FW-HTF-RL: Testing a Responsible Innovation Approach for Integrating Precision Agriculture (PA) Technologies with Future Farm Workers and Work

NSF Award # 2026431 (October 1, 2020 to September 30, 2024) $2.99M

Asim Zia and Donna Rizzo (UVM PIs)

Gardezi

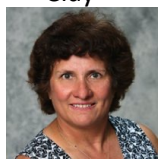
Zia

Clay

McMaine

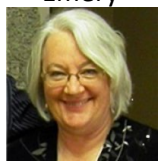
Rizzo

Clay



Michael

Emery



Ricketts

Alvez

Faulkner

Koliba

Merrill

Colby

Bedireddy

Scroth

Schneebeli

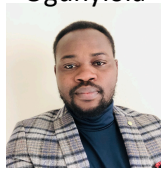
O'Neil-Dunne

Hamshaw

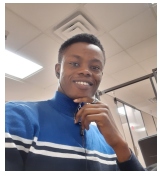
Near

Cheney

Ogunyiola

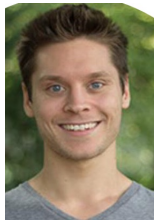


Adereti



Joshi

Guion



Sprio

Ryan

The University of Vermont

Motivation and the Global Challenge!

- "**Feeding the world while cooling the planet**" is a global challenge because agriculture contributes up to 35% of global greenhouse gas emissions, is a leading cause of biodiversity loss and water pollution, yet 805 million people continue to face hunger and malnutrition.

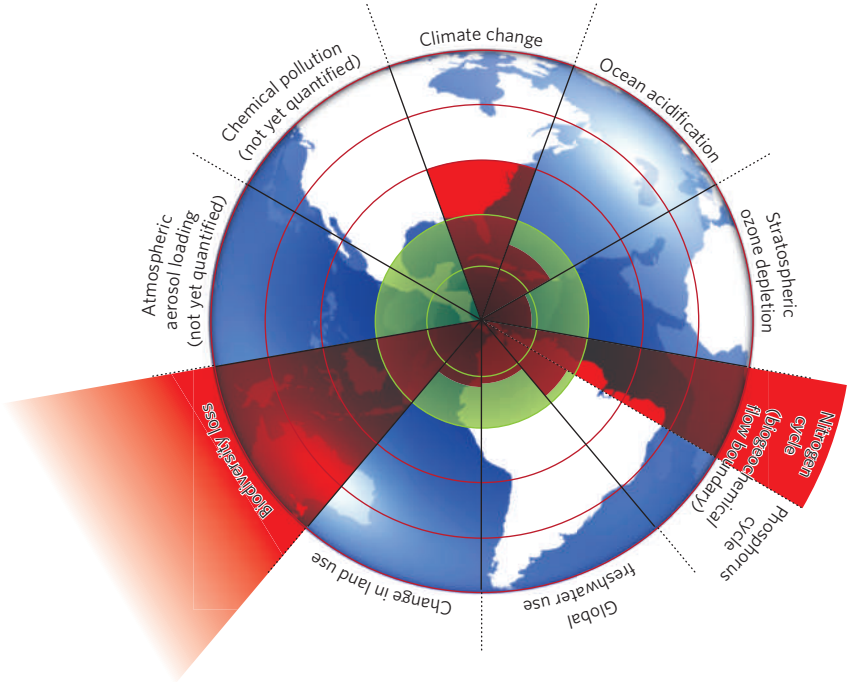


Figure 1 | Beyond the boundary. The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

nature Vol 461|24 September 2009

FEATURE

A safe operating space for humanity

Identifying and quantifying planetary boundaries that must not be transgressed could help prevent human activities from causing unacceptable environmental change, argue **Johan Rockström** and colleagues.

Potential (Re-)Solutions to “Feeding the world while cooling the planet” Challenge!

- User inspired design and deployment of sustainable technologies that ensure provision of food for all people on the planet yet reduce the environmental impact of food on freshwater nutrients, greenhouse gas emissions and biodiversity are urgently needed for addressing this global challenge.

- Examples: Precision Agriculture; Climate Smart Agriculture; Agro-ecology; Permaculture; Ecological Design;…….

- **Land Sparing Vs. Land Sharing** Debate for Ag Lands

- Technological break-throughs in Artificial Intelligence (AI), real-time social sensing (e.g. real time social media feeds, personal wearables) and environmental sensing & monitoring (e.g. in situ air, water and soil sensors, unmanned aerial vehicles/drones, satellites) have opened up unprecedented opportunities to inform the design of next generation AI augmented sustainable technologies.

- Big Brother vs. Co-Production of Knowledge/Action Debate!!

Overview of Project Objectives

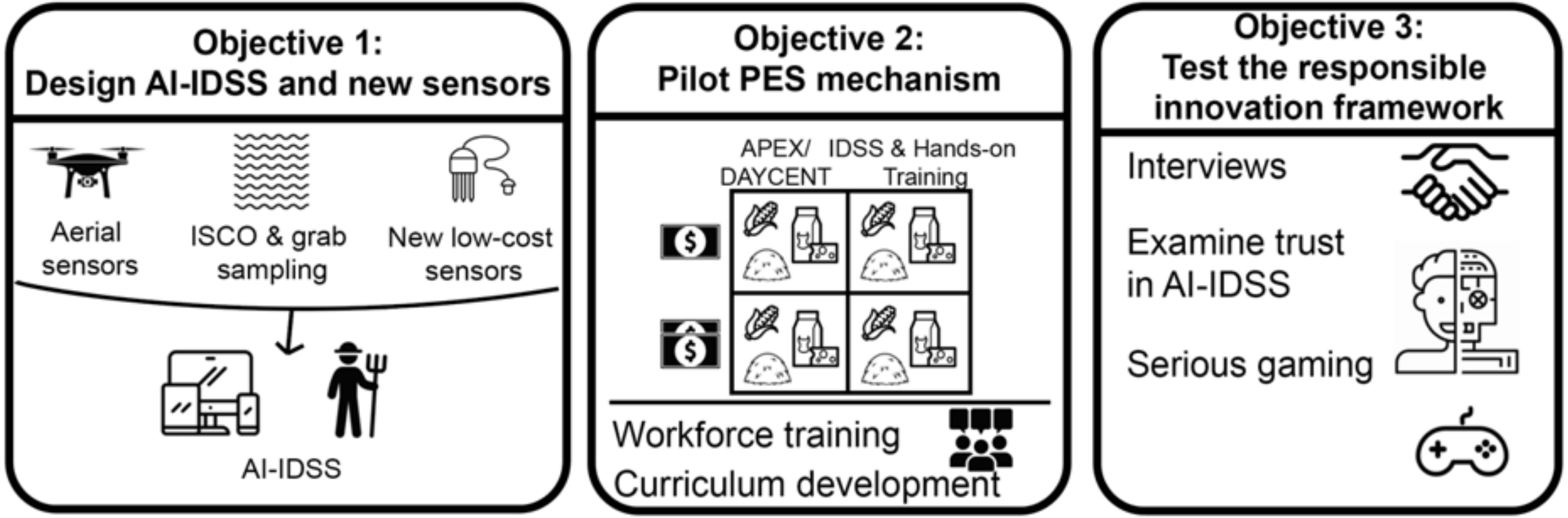


Figure 3: Summary of project objectives

The University of Vermont

Objective 2: Pilot an on-farm, sensor-driven performance-based payment for ecosystem services (PES) mechanism

	APEX/DAYCENT models only	AI-IDSS and hands-on training
Baseline monetary incentives	Control group	Treatment 1
Baseline & Performance-based monetary incentives	Treatment 2	Treatment 3

Table 1: A 2 x 2 full factorial experimental design for payment for ecosystem services (PES) mechanism (Source: PI's own)

Sampling Design (from the proposal)

24 farms in VT and 24 farms in SD, totaling 48 farms to be sampled as living laboratories

12 farms in each of the 4 experimental groups

Each experimental group in this 2 x 2 factorial design will comprise of four corn/soybean, four dairy/cattle, and four alfalfa/hay farms in SD and VT.

Experimental design considerations for minimizing threats to internal and external validity and leveraging ongoing programs

1. **Suggest using APEX model for control group and Treatment 2** that has been developed by Stone Environmental and VT DEC (Farm-PREP tool)
2. For controlling additional variability in the farm sampling, **we can only focus on early adopters of PA and farmers interested in adopting PA** technologies but have not adopted PA yet.
3. 25% attrition rate can be built into the experimental design, **so we suggest an initial recruitment of 60 farmers** (30 per state).
4. **Develop a "training for hands-on training" program** to ensure consistent delivery of hands-on training in both states for treatment groups 1 and 3.

Design questions for discussion and collaboration/synergies

- Should performance-based incentive payments be only focused on P reduction in VT and N reduction in SD, or should it be cumulatively scaled for P, N and C reductions?
- **How is PES commission considering scaling the payments?? Cumulative for P, N, C, Biodiversity?**
- Conjoint analysis of farmer surveys in VT and SDSU underway to compute farmer WTA payments (baseline set on current NRCS payments) for three BMPs: Buffers, Cover Crops and Reduced Tillage. Should these payments be similar across SD and VT?
- **How is PES commission considering the measurement of P, C and N flows from the farms for baseline and payment periods in the PES programs? Model based or Data driven??**

Revisiting (Re-)Solutions to “Feeding the world while cooling the planet” Challenge!

- Should Precision Ag and Climate Smart Tech be designed for intensive agriculture and spare more land for forest and biodiversity conservation? **[Land sparing design]**

- Can Precision Ag and Climate Smart tech be integrated with agro-ecology/permaculture/ecological design for producing food and conserving P, N and C on all ag, forest and urban lands? **[Land sharing design]**

- Which features of new precision ag technologies can enhance **trust** of food producers in sensor driven AI-IDSS?

THANK YOU

- For more information: Asim.Zia@uvm.edu & Donna.Rizzo@uvm.edu

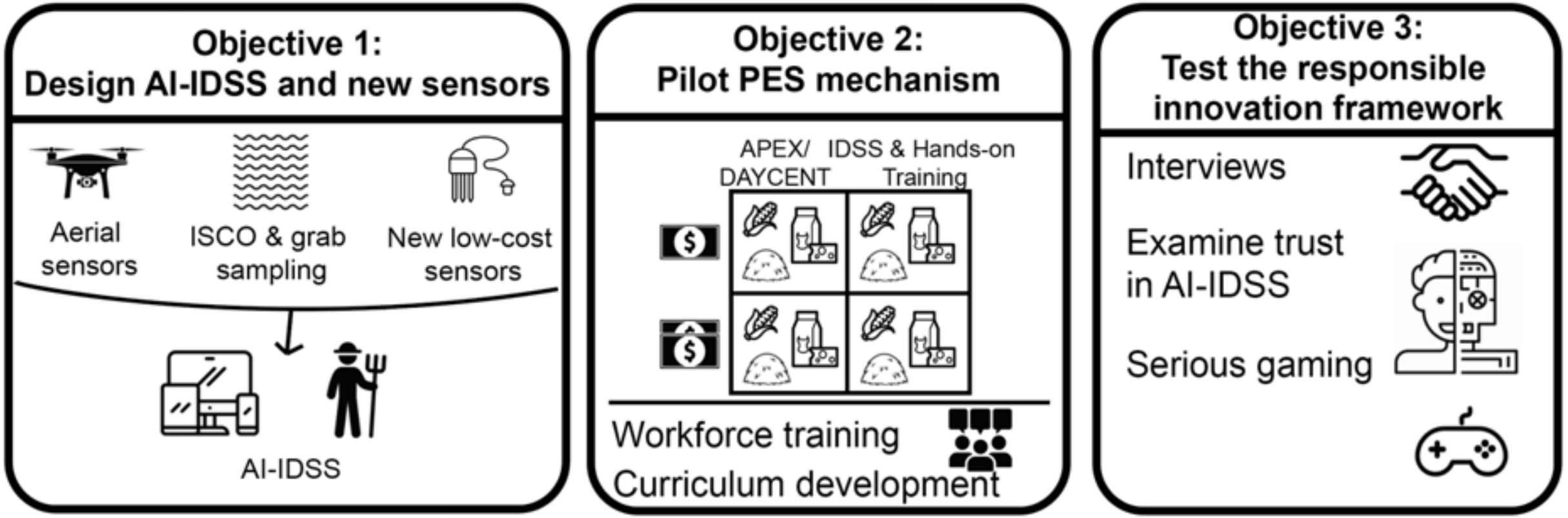


Figure 3: Summary of project objectives