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United States Department of Agriculture
Project Initiation

Project Data for Accession Number 1028246

Project Title

A Digital Rice Selection System that Integrates UAV Imaging, Machine Learning, and Multi-Trait Decision-Making

Project Details

Sponsoring Institution National Institute of Food and Agriculture	**Project Status** COMPLETE
Funding Source NIFA Non Formula	**Grant Year** 2022
Grant No. 2022-67021-36584	**Cumulative Award Amt.** $649,955.00
Proposal No. 2021-11533	**Multistate No.** (N/A)
Project Start Date Jan 15, 2022	**Project End Date** Jan 14, 2026
Program Code [A1541] Food and Agriculture Cyberinformatics and Tools	

Project Director

Yang, Y.

Recipient Organization

TEXAS A&M AGRILIFE RESEARCH

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Performing Department

(N/A)

Non Technical Summary

Traditional crop breeding relies on time-consuming and inefficient manual field observations or samplings. Unmanned aerial vehicle (UAV)-based high-throughput phenotyping promises to alleviate the phenotyping bottleneck and provide the capability for repeated non-destructive measurement of thousands of genotypes grown in field experiment plots in crop selection cycles. Major challenges remain to enable more sophisticated analyses and development of integrated decision-making systems that can greatly accelerate crop improvement and phenotyping. We propose to develop a Digital Rice Selection System that integrates UAV imaging, machine learning, and multi-trait decision-making. Objectives are: 1) Quantify key phenological, morphological and architectural traits that capture rice growth and development; 2) Acquire multi-viewpoint UAV images of rice genotypes during critical growth stages; 3) Develop advanced image analysis algorithms to derive key phenological, morphological and architectural traits for critical rice growth stages, and 4) Develop a digital rice selection system that screens for best-performing genotypes through data

integration and multi-trait decision making.Ground truth data for key traits during critical rice growth stages will be collected along with high-resolution RGB/multispectral UAV images from multiple camera angles. We will develop (1) advanced machine learning algorithms to extract key traits, (2) multi-trait-based machine learning models to estimate final aboveground biomass and grain yield, and (3) a multi-criteria decision-making system to select best-performing rice genotypes. The proposed project represents a major effort in delivering an integrated UAV imagery-based decision-making system to rice breeders and researchers and will be an indispensable tool to greatly improve rice breeding and phenotyping efficiency.

Animal Health Component

Animal Health Component: 0%

Research Effort Categories

Basic	60%
Applied	40%
Developmental	0%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
206	1530	1060	80%
206	1530	1081	20%

Knowledge Area

[206] Basic Plant Biology

Subject Of Investigation

[1530] Rice

Field Of Science

[1060] Biology (whole systems)

[1081] Breeding

Keywords

Machine Learning, High-throughput Phenotyping, Digital Rice Selection System, UAV Image

Goals / Objectives

We propose to develop a Digital Rice Selection System that integrates UAV imaging, machine learning, and multi-trait decision-making. Specific objectives areQuantify key phenological, morphological and architectural traits that capture rice growth and developmentAcquire multi-viewpoint UAV images of rice genotypes during critical growth stagesDevelop advanced image analysis algorithms to derive key phenological, morphological and architectural traits for critical rice growth stagesDevelop a digital rice selection system that screens for best-performing genotypes

through data integration and multi-trait decision making The overall goal of the proposed project is to transform traditional rice crop research towards a digital- and technology-centered integrated research paradigm for greatly improved breeding and production efficiency and help maintain the competitive edge of US agriculture.

Project Methods

We propose to develop a Digital Rice Selection System that integrates UAV imaging, machine learning, and multi-trait decision-making. Objectives are: 1) Quantify key phenological, morphological and architectural traits that capture rice growth and development; 2) Acquire multi-viewpoint UAV images of rice genotypes during critical growth stages; 3) Develop advanced image analysis algorithms to derive key phenological, morphological and architectural traits for critical rice growth stages, and 4) Develop a digital rice selection system that screens for best-performing genotypes through data integration and multi-trait decision making.Ground truth data for key traits during critical rice growth stages will be collected along with high-resolution RGB/multispectral UAV images from multiple camera angles. We will develop (1) advanced machine learning algorithms to extract key traits, (2) multi-trait-based machine learning models to estimate final aboveground biomass and grain yield, and (3) a multi-criteria decision-making system to select best-performing rice genotypes.