DEPARTMENT OF FOOD, AGRICULTURAL, AND BIOLOGICAL ENGINEERING

Satellite and drone-based assessment of cover crop biomass and nutrient uptake efficiency

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INTRODUCTION

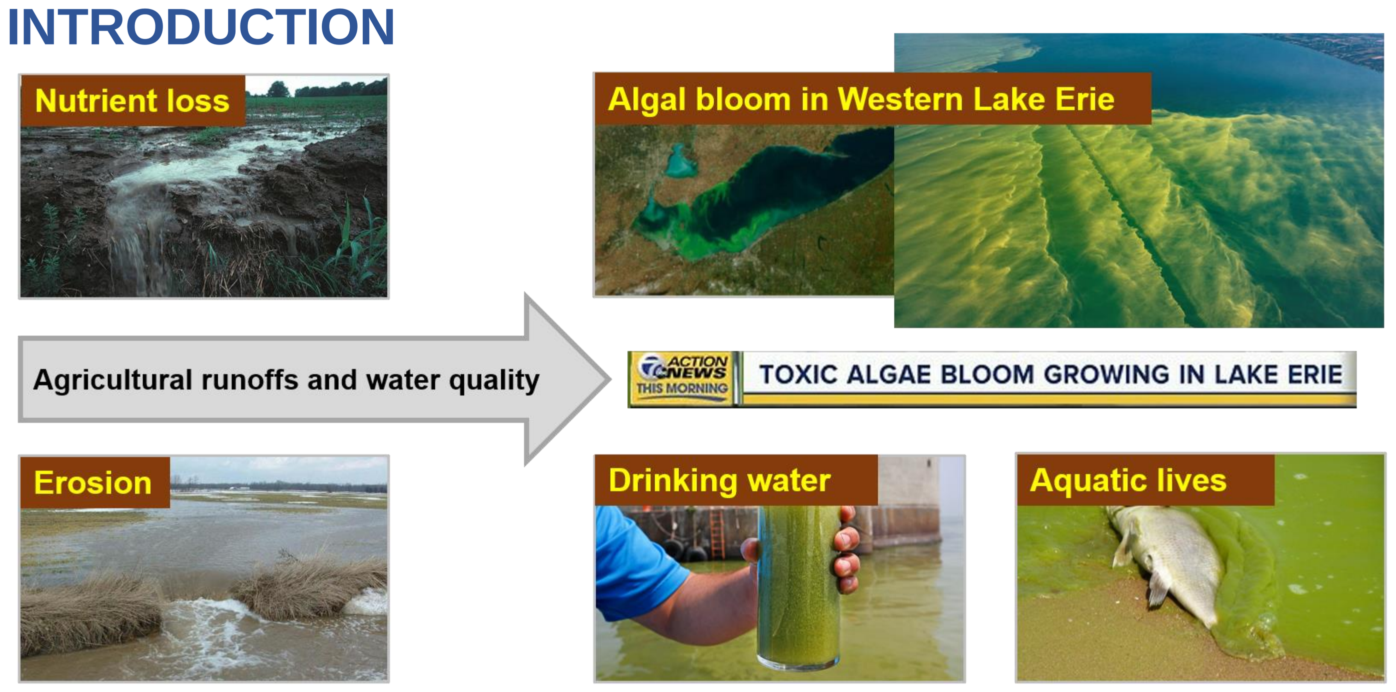

***Fig. 1**: Environmental issues due to current agricultural practices*

- Excess nutrients from current agricultural practices have led to water quality problems in the Great Lakes and around the world [1] (Fig 1).
- These agricultural practices have also led to loss in soil organic carbon and soil health degradation.
- Cover cropping has been considered as one of the conservation practices that improve water quality and soil health while improving agricultural productivity [2] (Fig 2).
- Traditional field-based approaches for monitoring the impacts of cover crops on agronomic outcomes, and soil and water quality are costly, laborious, and destructive in nature to scale-up to larger areas.

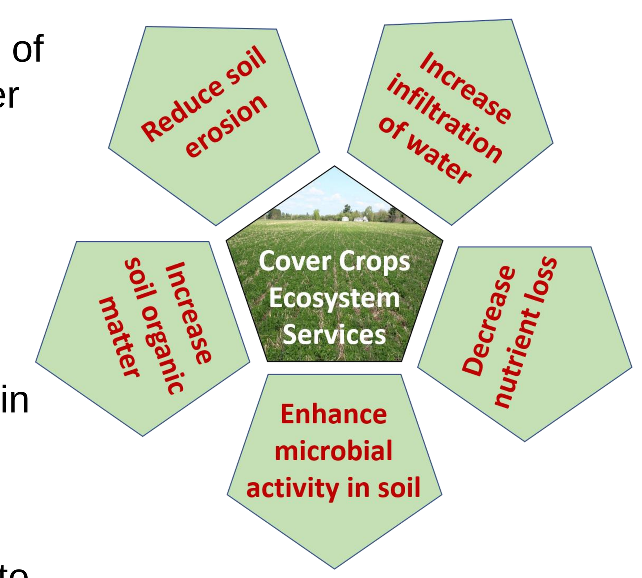

***Fig. 2**: Benefits of cover cropping practice*

OBJECTIVES

To investigate the efficacy of drone and satellite technologies for monitoring cover crops and their nutrient uptake efficiency.

Study Area

- **15 cover crop fields in the Northwest Ohio were used for field data collection (Fig 3).**
  - 12 farmers from 10 counties were involved.
  - Fields were planted in cereal rye after the harvest of soybean in fall.
  - Drilling was used to plant cereal rye in 13 fields.
  - Cover crops were planted using an aerial approach in one field and a broadcast in another field.

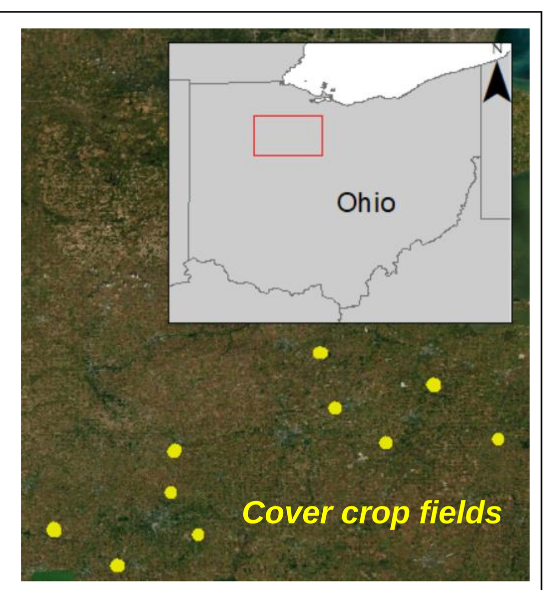

***Fig.3**: Study area*

METHODS

Data collection

- Field data were collected for three times (Fig 4).
  - *T1: March 2 to March 9*
  - *T2: March 29 to April 6*
  - *T3: April 26 to May 12*
- Six biomass samples per field from 0.5x0.5 m quadrat were collected.
- Drone surveys with DJI Phantom4 with a multispectral sensor were conducted.
  - *Spectral Bands: Blue, Green, Red, Red Edge, Near-infrared*

***Fig 4**: Data used in the study*

- Drone flights were conducted before sample collection.
- Images from the PlanetScope (3-meter) satellite were compiled and processed.
  - *Spectral Bands: Blue, Green, Red, Near-infrared*

Data processing

- Biomass and soil samples were sent to lab to determine nutrient content (Fig 5).
- Reflectance and vegetation indices were calculated from drone and satellite (Fig 5) images.
- Correlation between biomass, nutrient content, and vegetation indices from remotely sensed images were determined.

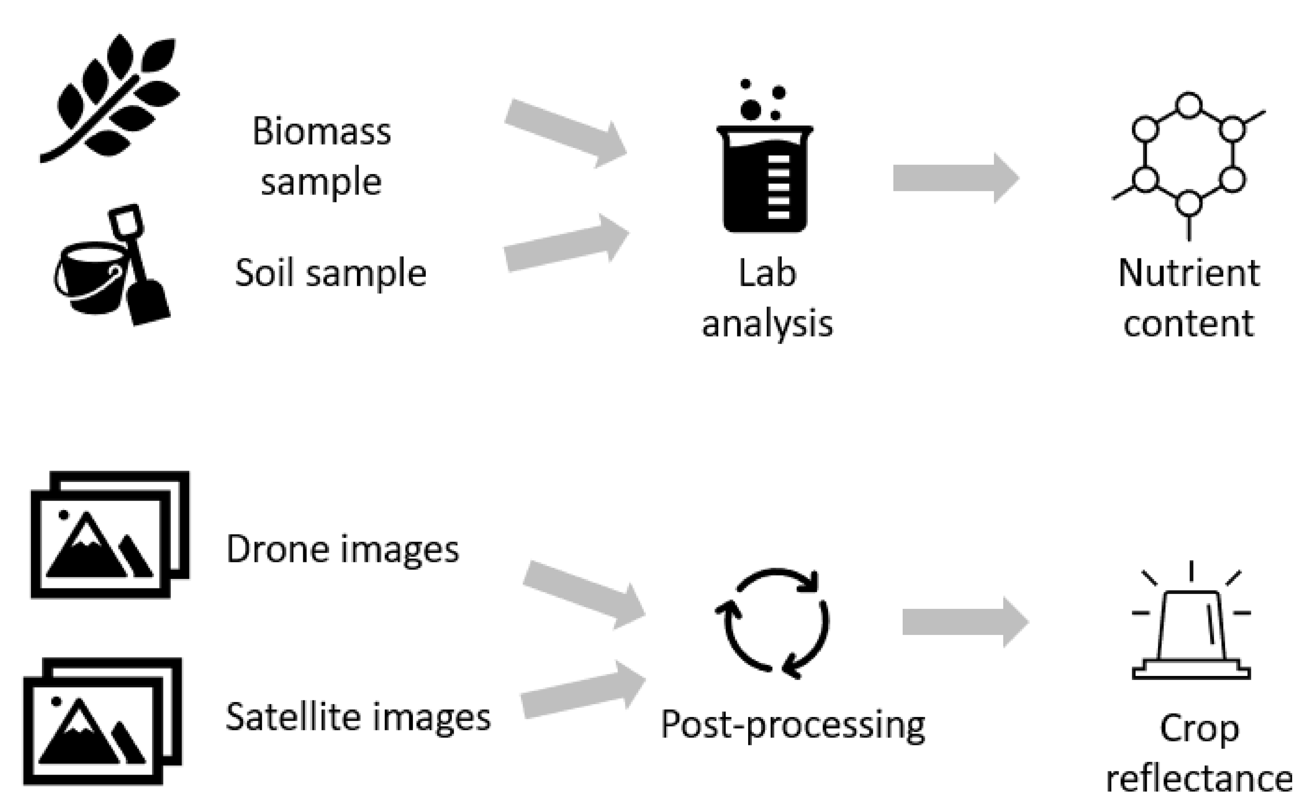

***Fig 5**: Data processing steps*

PRELIMINARY RESULTS

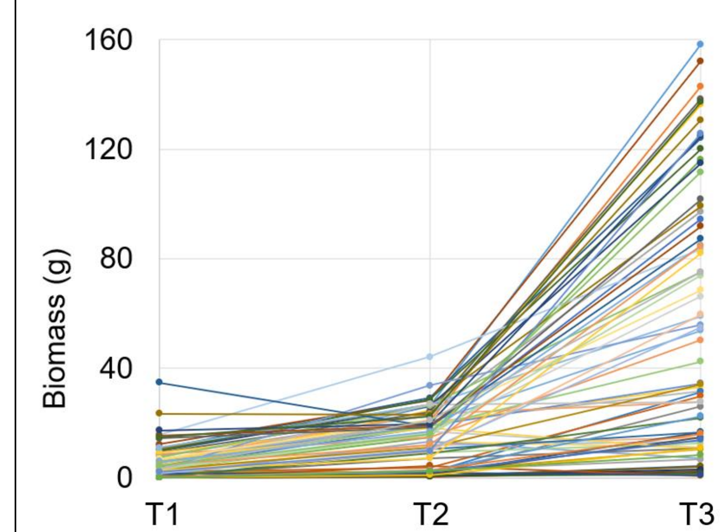

***Fig 6**: Cover crop biomass at three data collection periods*

- Significant biomass growth was observed between T2 to T3 (Fig 6).
- Biomass was correlated well with plant tissue nitrogen and phosphorus (Fig 7).
- High correlation was observed between biomass and NDVI from both drone and satellite data (Fig 8).
- A majority of fields had nitrate drawdown at T3.
- Biomass and soil organic matter did not have significant positive correlation.

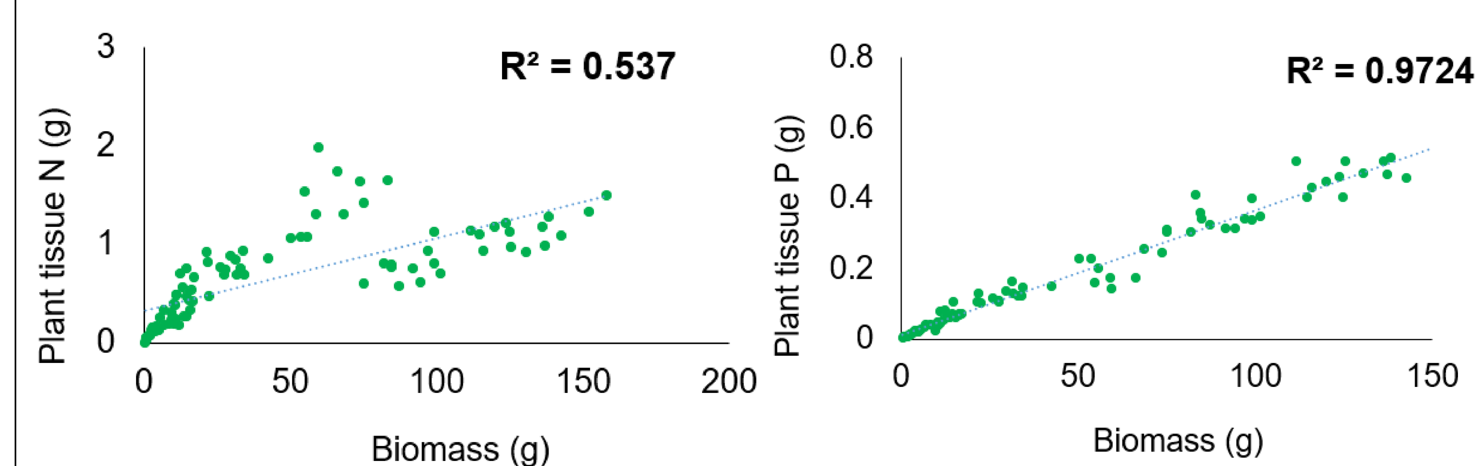

***Fig 7**: Relationship between plant tissue nutrient weight and biomass*

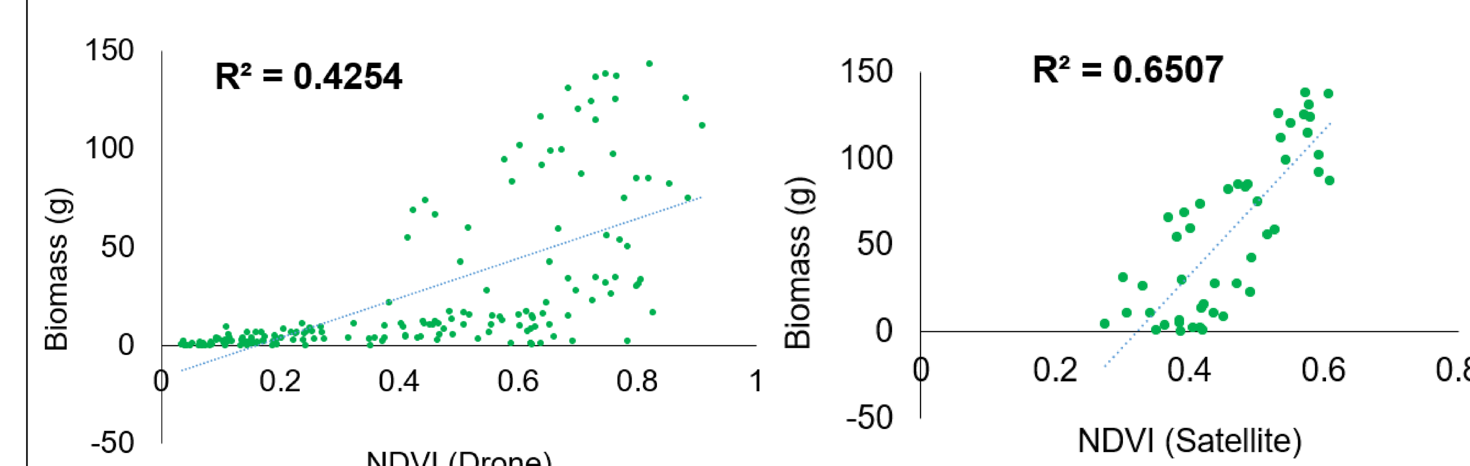

***Fig 8**: Relationship between NDVI and biomass*

CONCLUSIONS

- Biomass was positively correlated with vegetation indices derived using satellite and drone images.
- Vegetation indices from remote sensing data can be used to predict growth as well as nutrient uptake ability of cover crop.

FUTURE WORKS

- Quantify non-linear relationships between plant and soil nutrients using machine-learning models based on remote sensing data.

REFERENCES

[1] Gronewold, A. D., Fortin, V., Lofgren, B., Clites, A., Stow, C. A., & Quinn, F. (2013). Coasts, water levels, and climate change: A Great Lakes perspective. Climatic Change, 120(4), 697–711.
[2] Strock, J. S., Porter, P. M., & Russelle, M. P. (2004). Cover Cropping to Reduce Nitrate Loss through Subsurface Drainage in the Northern U.S. Corn Belt. Journal of Environmental Quality, 33(3), 1010–1016.

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