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

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AG2PI Agricultural Genome to Phenome Initiative

USDA NIFA

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.

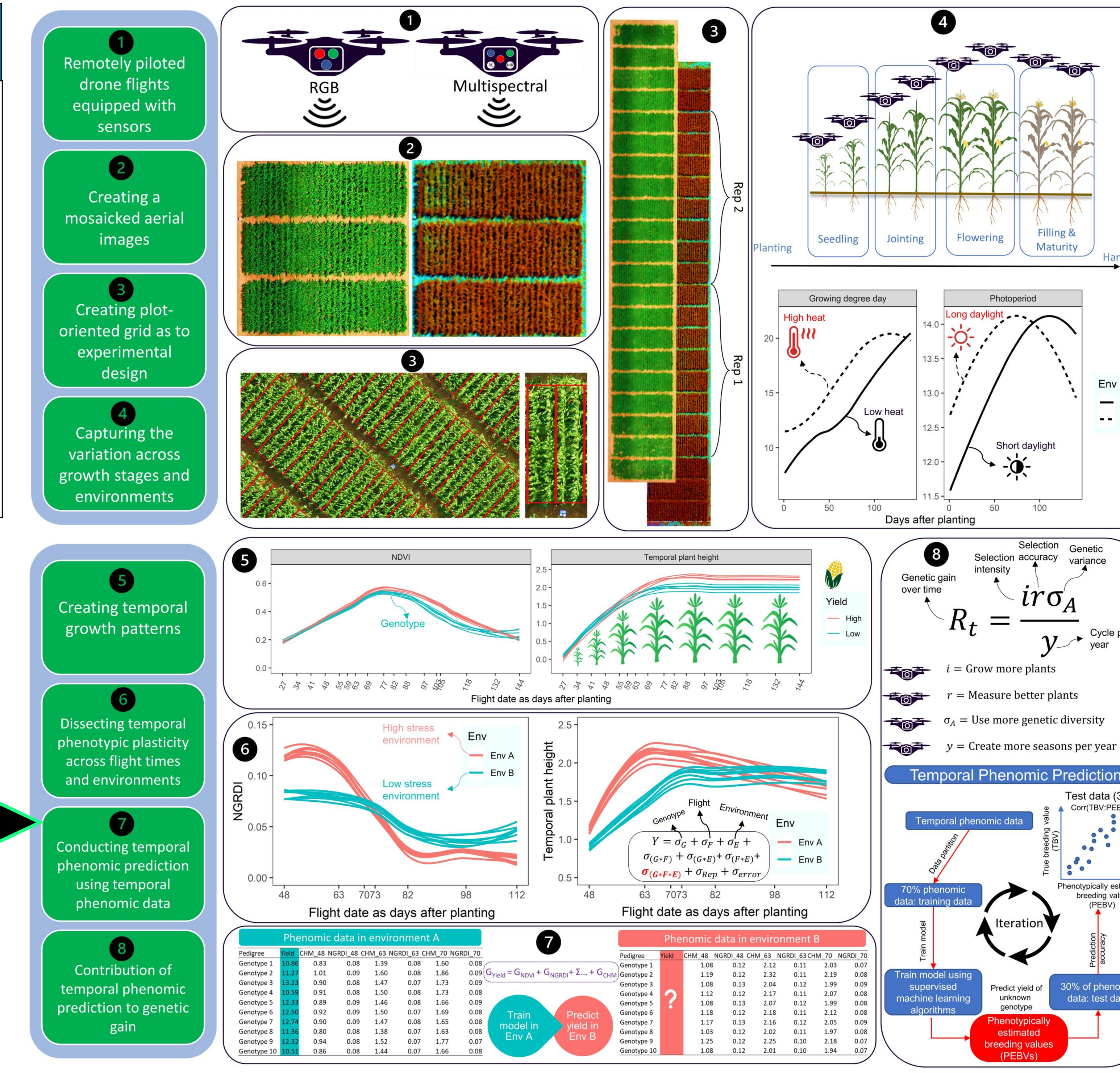
2

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 Scientists Care About Drones?

1 Automate routine measurements

Decrease labor or increase plots measured on traits:
- 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.

5 Crop management

Identify novel stress signatures for farmer / agronomist management.

6 Breeding innovations

Identify new phenotypes and mechanisms of biological importance.

7 Increased data intake

Screen larger populations and more farmer-relevant conditions than controlled environments.

1) Enhance communication around UAS in agriculture

A coordinator will promote enhanced visibility and communication through multiple groups and disciplines who have developed methods, tutorials, trainings and research around UAS in agriculture.

Communication will take place during virtual meetings, hosted in the form of discussions. Experts will facilitate discussions to help spread awareness and share experiences to advance our collective research knowledge.

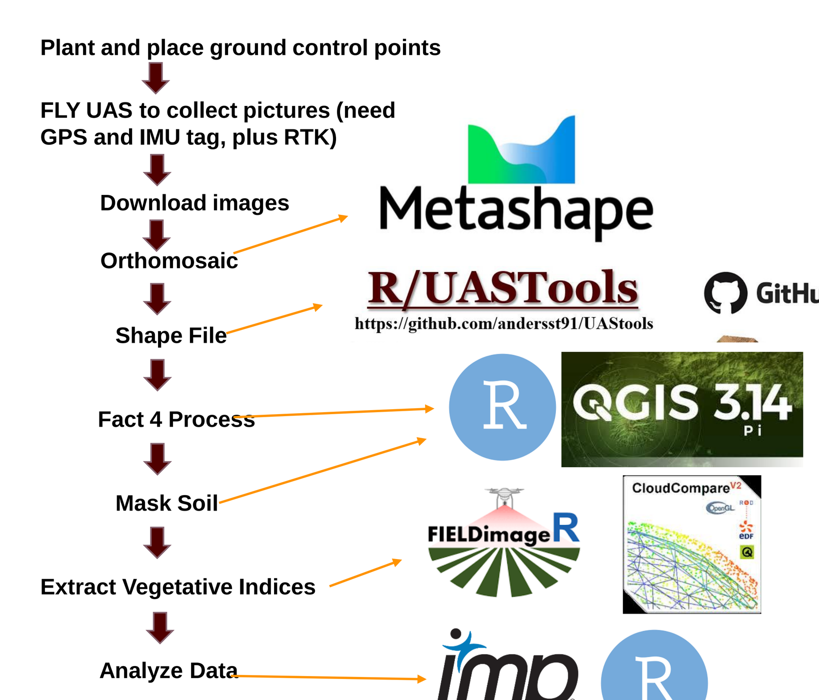
Jan 2024: UAV/UAS/Drone restrictions for agricultural research and how different organizations are dealing with them. Watch on YouTube: https://youtu.be/AABalsvds80

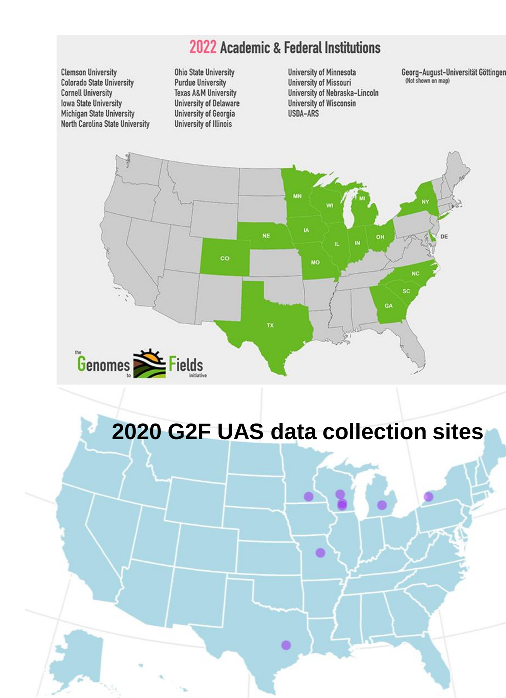
Upcoming: Open Source Software, Data Organization and Storage, & Hyperspectral UAS

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 into products using the same pipeline and making publicly available. https://www.genomes2fields.org/





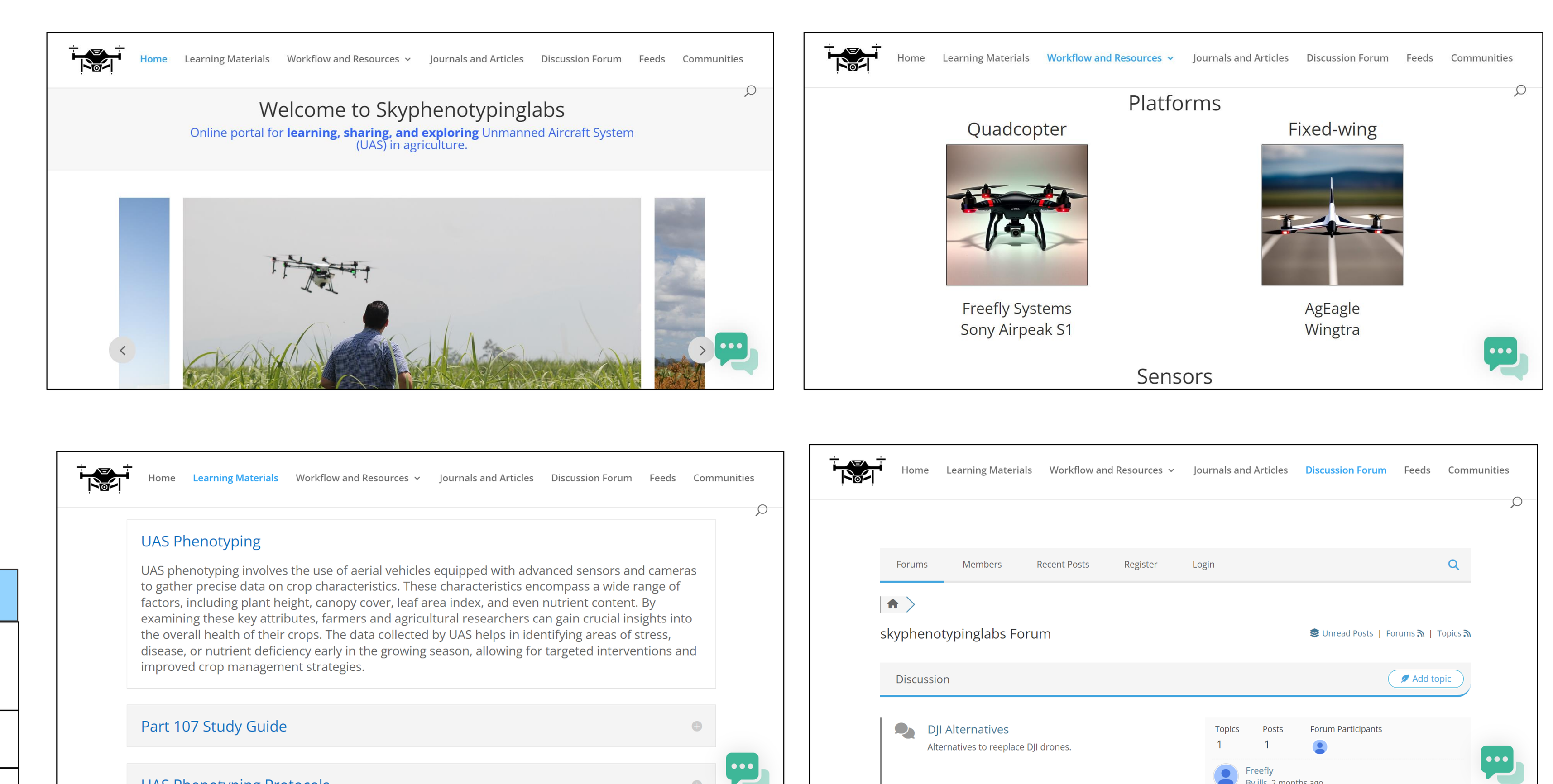
Current pipeline workflow and 2020 multi-locational data processed to date.

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	N/A	Yes	566 GB	1.08 TB
2020	Arlington, WI	Yes	N/A	N/A	56.7 GB	481 GB
2020	Hancock, WI	Yes	N/A	N/A	38.2 GB	231 GB
2020	Madison, WI	Yes	N/A	N/A	63 GB	433 GB
2020	Missouri	Yes	N/A	Yes	707 GB	1.74 GB
2020	Michigan	Yes	Yes	Yes	73.9 GB	404 GB
2020	New York	Yes	Yes	N/A	39.4 GB	39.4 GB
2020	Minnesota	Yes	N/A	Yes	94 GB	451 GB
2020	Delaware	Yes	Yes	Yes	88.2 GB	465 GB
2020	Iowa	Yes	N/A	N/A	583 GB	722 GB
2020	Colorado	In Process	In Process	In Process	93.3 GB	564 GB
2021	Nebraska	Yes	N/A	Yes	53.7 GB	229.7 GB
				Total:	**2.4 TB**	**6.1 TB+**

3) Web platform with necessary UAS resources

A website has been developed with the goal of centralizing information on using UAS in agriculture. This includes protocols, datasets, links to software, code and workflows.

Visit the site at https://skyphenotypinglabs.org/



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