PRECISE System

Proactive Resource Efficiency via Coordinated Imaging and Sprayer Execution

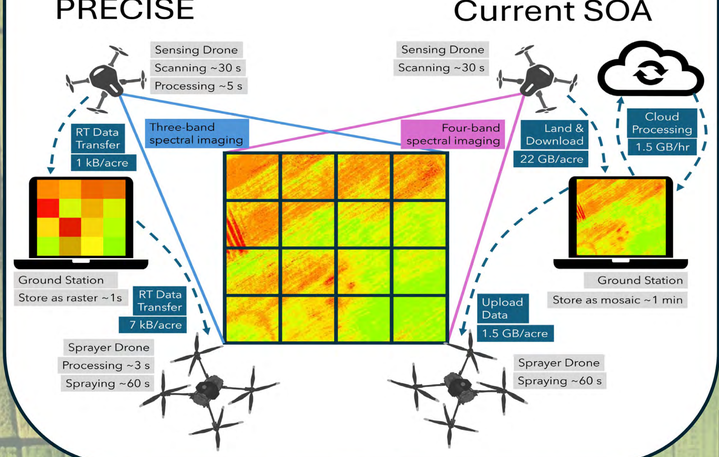
Introduction

The **PRECISE** system is an unmanned aerial vehicle (UAV) system designed to **assess field nutrient conditions AND distribute fertilizer simultaneously.**

A multispectral scanning drone observes the amount of essential nutrients (NPK) in a field while communicating to a spreader drone with variable rate application (VRA) to minimize over-fertilization and under-fertilization of agricultural fields. PRECISE is a **disruptive technology** that uses **existing** UAV and multispectral imagery hardware with **new operating procedures** and **software** to **streamline** data acquisition and processing, enabling simultaneous operation of sensing and spraying drones with **only a momentary delay**.

Comparison to SOA

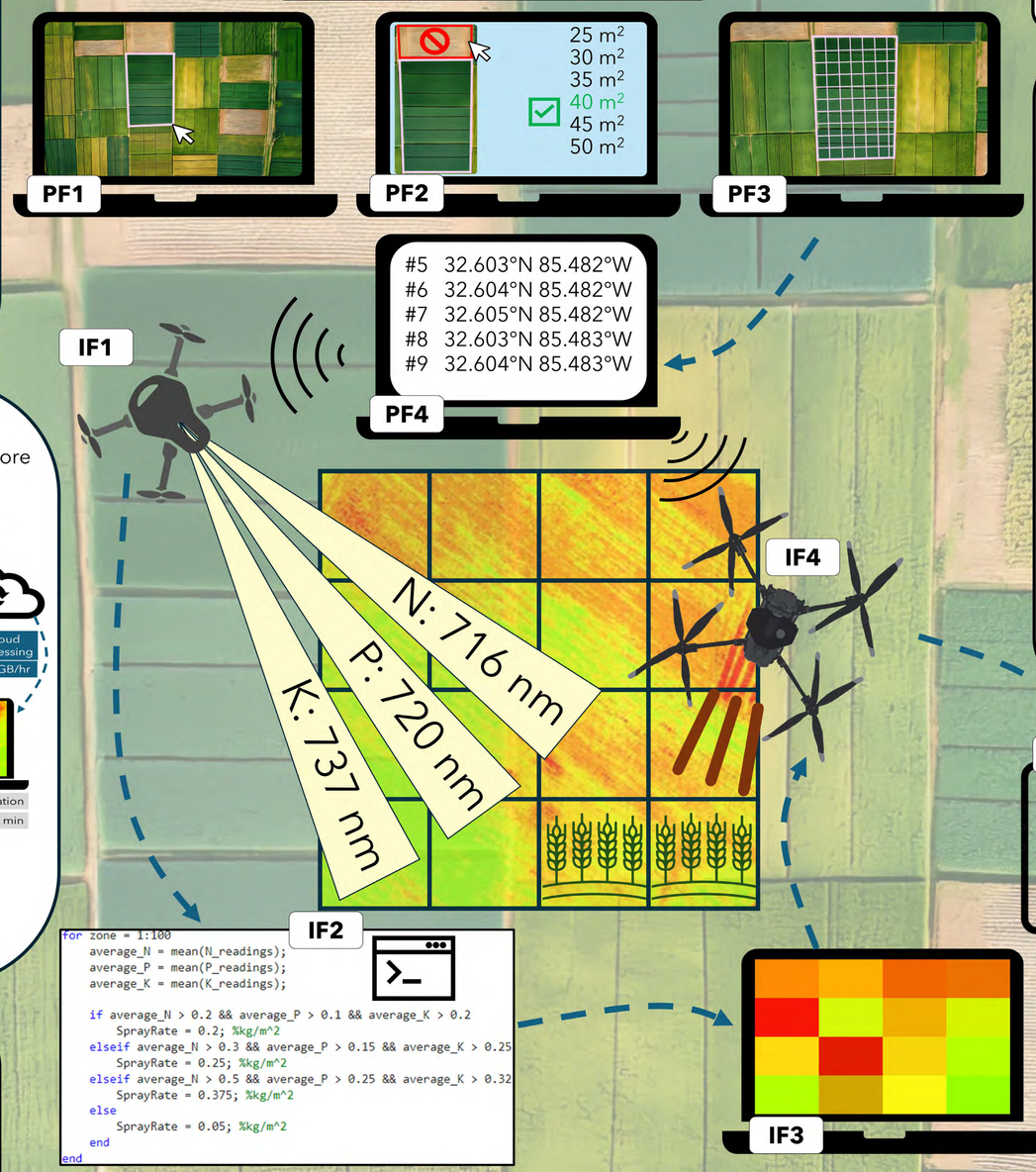
PRECISE decreases the time between scanning and spraying by more than **98%** compared to state-of-the-art (SOA) drone systems



Cost Comparison

Per Acre Cost Comparison ($)			
	Chemical fertilizer (Land-based application)	Chemical fertilizer (PRECISE application)	Biochar fertilizer (PRECISE application)
Techno-economic analysis			
Fertilizer production cost	$ 73.40	$ 73.40	$ 75.00
Application cost	$ 11.00	$ 20.00	$ 20.00
Capital cost	$ 8.17	$ 7.45	$ 7.45
Maintenance cost	$ 12.50	$ 2.00	$ 2.00
Total financial cost	**$ 105.07**	**$ 102.85**	**$ 104.45**
Life cycle assessment (Economic Impact)			
Eutrophication potential	$ 30.00	$ 25.00	$ 12.00
GHG emissions	$ 12.39	$ 12.23	$ 3.72
Acidification potential	$ 52.00	$ 39.00	$ 24.70
Fossil fuel depletion	$ 40.04	$ 38.80	$ 10.85
Total Cost	**$ 239.50**	**$ 217.88**	**$ 155.72**
Difference in using PRECISE		**$ 21.62**	**$ 83.78**

Overview



Operations

consist of two phases: pre-flight (**PF**) and in-flight (**IF**)

Pre-flight (**PF**)

PF1: User delineates the target field through ground station graphical user interface (GUI)

PF2: User selects size of rectangular management zones (ranging from 25–50 m^2) and indicates no-fly zones

PF3: PRECISE software automatically generates a uniform grid of cells within the field

PF4: Each cell is assigned an ID number, and its GPS coordinates and dimensions are passed to both UAVs

In-flight (**IF**)

IF1: Sensing UAV flies over each cell, assessing the spectral reflectance at three wavelengths corresponding to Nitrogen, Phosphorus, and Potassium levels

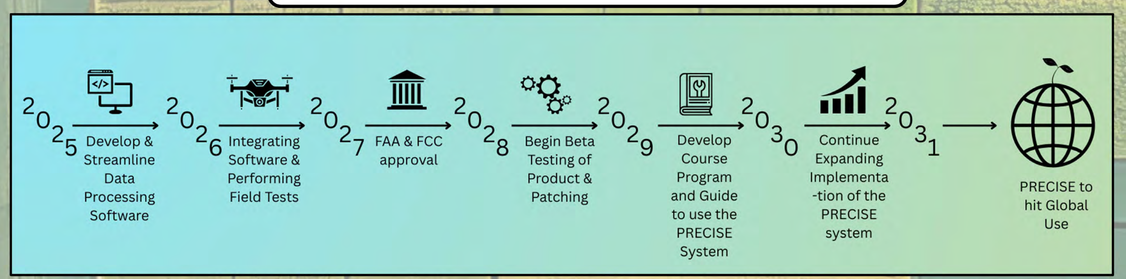
IF2: Reflectance at each wavelength is averaged over the area of the cell and mapped to fertilizer application rates using a C++ lookup table

IF3: Sensing UAV transmits application rate to the ground station, which stores it as a raster data map

IF4: Ground station forwards the application rate to the spreader UAV which distributes biochar-based fertilizer

IF5: Process continues with the UAVs returning to a designated landing zone for rotating batteries and refilling the fertilizer hopper

Developmental Timeline



Conclusion

- PRECISE decreases the time of drone-based remote sensing and VRA by more than **98%** compared to existing systems
- Using PRECISE technology with chemical or biochar-based fertilizers can save $21 and $83, respectively in economic and environmental impacts
- PRECISE can be implemented with existing drone hardware to accelerate its development and global use

The future of farming is here

Auburn University