CFAES DEPARTMENT OF FOOD, AGRICULTURAL, AND BIOLOGICAL ENGINEERING

Application of satellite and drone-based imagery for monitoring cover crop biomass and their nutrient uptake efficiency

Kushal KC[1], Matthew Romanko[2], Steve Culman[3], Boden Fisher[2], Brigitte Moneymaker[2], Chris Strasbaugh[4] and Sami Khanal[1,*]

INTRODUCTION

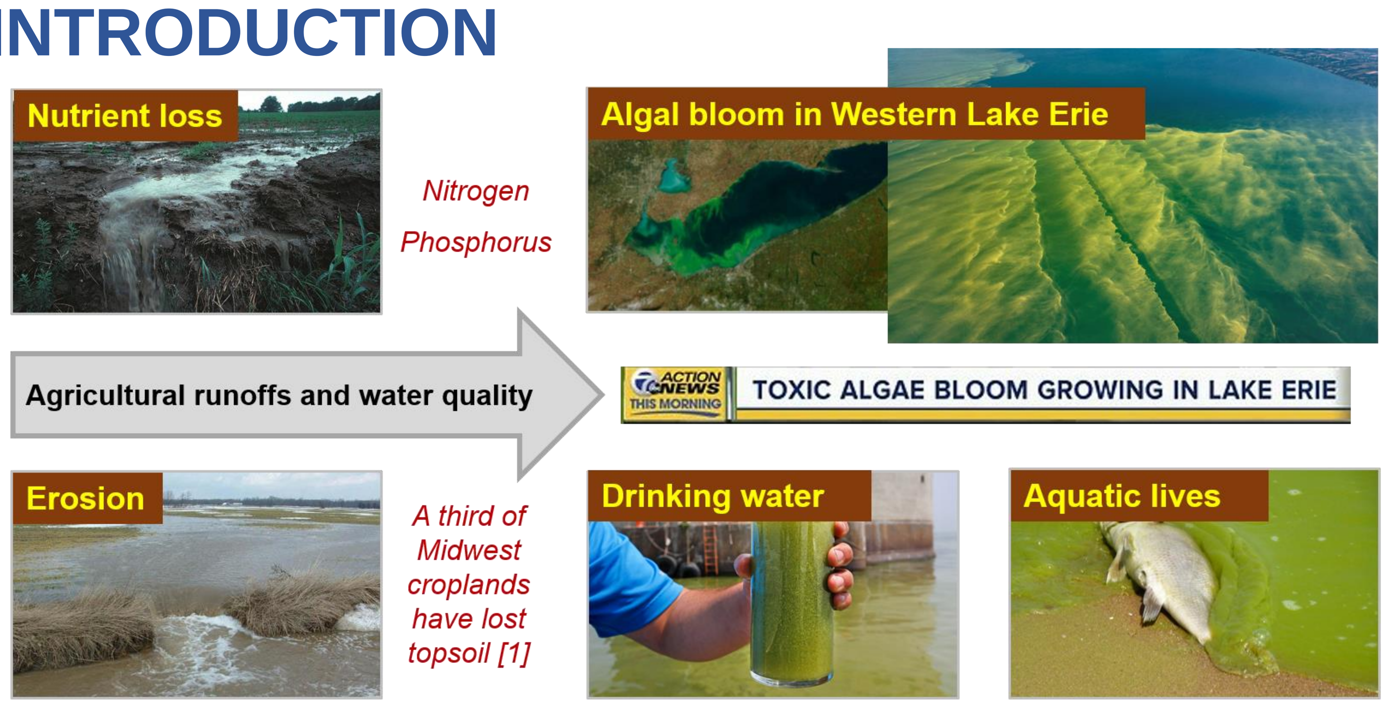

***Fig. 1**: Environmental issues due to current agricultural practices*

- Current agricultural practices are one of the major drivers of water quality problems in the Great Lakes and around the world [2] (Fig 1).
- Nutrients runoff and soil erosion have led to the growth of algae in the water resources and soil health degradation in croplands.
- Cover cropping has been considered as one of the conservation practices that improve water quality and soil health while improving agricultural productivity [3] (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.

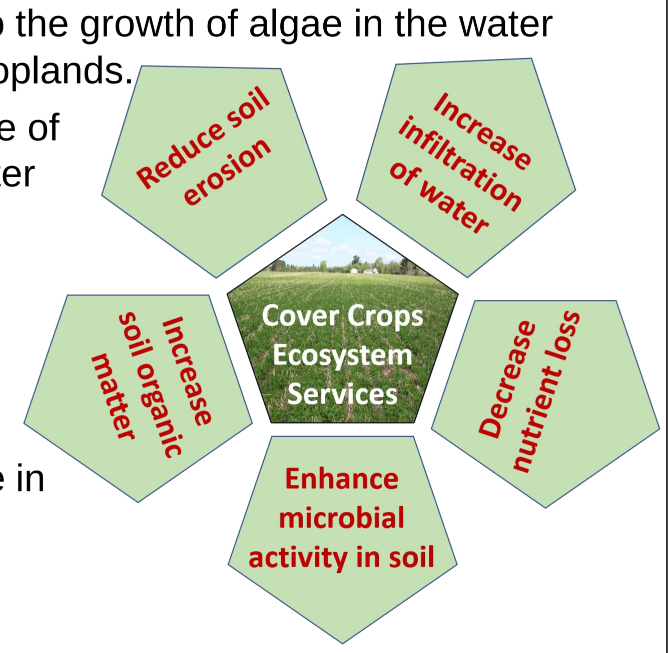

***Fig. 2**: Benefits of cover cropping practice*

Objective

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 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. An aerial approach was implemented in one and a broadcast in another field.
  - Field works were done during cover crop growing season of 2020 (fall of 2020 to spring of 2021).

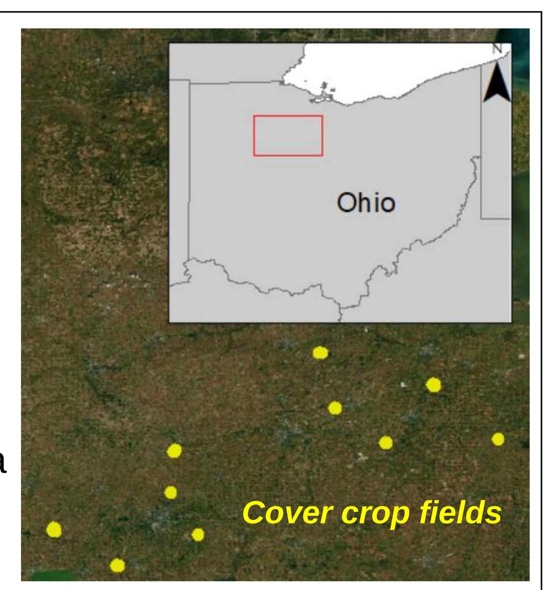

***Fig.3**: Study area*

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 were conducted with DJI Phantom4 with a multispectral sensor onboard.
  - *Spectral Bands: Blue, Green, Red, Red Edge, Near-infrared*

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

- Drone flights were conducted before sample collection.
- Satellite images from the PlanetScope (3-meter) satellite were compiled and processed.
  - *Spectral Bands of satellite images include Blue, Green, Red, Near-infrared*
- Regression models were built with remote sensing-based crop health variables and cover crop biomass

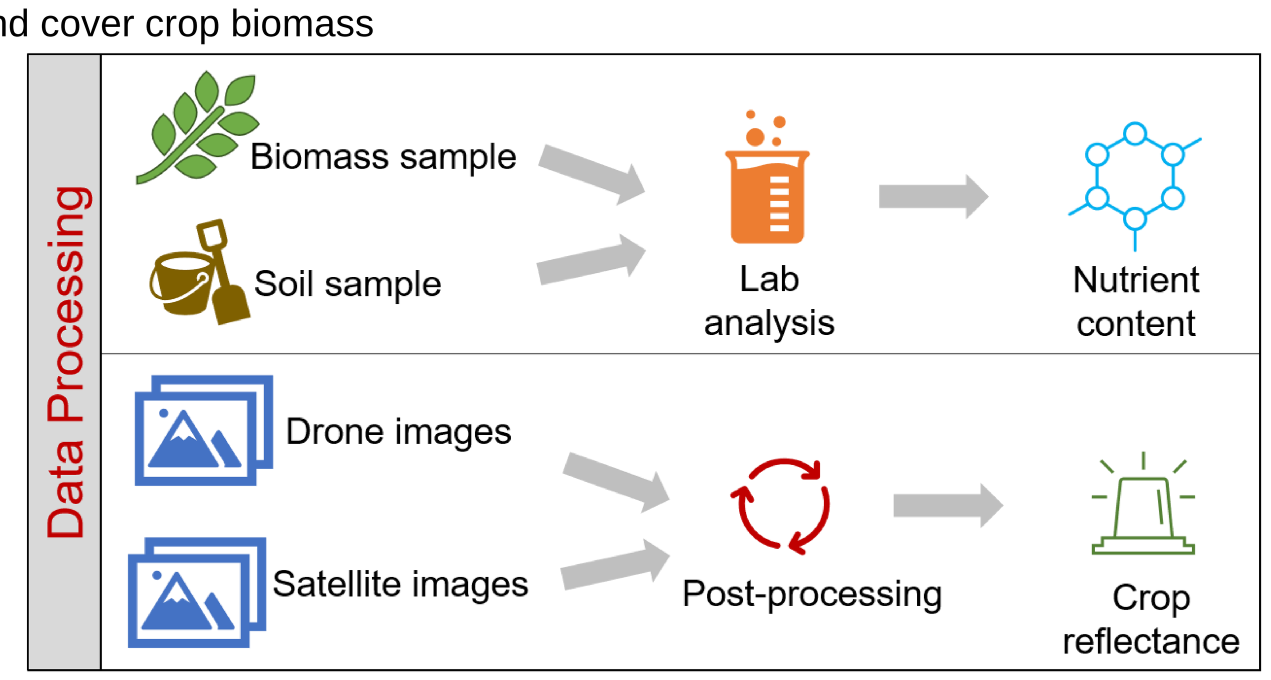

***Fig 5**: Data processing steps*

FINDINGS

- Significant biomass growth was observed between T2 to T3 (Fig 6).
- Biomass was correlated well with plant tissue nitrogen and phosphorus (Fig 7).
- Random forest (RF), support vector machine (SVM), and gradient boosting (GB) were found to perform better in the estimation of biomass (Fig 8).
- The models showed consistently higher R2 for satellite data than drone data which was not expected (Fig 9).

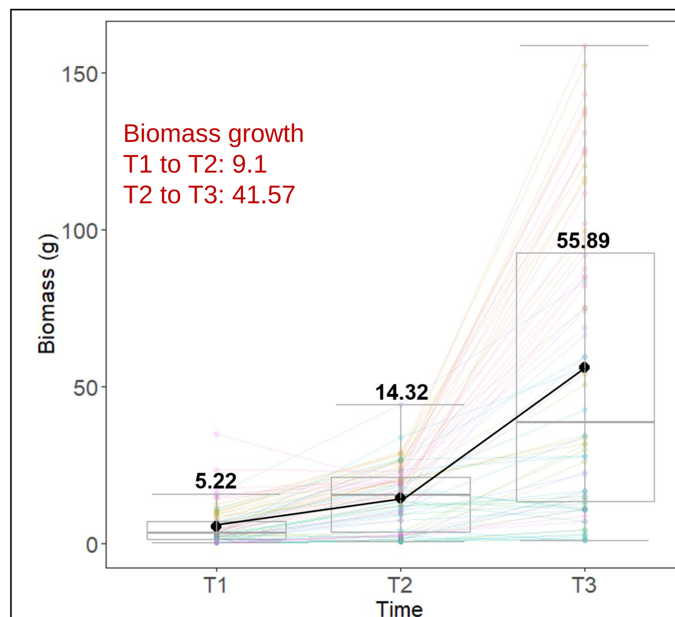

***Fig 6**: Cover crop biomass at three data collection periods*

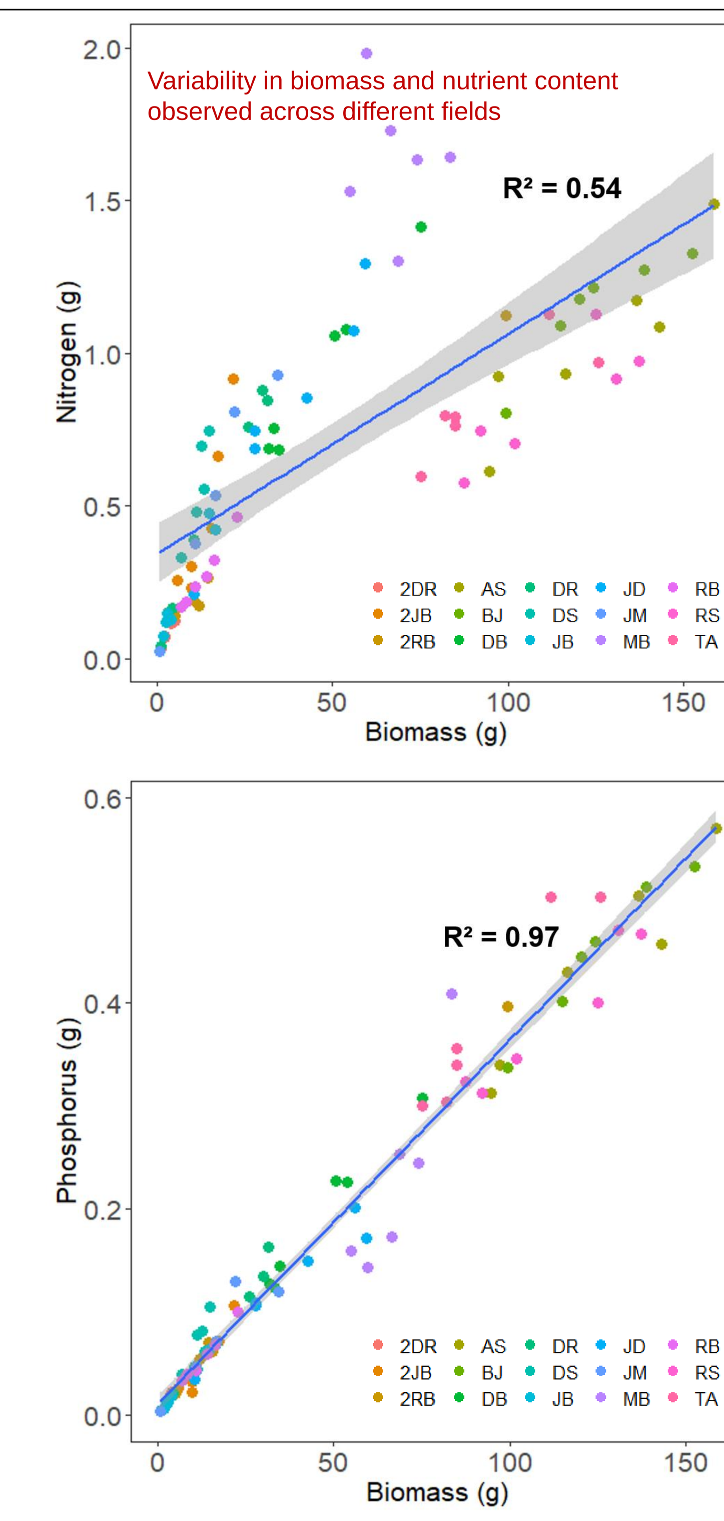

***Fig 7**: Relationship between plant tissue nutrient weight and biomass*

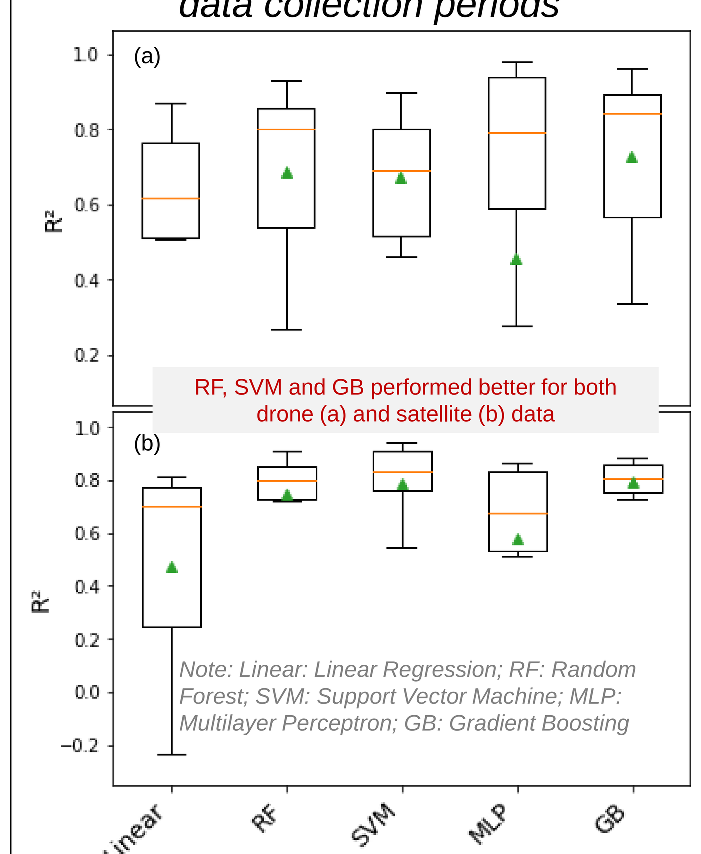

***Fig 8**: Performance of biomass prediction models in a 10-fold cross-validation*

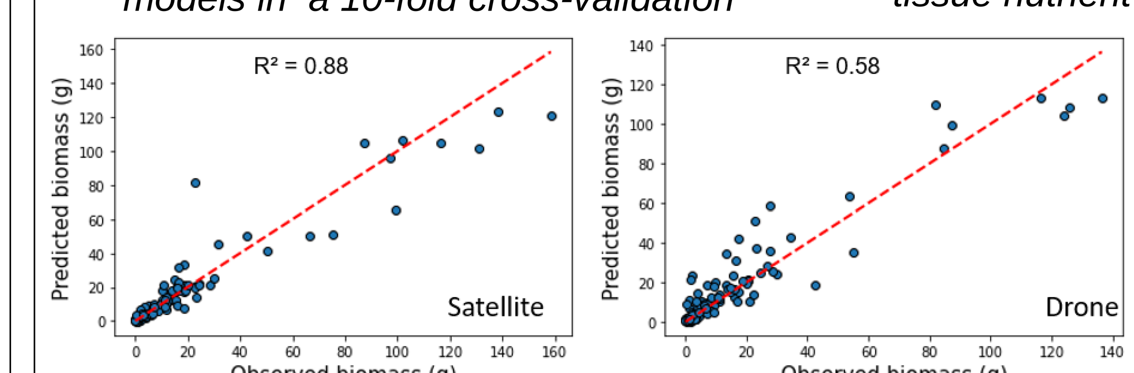

***Fig 9**: Comparison of predicted biomass from Gradient Boosting with observed independent data*

IMPLICATIONS

- Cost effective prediction of cover crop biomass and their nutrient uptake efficiency at a landscape scale under various management practices and weather conditions.
- Provides information/locations about underperforming hotspots within a field/region.
- The findings from the study can be useful in developing cost-share programs for promoting the adoption of cover crops.

REFERENCES

[1] Thaler, E. A., Larsen, I. J., & Yu, Q. (2021). The extent of soil loss across the US Corn Belt. Proceedings of the National Academy of Sciences, 118(8). https://doi.org/10.1073/pnas.1922375118
[2] 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.
[3] 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.

ACKNOWLEDGEMENTS

Hatch Project NC1195; and OSU SEED Grants from Linkages & Leverage program and Sustainability Institute

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

[1]Department of Food, Agricultural, and Biological Engineering, The Ohio State University
[2]Ohio State University Extension, The Ohio State University
[3]School of Environment and Natural Resources, The Ohio State University
[4]College of Engineering Technology Services, The Ohio State University
*Corresponding author