CPS Medium: TTP: Sharing Farm Intelligence via Edge Computing
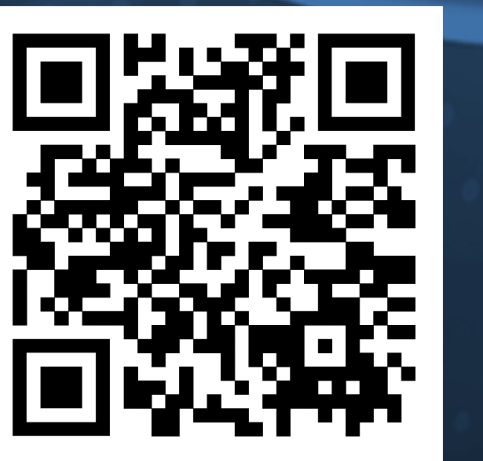
Lead PI: Flavio Esposito[1] - PI: Nadia Shakoor[2],
Co-PIs Vasit Sagan[1], Reza Tourani[1], and Kate Holdener[1]

[1] Computer Science, Saint Louis University   [2] Donald Danforth Plant Science Center
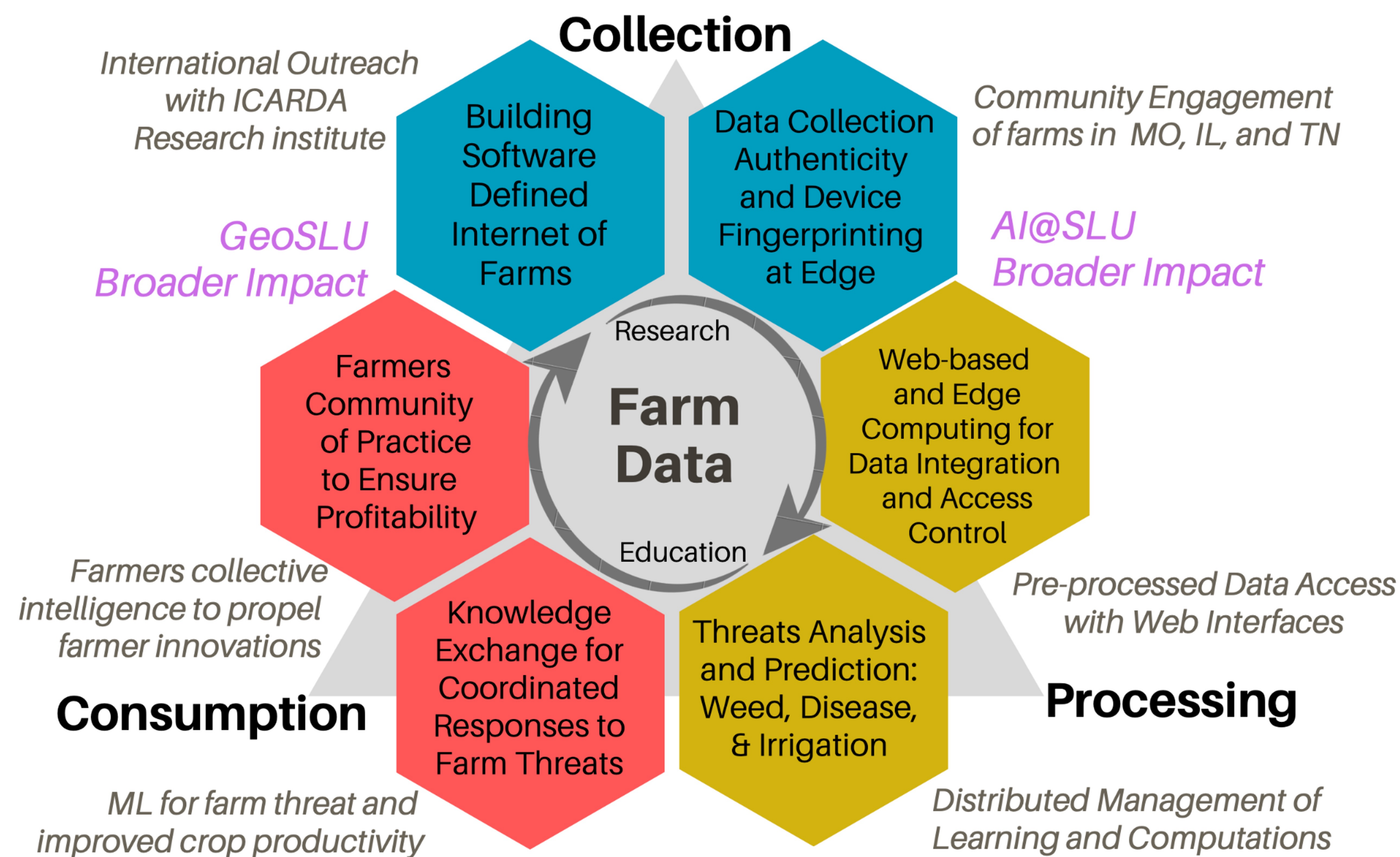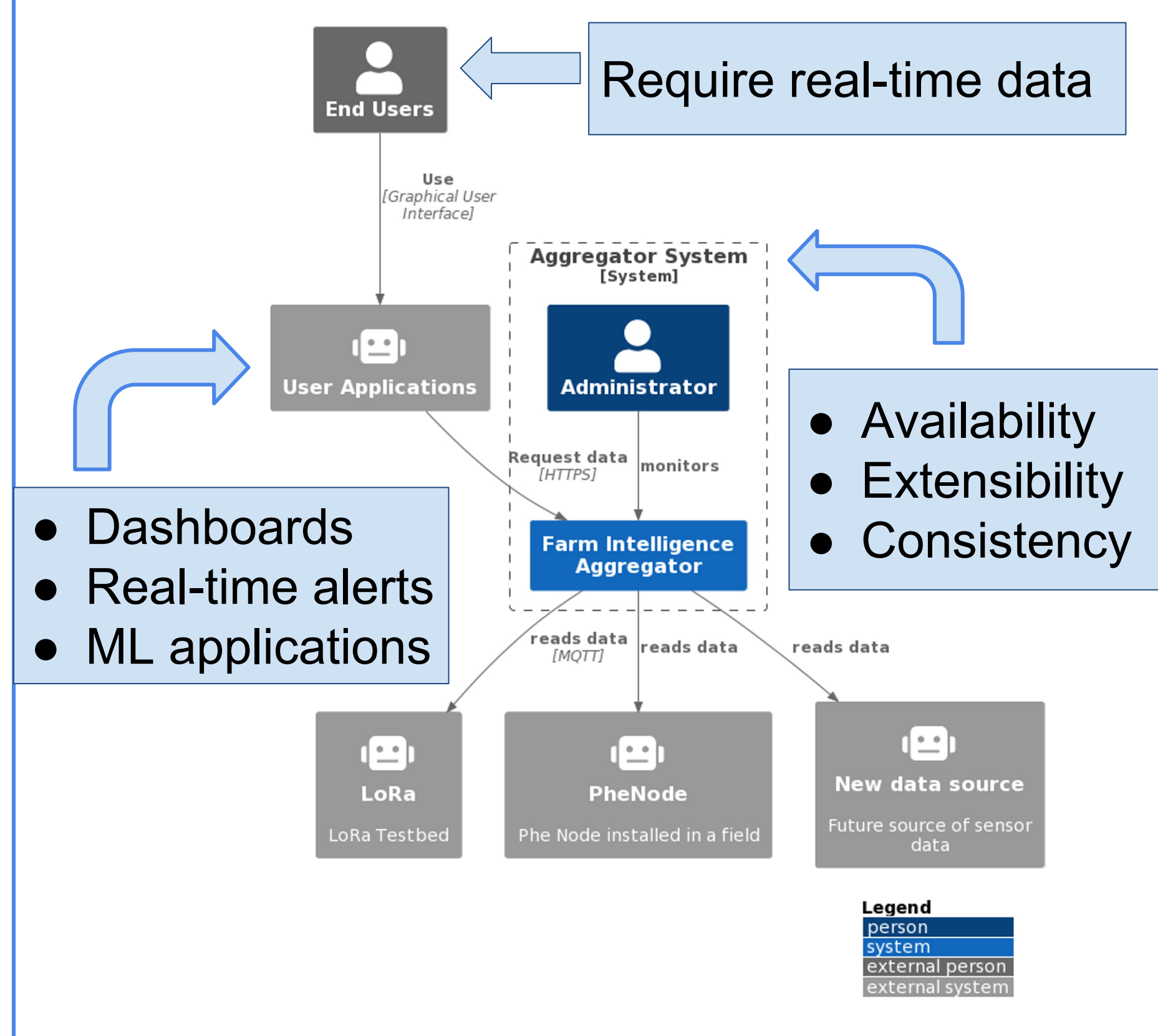
Challenges and Goals

- **Ineffective** farm **management & monitoring** due to no access to raw/aggregated sensor data
- **Slow response to plant changes** due to lack of predictive analytics
- **Unable to share data** due to lack of software platform to share data
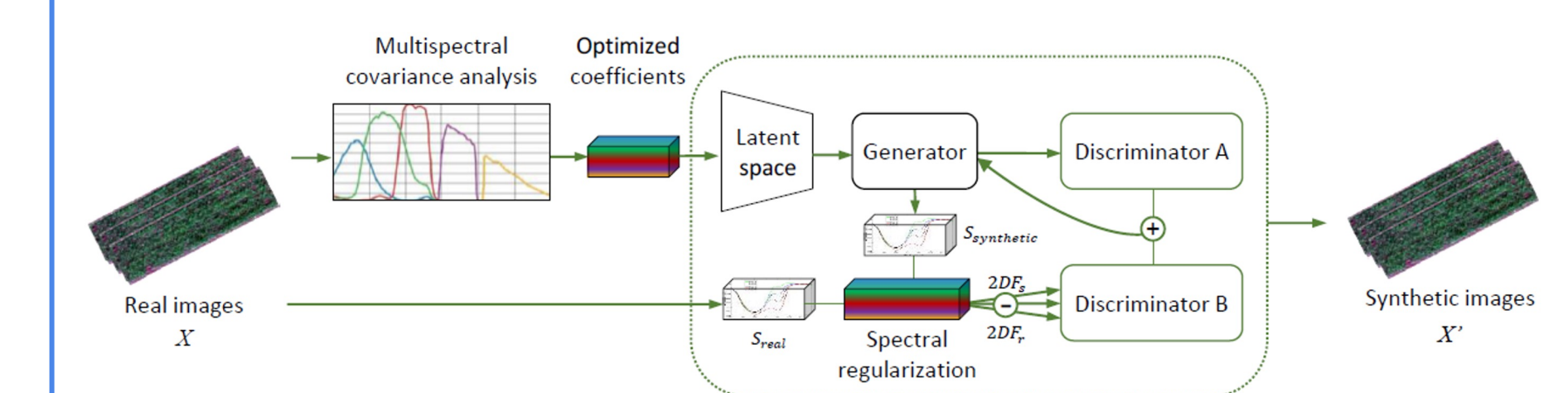
Scientific Impact

- **Monitoring & Management**
  - Secure software platform (*Farm Intelligence Aggregator*)
  - Resource efficient communication (e.g. *SoftFarmNet*)
- **Predictive Analytics** - Novel deep learning systems (e.g. *PlantPlotGAN*)
- **Privacy & Security** - Novel architectures (*IoT Sentinel*)

Farm Intelligence Aggregator

- Dashboards
- Real-time alerts
- ML applications

- Availability
- Extensibility
- Consistency

Require real-time data

International Outreach with ICARDA Research institute

GeoSLU Broader Impact

Community Engagement of farms in MO, IL, and TN

AI@SLU Broader Impact

Collection
- Building Software Defined Internet of Farms
- Data Collection Authenticity and Device Fingerprinting at Edge
- Web-based and Edge Computing for Data Integration and Access Control

Farm Data — Research / Education

- Farmers Community of Practice to Ensure Profitability
- Knowledge Exchange for Coordinated Responses to Farm Threats
- Threats Analysis and Prediction: Weed, Disease, & Irrigation

Consumption

Processing

Farmers collective intelligence to propel farmer innovations

ML for farm threat and improved crop productivity

Pre-processed Data Access with Web Interfaces

Distributed Management of Learning and Computations

PlantPlotGAN

Uses GENAI to generate multispectral synthetic crop imagery for early plant disease detection.
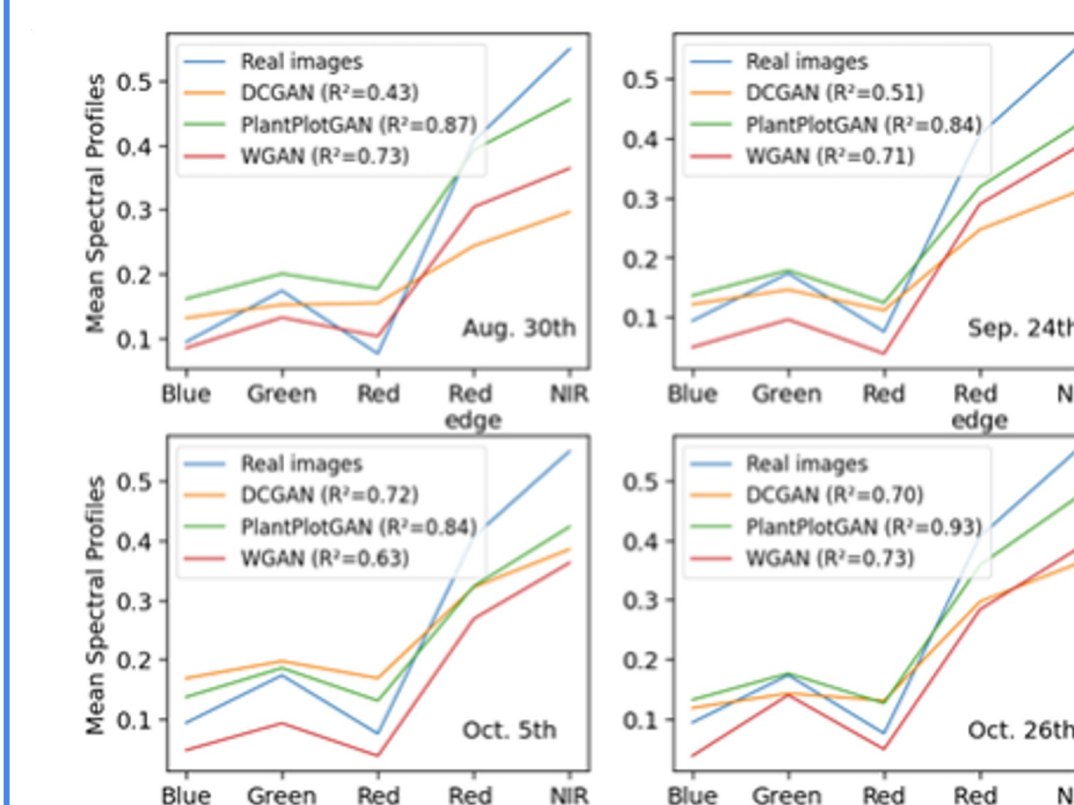
Results
- Early disease detection accuracy: 84%
- R^2 real image similarity: 93%

Broader Impact (Society)

Farmers - Improved farm monitoring & management
Plant Scientists - Improved crop yields
Computer scientists - Novel & improved ML models
Government Agencies - Improved food security

Broader Impact (Education & Outreach)

Saturday K-12 Stem Camps (SCC) - Agriculture Cyber-Physical System
Taylor Geospatial Institute - Outreach to community https://taylorgeospatial.org/

Broader Impact (Potential Impact)

Farm Intelligence Aggregator: Data sharing platform
IoT Sentinel: 96% attack detection accuracy
SoftFarmNet: 50% higher channel utilization
PlantPlotGAN: 84% early disease detection accuracy