+
2020	Delaware	Not Yet	Not Yet	Not Yet	na	na
				Total:	1.56 TB+	4.71 TB+

3 Web platform with necessary UAS resources

In this project a website will be developed to centralize information on using UAS in agriculture. This will include protocols, datasets, links to software, code and workflows. The construction of this site is currently underway using the outline below.

Acknowledgements

We thank the many staff, students and funding agencies that have made this project and others like it possible We thank USDA-NIFA for support of AG2PI and AG2PI for support of this project. Also thanks to USDA-NIFA-AFRI Awards 2020-68013-32371 and 2021-67013-33915 in developing knowledge and analysis pipelines.

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