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Building the Methodological Foundation: A Six-Step Framework for Integrating Remote Sensing, AI, and Crop Models for Crop Area and Production Monitoring In Honduras

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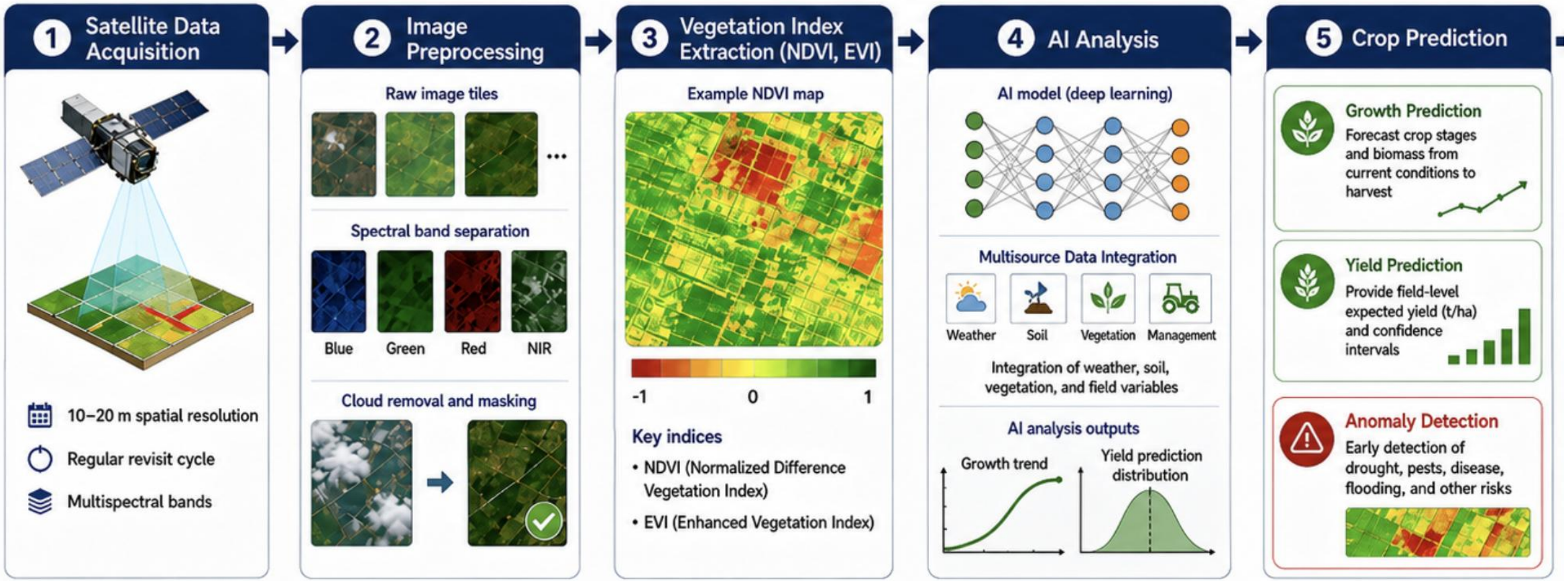
Remote Sensing Data and Artificial Intelligence



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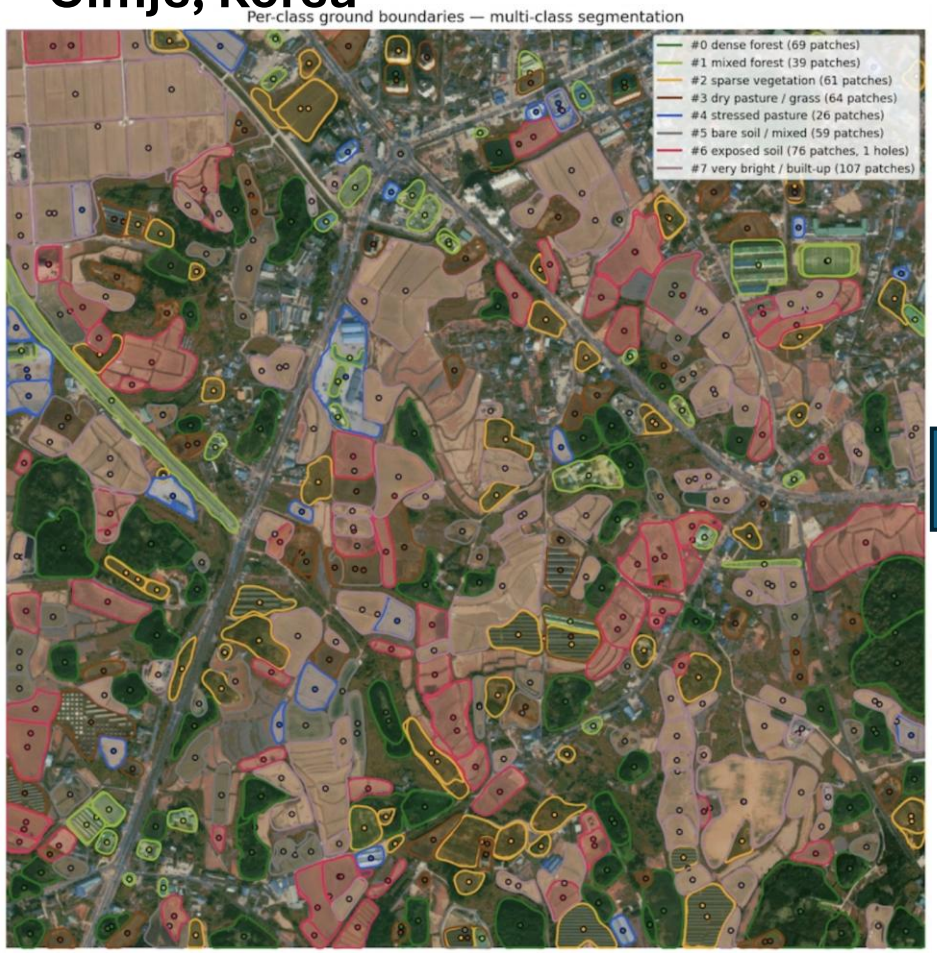
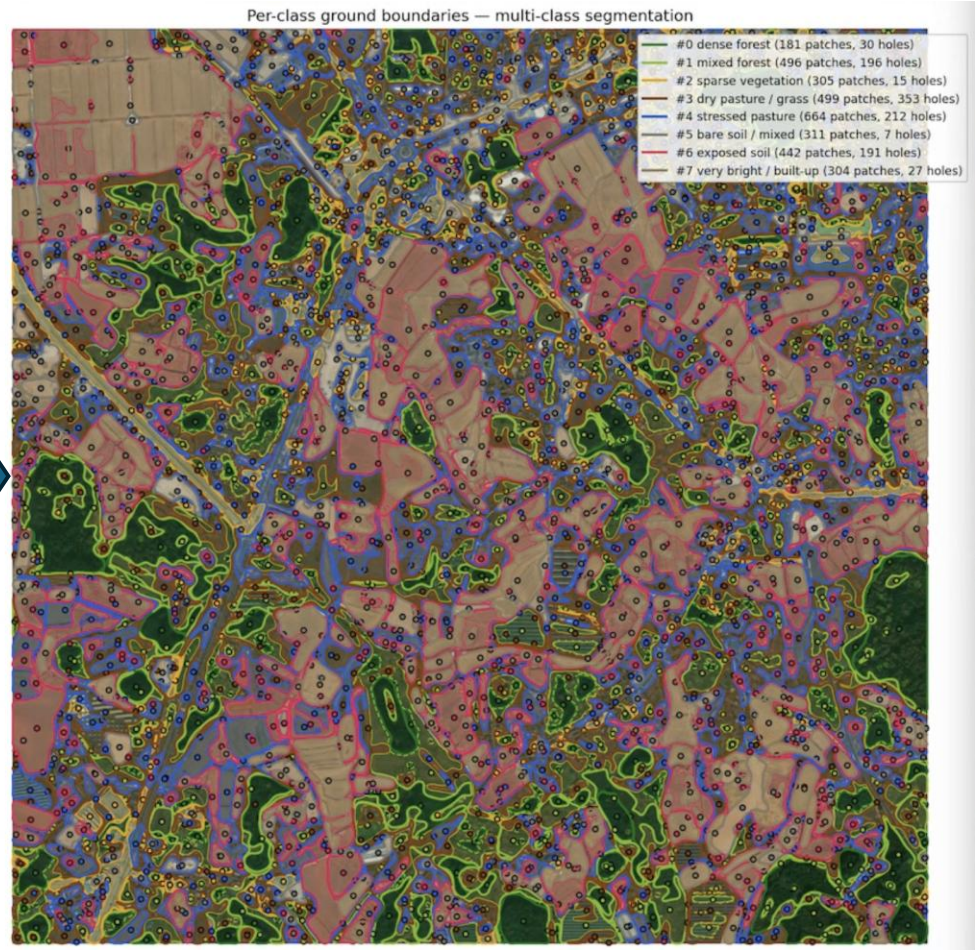
Remote Sensing Based Crop Area

Landcover Classification using AI and Ray-Tracing Algorithm - Gimje, Korea





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Remote Sensing Based Crop Area

Landcover Classification using AI and Ray-Tracing Algorithm - Catacamas Valley, Honduras

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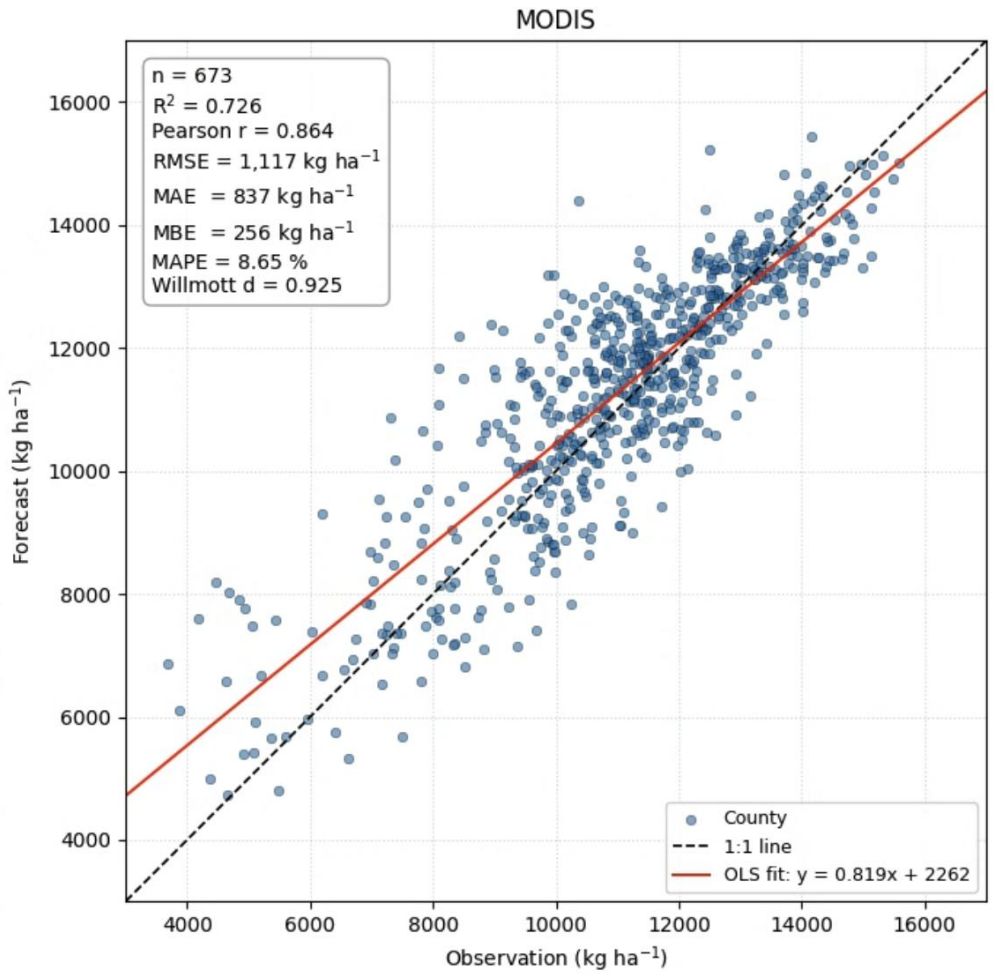
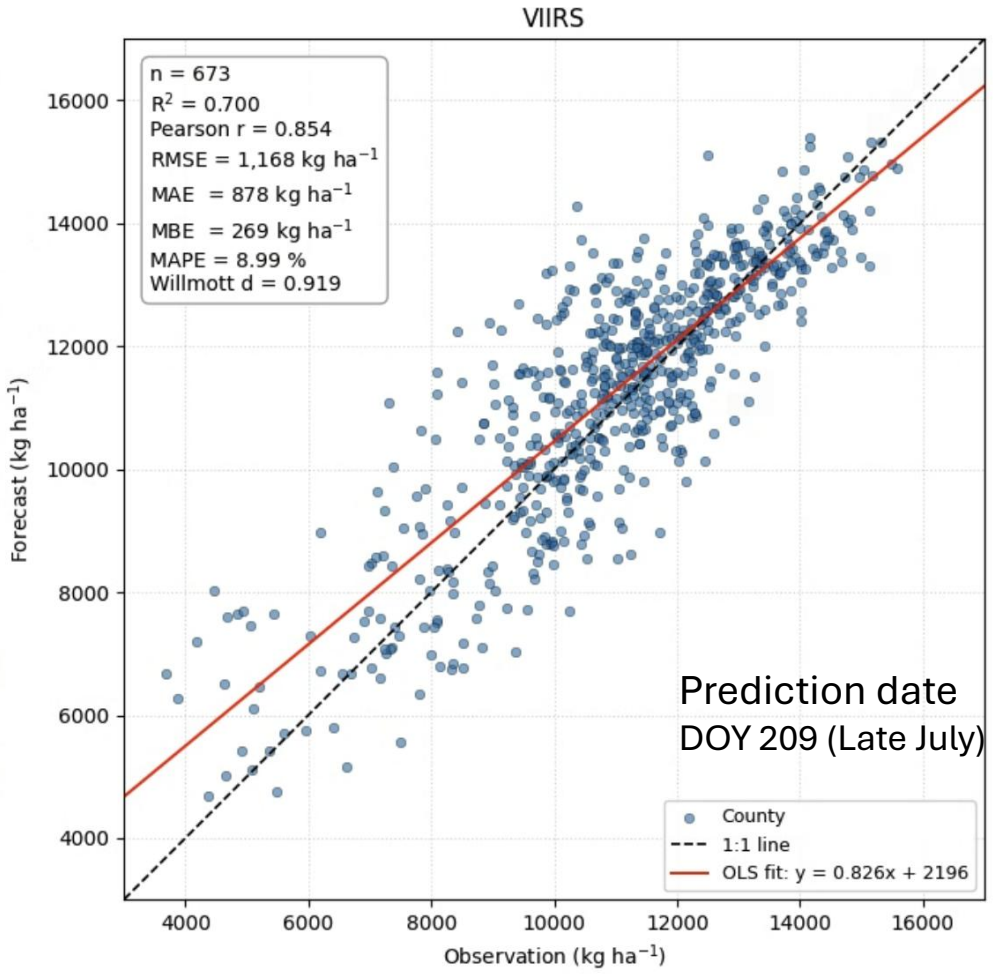
Remote Sensing Based Yield Forecast in the US

Maize Yield Forecast in 2024 using MODIS and VIIRS Data





Prediction date
DOY 209 (Late July)

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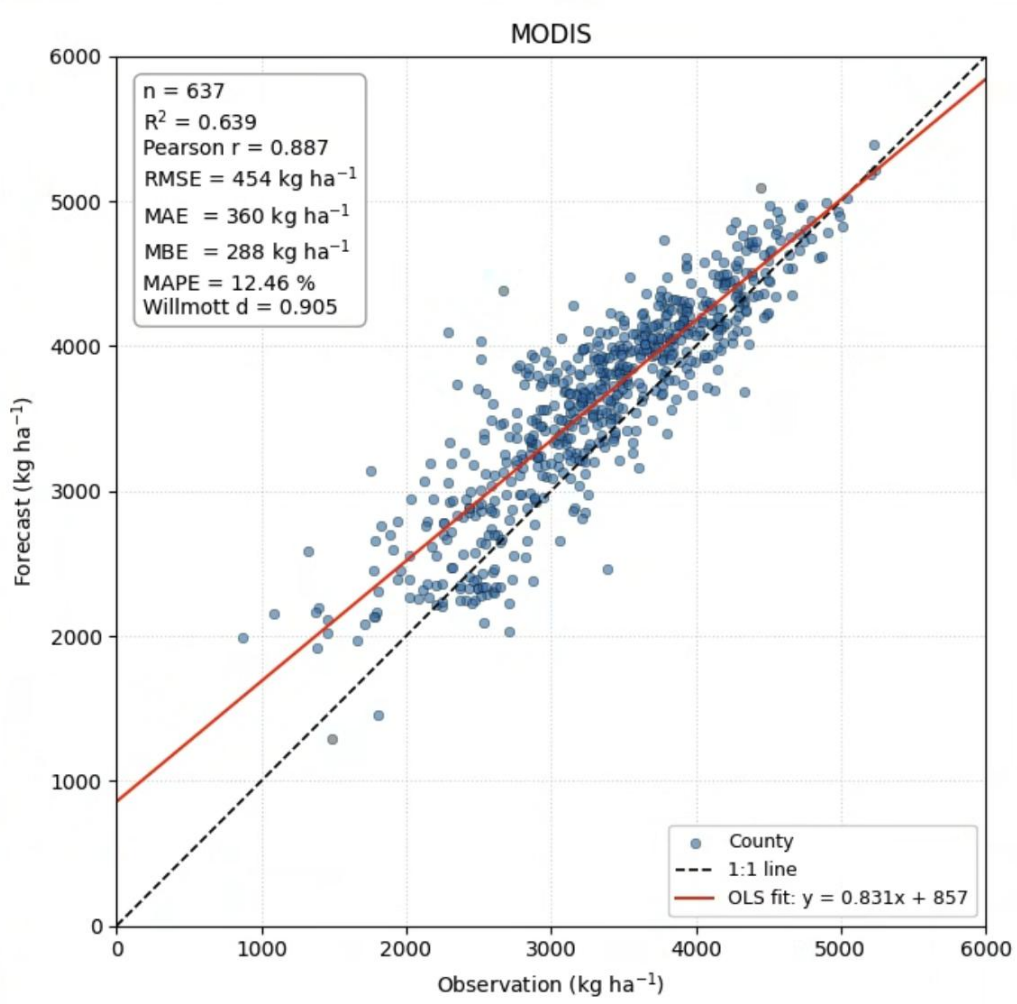
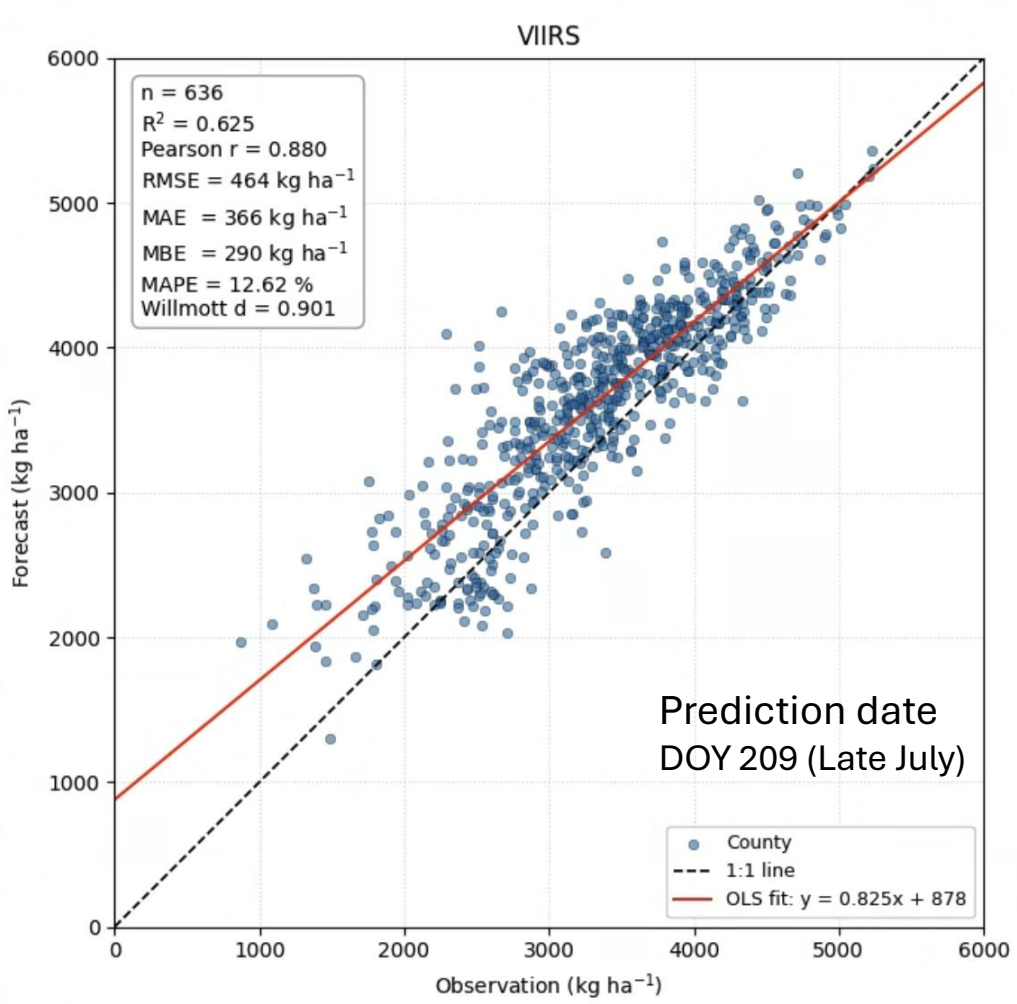
Remote Sensing Based Yield Forecast in the US

Soybean Yield in 2024 using VIIRS and MODIS





Prediction date
DOY 209 (Late July)

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What is Missing?

Limited field-level data on planted area, growth status, yield, and management

Sparse historical yield records for corn and beans

- AI models trained on scarce data risk overfitting to specific years or regions
- Predictions become unstable beyond observed conditions

In data-limited environments,

- ***Crop models can improve prediction stability beyond observed conditions by representing the biological processes that govern crop growth and yield formation***

- ***Hybrid approaches can help reduce the risk of overfitting by integrating process-based crop responses with remote sensing data and AI-driven prediction methods***

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What Crop Models Can Offer

- **Estimate yield with sparse data**

  Use weather and soil data to simulate growth and yield, even where field observations are limited

- **Interpret satellite signals**

  Distinguish whether vegetation changes reflect biological stress or differences in cropping calendar

- **Augment AI training data**

  Provide simulated yield outputs and process-based covariates when ground-truth labels are scarce.

- **Project unobserved conditions**

  Forecast outcomes under drought, heat, and delayed planting scenarios not seen in historical records.

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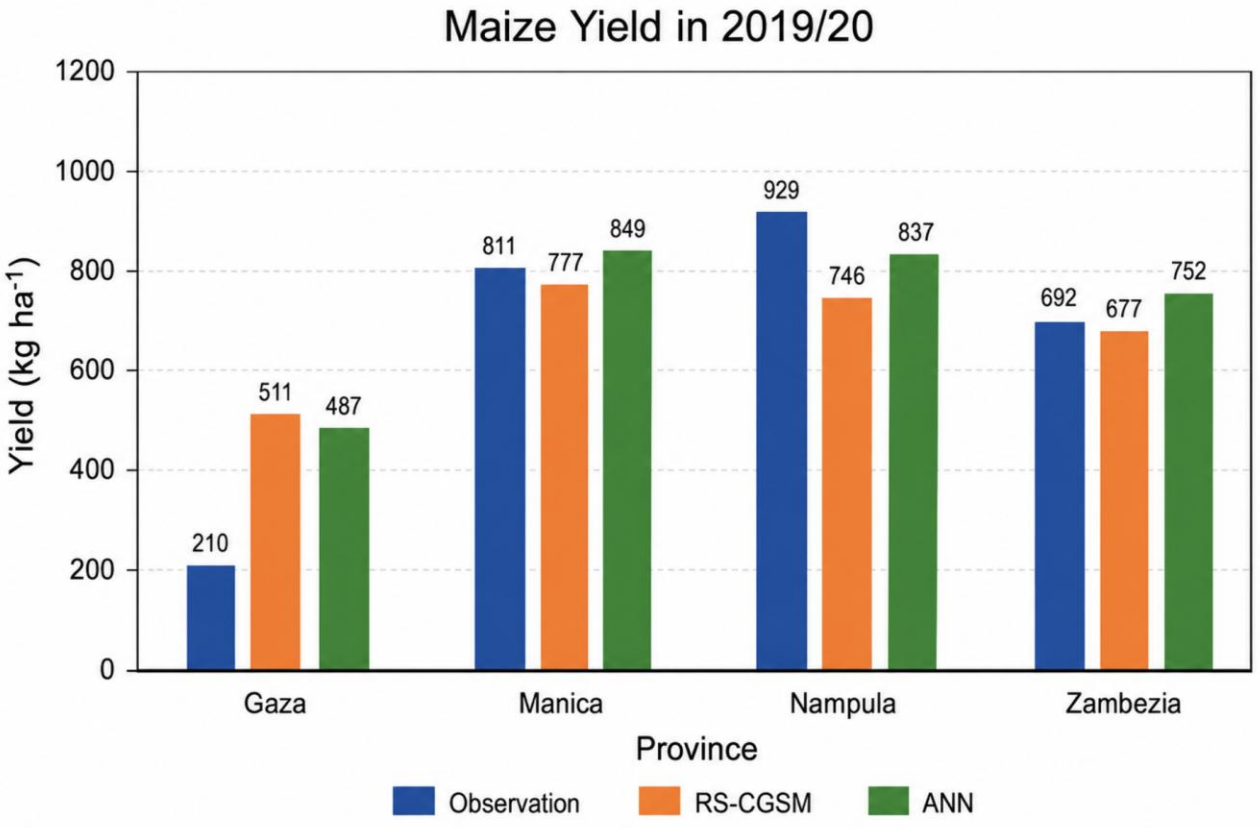
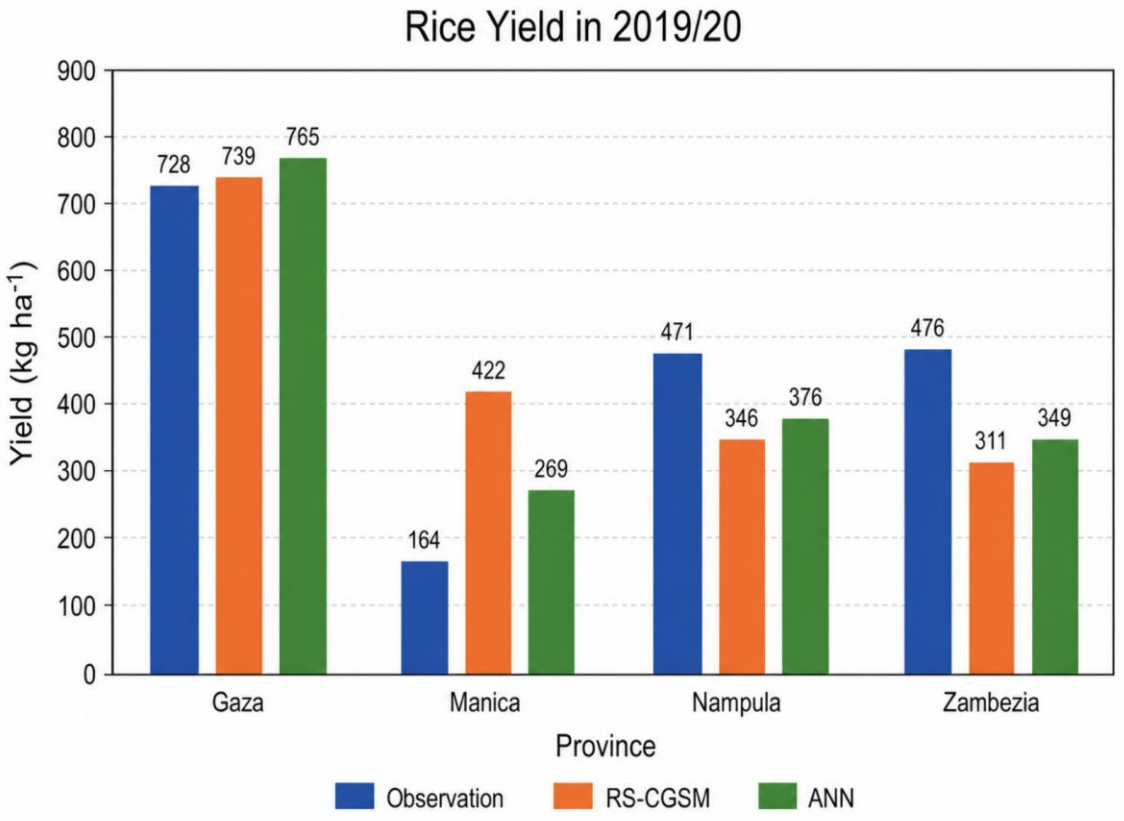
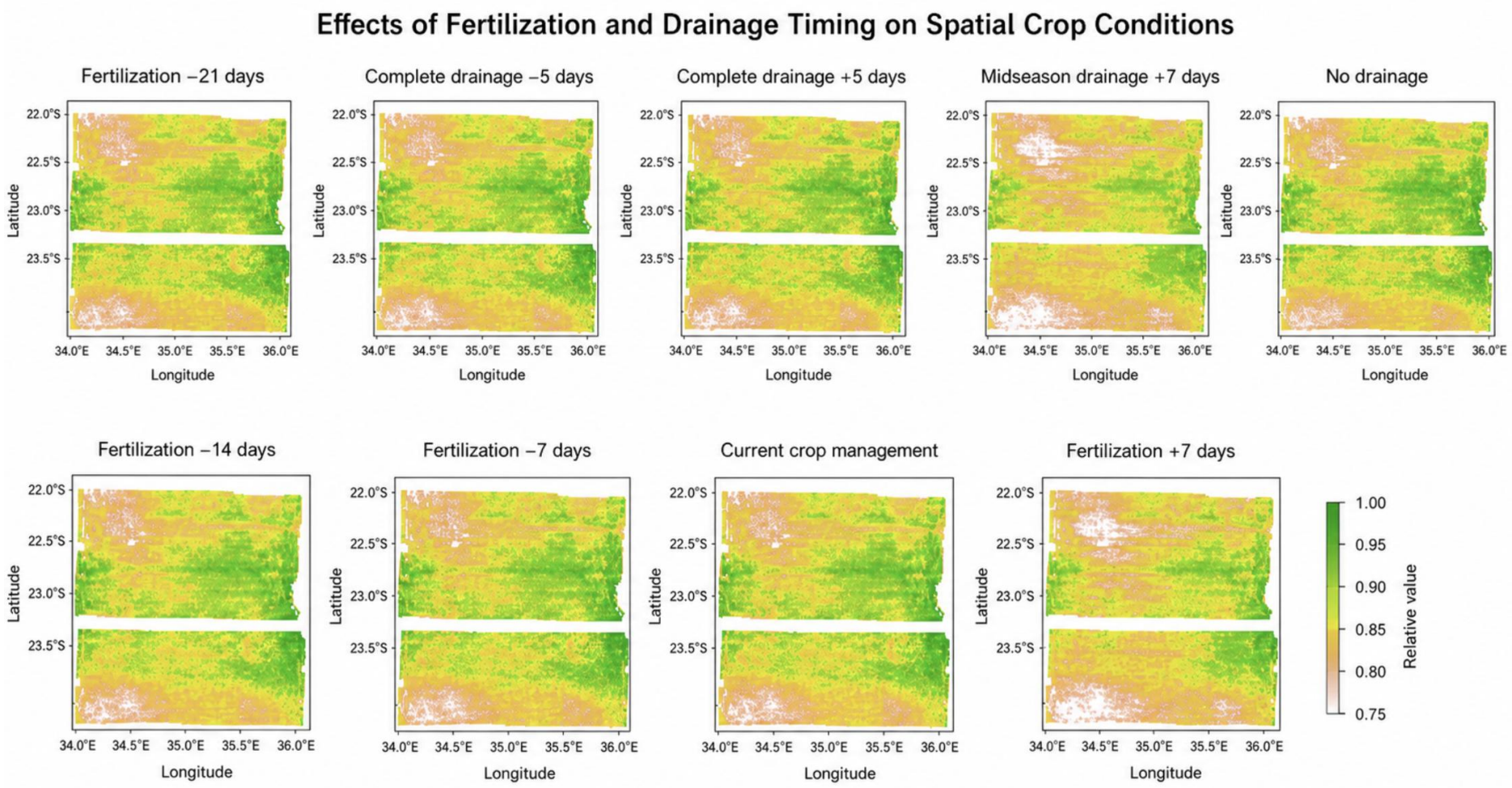
Yield Forecast using RS and Crop Model in Mozambique

Crop Yield Forecast using Remote Sensing Data and Process-Based Crop Model
- Prediction Date: Jan 15 2020





Assimilation of Drone Data into Crop Growth Simulations



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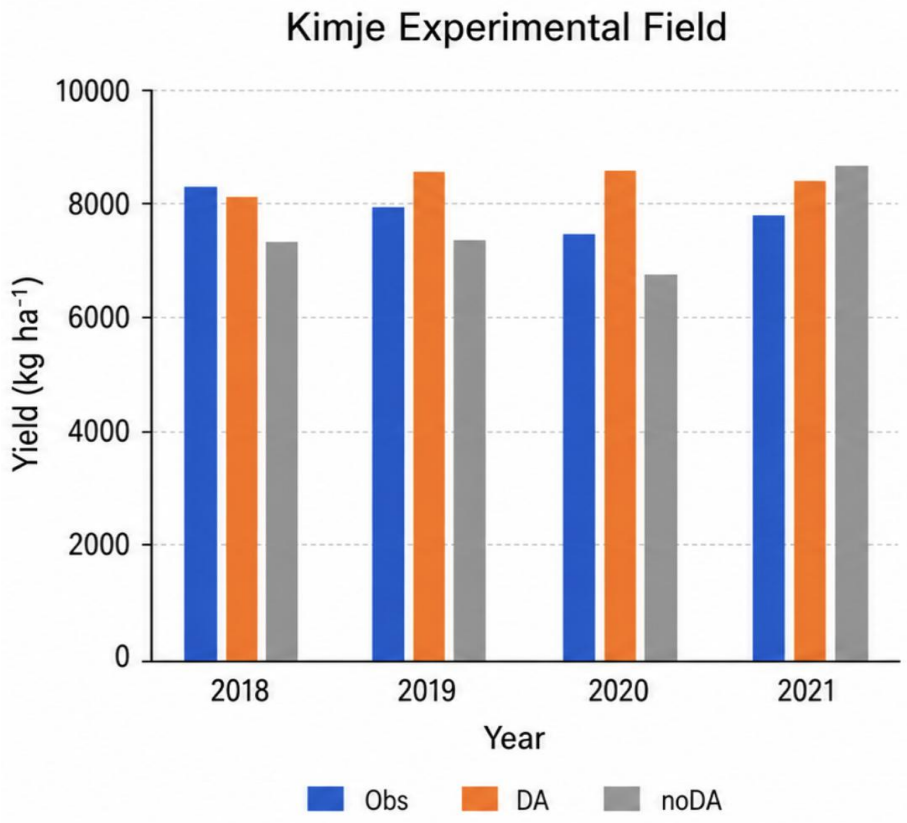
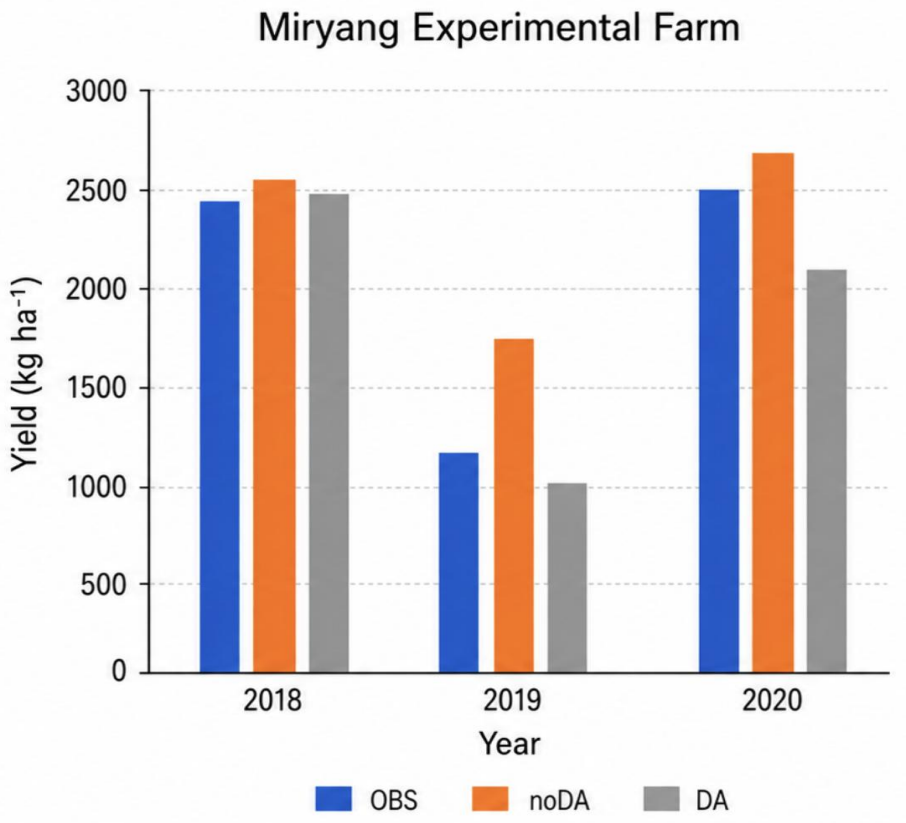
Assimilation of Drone Data into Crop Growth Simulations

Incorporating drone imagery improved crop yield prediction accuracy

- **The prediction error decreased from 11% to 8% for rice on average**
- **The prediction error decreased from 21% to 9% for soybean on average**





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Integrated approaches are proposed

Component	Primary Role
Remote Sensing	Observe planted area, growth status, and vegetation indices over wide regions
AI	Learn spatial-temporal patterns and scale predictions across the country
Crop Model	Compensate for sparse observations; explain growth and yield formation
Drones	Sample at strategic points to anchor representative national estimates

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Application to Honduras (Olancho & El Paraíso)

1 Data Acquisition
- Satellite imagery
- Drone imagery
- Weather data
- Field data

2 Crop Area Mapping
- NDVI/EVI
- AI classification of crop types

3 Crop Growth Monitoring
- Track seasonal vegetation
- Detect anomalies

4 Crop Model Assimilation
- Simulate growth
- Assimilate LAI & biomass

5 AI Yield Estimation
- ML/DL models on satellite + weather time-series
- Bias Correction

6 Production Monitoring
- Area × Yield
- Regional production
- Decisions

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Conclusion

❖ **From Observation to Operation**

- Remote sensing, AI, and crop models transform vegetation signals into actionable production intelligence

❖ **Integrated Monitoring Pipeline**

- A consistent workflow provides cultivated area, in-season crop condition, and pre-harvest yield estimates

❖ **Spatiotemporal Crop Monitoring**

- Spatially and temporally explicit information supports food security assessment, market planning, and evidence-based policy decisions

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Thank You

- Acknowledgments
  - Government of Honduras: SAG, COPECO, INE
  - ODA institutions: FAO, CIAT
  - Funding: World Bank / KGGTF

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