Research / Extension expertise

- Precision agriculture, machinery automation and development of digital tools to help improve the farm operation and in-season decisions.

Relevant research summary & findings

- Remote sensed imagery for 1) corn and in-season N applications (reduced rates; higher N-use efficiency) and 2) high resolution soil characterization (new data layers to inform fertilizer applications)
- Sub-surface placement of P and K fertilizers (reduced rates)
- Fertilizer applicator workshops and demonstrations (farmers and other operators)
- Mobile Applications (APPs): Ohio State PLOTS, FeRt and SpreadCAL
- CFAES Water Quality Task Force: importance of ‘translation’
- eFields Report – see [https://digitalag.osu.edu/efields](https://digitalag.osu.edu/efields)
Water Quality/Lake Erie Strategies

Considerations:
► How well have we captured the impacts of changes in farm management practices on water quality outcomes?
► Margins are tight for Ohio grain and animal producers, and therefore any additional cost borne by this group must not only address DRP, but also return value to grain and animal production enterprises.
► Solutions for managing DRP should not reduce the proportion of Ohio cropland cultivated but increasing the adoption of conservation tillage or no-till production practices is important.
► Nutrient stratification over agricultural lands can be common in WLEB watersheds as most producers apply commercial fertilizer using surface application equipment (spinner and air boom spreaders).

Solutions:
► Expand data collection on actual spatial and temporal trends in farm practices being used.
► More research on effectiveness of interventions (evaluation research)
► Expand CFAES on-farm research foot print with focus on nutrient management (improve farmer engagement).
  o Expand research on fertilizer placement and variable-rate strategies.
► Facilitate engagement among researchers, farmers, other stakeholders
Research expertise

- Behavioral decision science, decision making under risk & uncertainty, integrating behavioral heterogeneity into systems models, adaptation to climate-exacerbated hazards, farmer adoption of conservation practices

Most relevant research summary & findings

- **Identifying the factors influencing adoption of BMPs**
  - Cover crops: Burnett et al. 2018
  - 4Rs of nutrient stewardship: Zhang et al. 2016; Smith et al. 2018
  - Willingness to take action: Wilson et al. 2014

- **Linking models of farmer behavior to watershed models**
  - Wilson et al. 2018

- **Applying behavioral solutions to conservation challenges**
  - Motivating action: Irwin et al. 2016; Wilson et al. 2018
  - Dealing with timescale challenges: Wilson et al. 2015
Water Quality/Lake Erie strategies

Considerations:

► The majority of farmers are willing to take additional action (~90%)
  ► Negative effect of age and rented acreage on willingness
► Perceived efficacy is a consistent barrier to adoption across practices
  ► Doubling farmer efficacy = enough change to meet loading reduction targets
► Adoption rates relatively static (2016-2018), but could double if we capitalize on “good intentions” (e.g., from 35 to 70% subsurface)

Solutions:

► Remove *perceived* information barriers: effectiveness
  ► Benefits framing (e.g., resiliency), longer programs
► Remove *real* structural barriers: confidence
  ► Landlords/rental agreements, access to equipment
► Spatially target practices to high risk fields/locations
  ► Particularly important for water mgmt, edge of field filtering/wetlands
► Decision support tools for in-field decision making!!!!
  ► Practices tailored to meet on-farm objectives given predicted BMP effectiveness over baseline conditions
Research expertise

- Partnerships with stakeholders
- Field studies of targeted management actions
- Watershed Modeling: What management is needed to WQ reach targets?
- Green infrastructure for urban stormwater management

Most relevant research summary & findings

- Formed Public-Private Partnership to locate BMPs on legacy P fields
  - $5M from USDA: Incl: Crop Consultants, Commodity Orgs & TNC
  - Quantify benefits of locating magt. to most needed sites
- Stakeholder-guided Multi-model approach
  - Partners incl: Govt. agencies, Ag. Orgs, Env. Orgs, other Universities.
  - Identified basin magt. plans that approach GLWQA targets
  - DRP harder to reduce than TP, most actions reduce P > N
  - Identified most effective magt. actions: i.e. subsurface placement
- Integrated studies-social, econ., ecology, eng., public health
  - Irwin, Wilson, Lee, Ludsin, LaBarge, Winslow, Jackson-Smith & external
  - White paper (Clean Lake 2020 Bill) highlights current actions and needs
Water Quality/Lake Erie strategies

Considerations: knowns and unknowns

► Limited human and economic resources, and need to accelerate WQ improvement.
► Some locations discharge more phosphorus than others (for decades!)
► Proprietary information makes it difficult to site practices at these locations
► How can we extrapolate from field-scale to basin-scale to guide policy and management?

Solutions: Targeting for Accelerated WQ & Model eval. for basin magt.

► Targeting to optimize resources and accelerate WQ gains
  ► Realize more “bang for the buck”
► At field scale (zones) and at HUC ~12 scale
  ► “Stewardship Watersheds”
► Possible with partnerships of Ag., Govt., Env. & Acad. Orgs
  ► Consider farmer indemnification to increase participation
► Multi-model effort to evaluate basin-scale scenarios
  ► Stakeholder-driven & integrated with social and economic analyses
Research expertise

► Surface water-groundwater interactions
► Nutrient/contaminant movement across shores/beds/banks

Most relevant research summary & findings

► Agricultural drainage ditches
  ► “Internal P” in ditch beds varies widely within and across individual farms
  ► If released over a year, P from ditch beds could account for a quarter of the soluble reactive P load to Lake Erie

► Beaches
  ► Lake Erie is more vulnerable to nutrient inputs from direct groundwater discharge than any of the other Great Lakes
Considerations:
- We still don’t know where the “hotspots” are and why. We are model-rich and measurement-poor.

Solutions:
- Easy Idea: Affordable, distributed sensors ($5-10K per station)
- Easy Idea: Add trees
  - Shade, temperature, habitat
  - Better sediment control than grass alone
- Big Engineering Idea: smart management of Ohio’s 14,000 miles of drainage ditches to improve water quality ("AI machine learning")
  - Store runoff in the landscape, maximize nutrient removal
  - Field of “machine learning” is rapidly maturing
  - Add flow control structures and affordable sensors
Research expertise

► Water treatment and technology development, water chemistry, water quality, design standards, harmful algal blooms, emerging contaminants, PFAS

Most relevant research summary & findings

► Assessing Ultrasound as a Source Water Reservoir Management Strategy to Control Cyanobacteria Blooms (Weavers et al.)

► Measuring PFAS compounds in surface waters, air and soils to determine mechanism of spread (Weavers et al.)

► Developing Design Standards to Enable the Use of Innovative Technologies in Ohio Public Systems (Weavers et al.)

► Evaluating cyanotoxin adsorption to natural and drinking water sorbents (Lenhart et al.)

► Ohio WRC funds starting investigators to focus on Ohio water challenges
Water Quality Strategies

Considerations:
► What technologies maximize net benefits to society?
► Where are the priority areas we need to implement technologies?
► Who receives the distribution of benefits and costs across different groups?
► When do we need to implement strategies to avoid/minimize irreversible damage or maximize mitigation efforts?
► Why do we need new technological approaches?

Solutions:
► Provide training on improving existing technologies.
► Facilitate implementation of advanced technologies.
► Collaborate among water stakeholders and researchers where knowledge gaps exist.
► Promote science-backed policy decisions to advance technological solutions.
Research expertise

- Weather, applied climatology, climate change, numerical simulations of climate; local impacts to changing weather patterns on Agricultural sector

Most relevant research summary & findings

- Temperatures in Great Lakes are increasing faster than national rates; most rapidly during the winter and at night (NCA4; ELPC)

- Precipitation in Ohio has increased 5-10% since the first half of the 20th century

- Extreme precipitation events (> 2”) are increasing

Data Source: NCEI
Water Quality/Lake Erie strategies

Projected Change in Average Precipitation
Period: 2041-2070 | Emission Scenario: A2

Projections:
► Projected 10% increase in annual precipitation by mid 21st century
► 65-85% increase in the number of extreme precipitation events (those > 2” per day)

Considerations:
► What is the role extreme precipitation events play in erosion and loss of nutrients?
► How robust are current conservation practices in light of increasing precipitation intensity?

Solutions:
► Increased/improved monitoring: NW Ohio observations are scarce compared to other areas of Ohio; Investment in upgrading OARDC Ag Weather Network currently underway (resource-limited) with SCOO
► Statewide hydro-stress test (climate models-hydrology-hydraulics)
► On-farm conservation research and education

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