Nutrients in Agriculture and the Environment

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Big 12 Water Conference
Nov. 18, 2014
Global Mega-Trends

World Population: 1950-2050

70% increase in Global Food Demand By 2050 (FAO, 2009.)

Source: U.S. Census Bureau, International Data Base, June 2010 Update.
Global Mega-Trends

World Grain Production

![Graph showing trends in grain production](FAOSTAT, 2014)

- Maize: $y = 64.847x - 125264$, $R^2 = 0.9692$
- Rice: $y = 40.052x - 77382$, $R^2 = 0.9797$
- Wheat: $y = 52.296x - 100694$, $R^2 = 0.9891$
Global Mega-Trends
World Grain Production – Forecast to 2050

FAOSTAT, 2014
World Fertilizer Use

173 million tonnes nutrients
Agricultural Nutrient Use

- Majority of nitrogen and phosphorus use is for fertilizer (Food Production)
  - 100 million tonnes N, 35 million tonnes P

Source: International Fertilizer Association, 2011
Fertilizer effects on food production

- Fertilizer inputs are a requirement for feeding the world population

Lost corn production without P fertilizer

\[ y = -1.09x + 2174 \]
\[ r^2 = 0.71 \]

\[ y = -1.08x + 2235 \]
\[ r^2 = 0.62 \]

Data from Dodd and Mallarino, 2005
Nutrient loss degrades water quality

Just as fertilizer increases crop growth...

...Nutrient inputs to fresh water increase algal growth

Centralia Lake
(photo courtesy of Kevin Price)

Cheney Lake
(photo courtesy of KDHE)
Algae growth in the Gulf of Mexico

NASA Satellite image of hypoxia in the Gulf of Mexico. Image by NASA
Nutrient Inputs $\rightarrow$ Eutrophication

- Eutrophication Process
  - add nutrients
  - algae grow
  - algae die and sink to bottom
  - algae decompose, and reduce dissolved $O_2$
  - fish die from lack of oxygen.
  - some algae produce toxins
A toxic algal bloom caused a three-day ban on water usage for a half-million residents in SE Michigan and Toledo.

Experts say it’s a ‘wake-up call.’

by Ryan Felton
Toxic algae closes Milford Lake to water sports lovers

by DAVE BERGMEIER Editor

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MILFORD LAKE – On the eve of one of the biggest recreation months of the year, Kansas biggest lake has been closed to water activities and may be closed through the weekend.

R.J. Harms, operations manager for the Milford Lake Project for the Army Corps of Engineers, said warning signs have been erected on many access roads and boat ramps.

The closure to water activities comes because of the potential illness that can occur through ingestion and also through breathing of the toxic algae, he said.

The lake’s campsites will be open but people are asked to avoid water contact. Harms said the water is the attraction. The lake has 163 miles of shoreline.

Closing a lake before a holiday is tough, he said. Normally lake visitation is about 40,000 to 50,000 people for the Labor Day weekend. Holidays and summer weekends are where many business operators, including marina operators, make money.
Nutrient Impacts on Water Quality

EPA Wadeable Stream Assessment, 2006
Nitrate Leaching

- Fertilizer applications can lead to very high nitrate concentrations in ground water

Groundwater NO3- concentrations in the Platte River Valley, Nebraska

Spalding et al., 2008
Water Conservation and Water Quality

• How does water quality influence water quantity?
  – low quality = limited use
  – low quality = low value
  – low value = low conservation

• Water quality plans must go hand-in-hand with water conservation plans
Grand Challenge

• Increase crop yields while decreasing nutrient losses
Best Management Practices

- Flexible and adaptive to diverse cropping systems
- Target key loss pathways
- Maintain or increase yields
Tillage effects on total P loss

Data from the MANAGE v3 database (Harmel et al., 2008)
Tillage effects on dissolved P loss

Data from the MANAGE v3 database (Harmel et al., 2008)
Manure Management

• Manure characteristics
  – Large quantities, viewed as waste, disposal.
  – Nutrient concentrations hard to predict
  – Un-balanced N and P concentrations
    • Dairy manure applied to meet corn N req.
      – 150 lbs available N → 315 lbs P₂O₅ applied
      – Only 50 lbs of P₂O₅ needed, >6X more P₂O₅ than needed
  – Bulky, difficult and expensive to transport
Manure Management

• Typical environmental issues
  – N leaching
    • over-application
    • Poor timing

Timing of fertilization

- BMPs must consider climate variables

*Monthly Average Precipitation for Northeast Kansas*
Timing of fertilization

- BMPs must consider climate variables

Maximum predicted P loss following application of poultry litter at 1, 2, 4, or 8 Mg/ha
Nutrient Loss Risk Assessment

*We need to develop tools that...*

- Give feed-back on agricultural management
- Select optimum BMPs based on site characteristics
- Document water quality benefits from BMP implementation
- Assist decision makers in a timely and accurate manner
Questions?