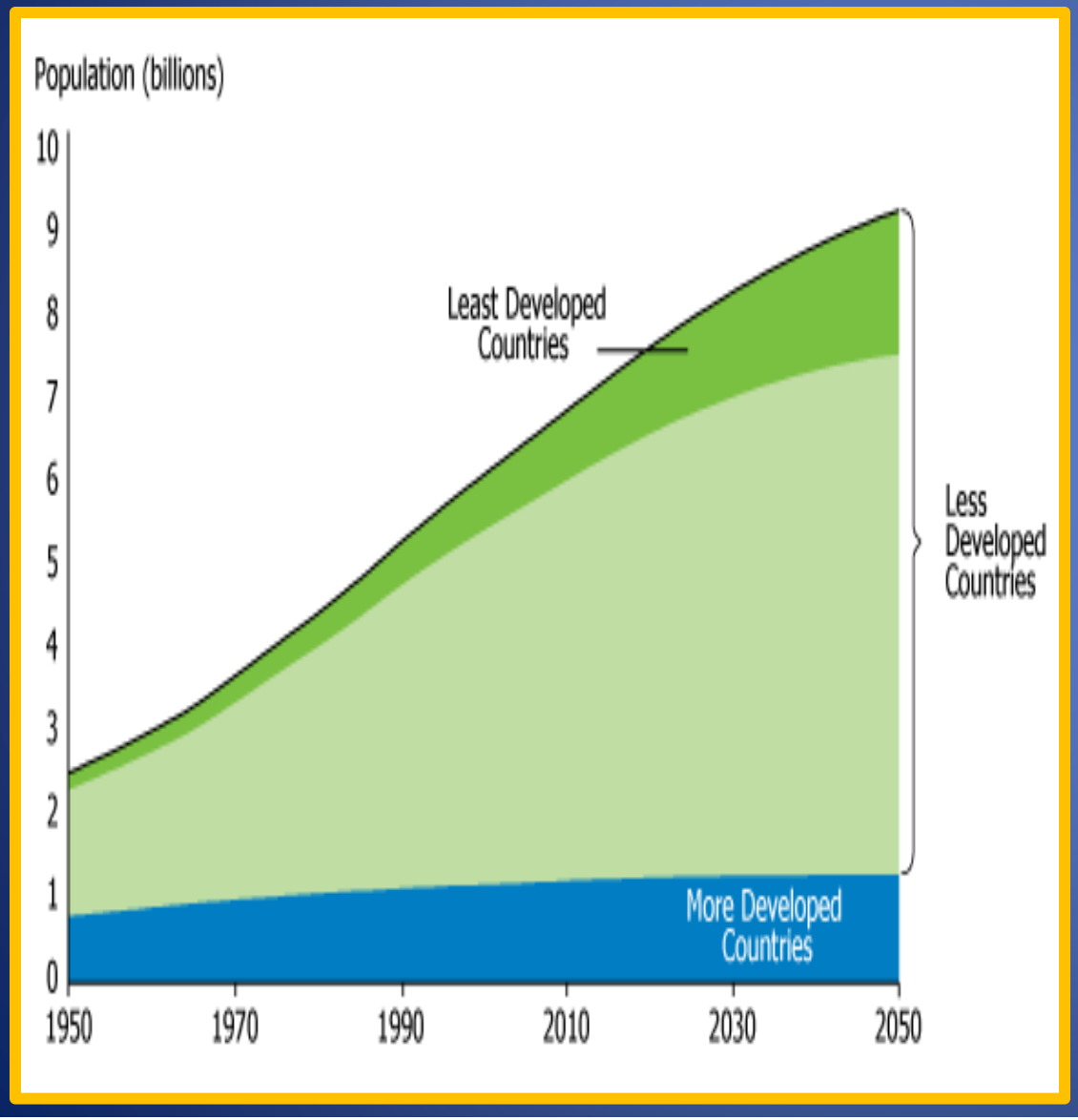
Innovation – Growing Solutions Through Technology

Global Challenges for Science-Informed Nutrient Management

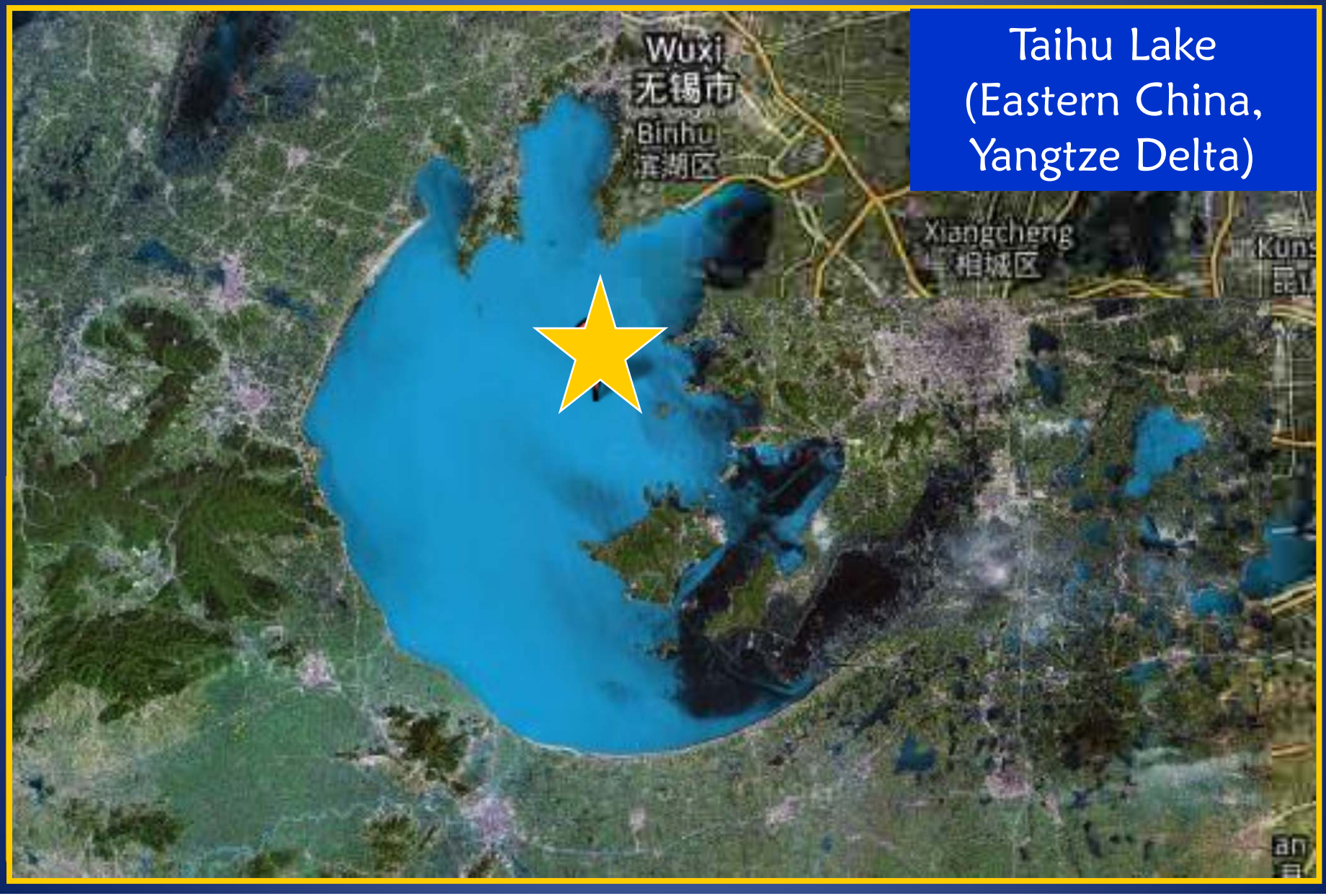
Dr. Tom Sims
College of Agriculture & Natural Resources
University of Delaware

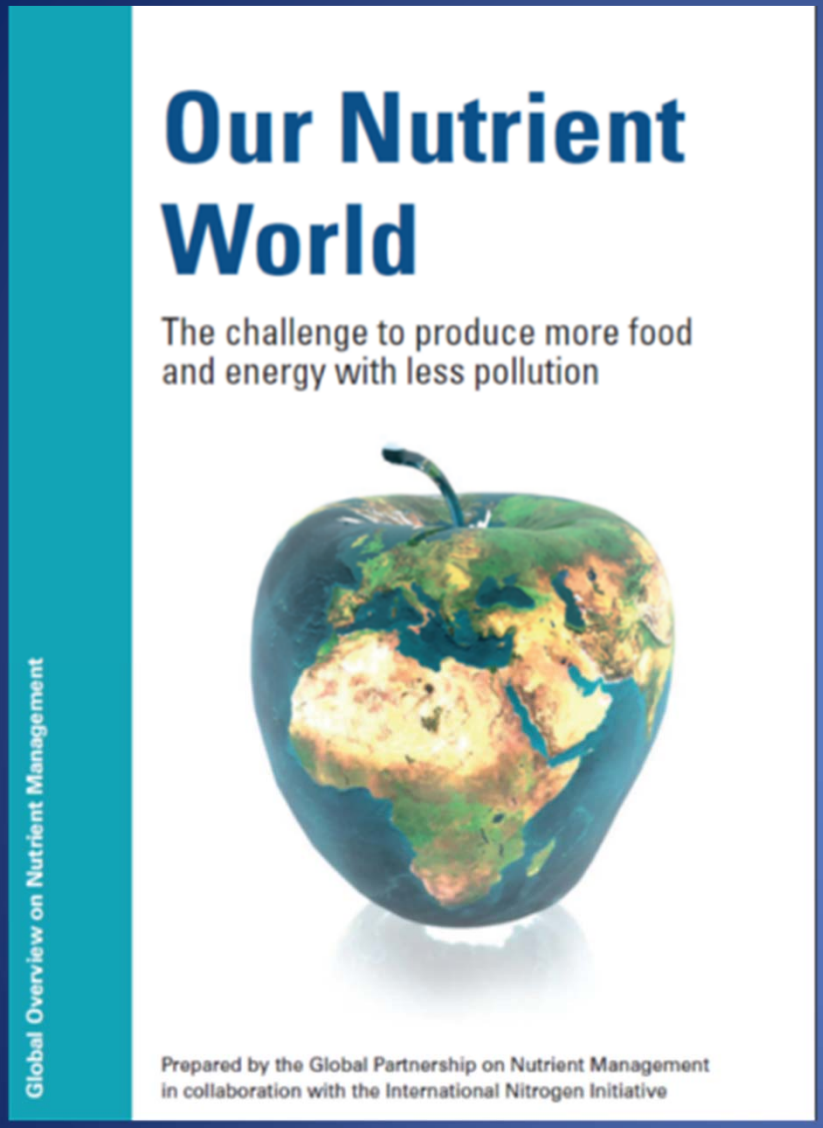
UNIVERSITY OF DELAWARE

Global Population Growth Drives Demand for Food Security, Nutrient Management



Global Concerns on Environmental Quality, Human and Ecosystem Health - Drivers for Improved NUE





UNEP Global Partnership Nutrient Management, 2013

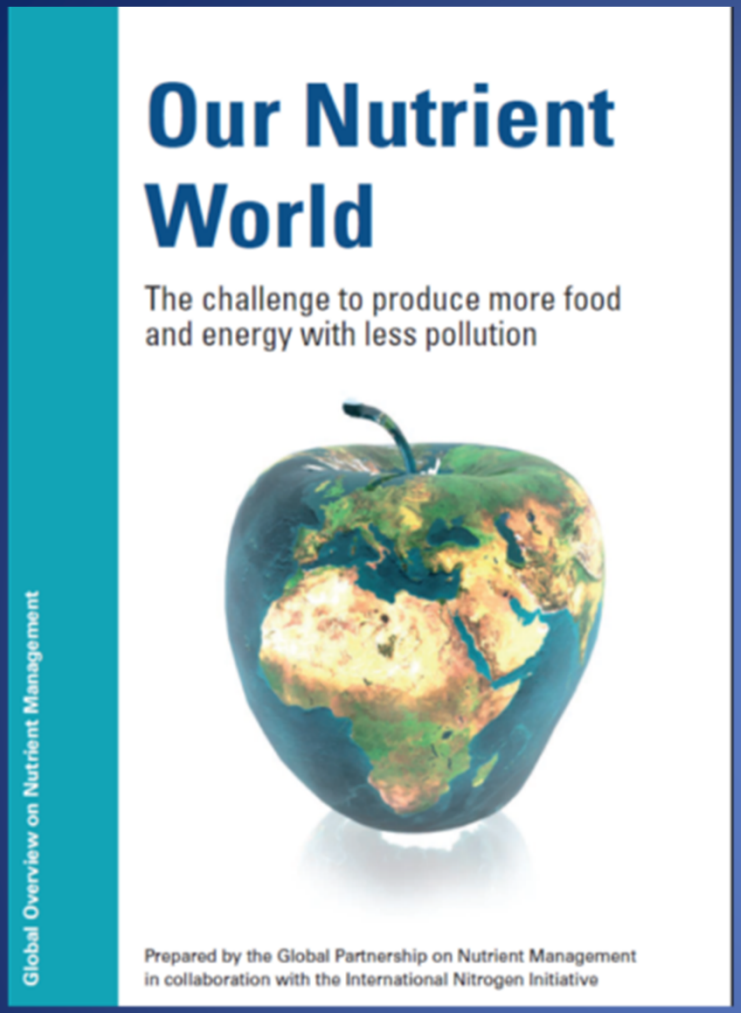
Our Nutrient World

"…nutrients are essential for plant growth, food production, and adequate nutrition for humans"

"…we live in a world of glaring contrasts – of excessive use of nutrients in some regions and insufficient use in others"

"..without swift, collective action, the next generation will inherit a world where millions may suffer from food insecurity, where nutrient pollution threats from too much use will become more extreme, and where unsustainable nutrient use will contribute even more to biodiversity loss and accelerated climate change"

Achim Steiner
United Nations Under-Secretary General and Director, UN Environmental Programme



UNEP Global Partnership Nutrient Management, 2013

23 authors and 25 contributors from >15 countries

Our Nutrient World: A Global Overivew

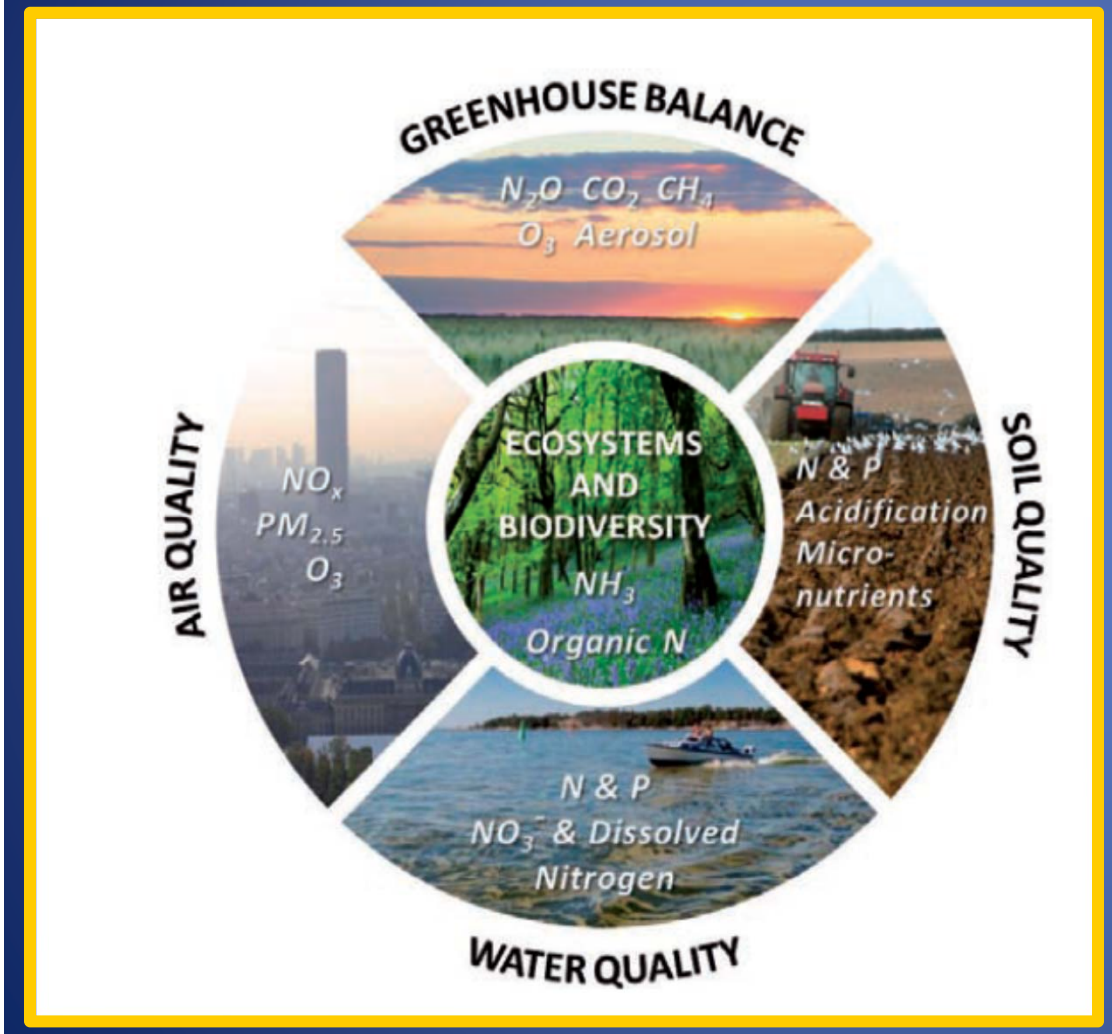
Global Partnership in Nutrient Management (GPNM)

"..a multi-stakeholder partnership comprised of governments, private sector, scientific community, civil society organizations and UN agencies"

"…committed to promote effective nutrient management to achieve the twin goals of food security through increased productivity and conservation of natural resources and the environment"

Purpose is "…raise awareness of the challenges, pointing to possible options … and stimulate further collection of evidence and trans-disciplinary dialogues with all stakeholders.."

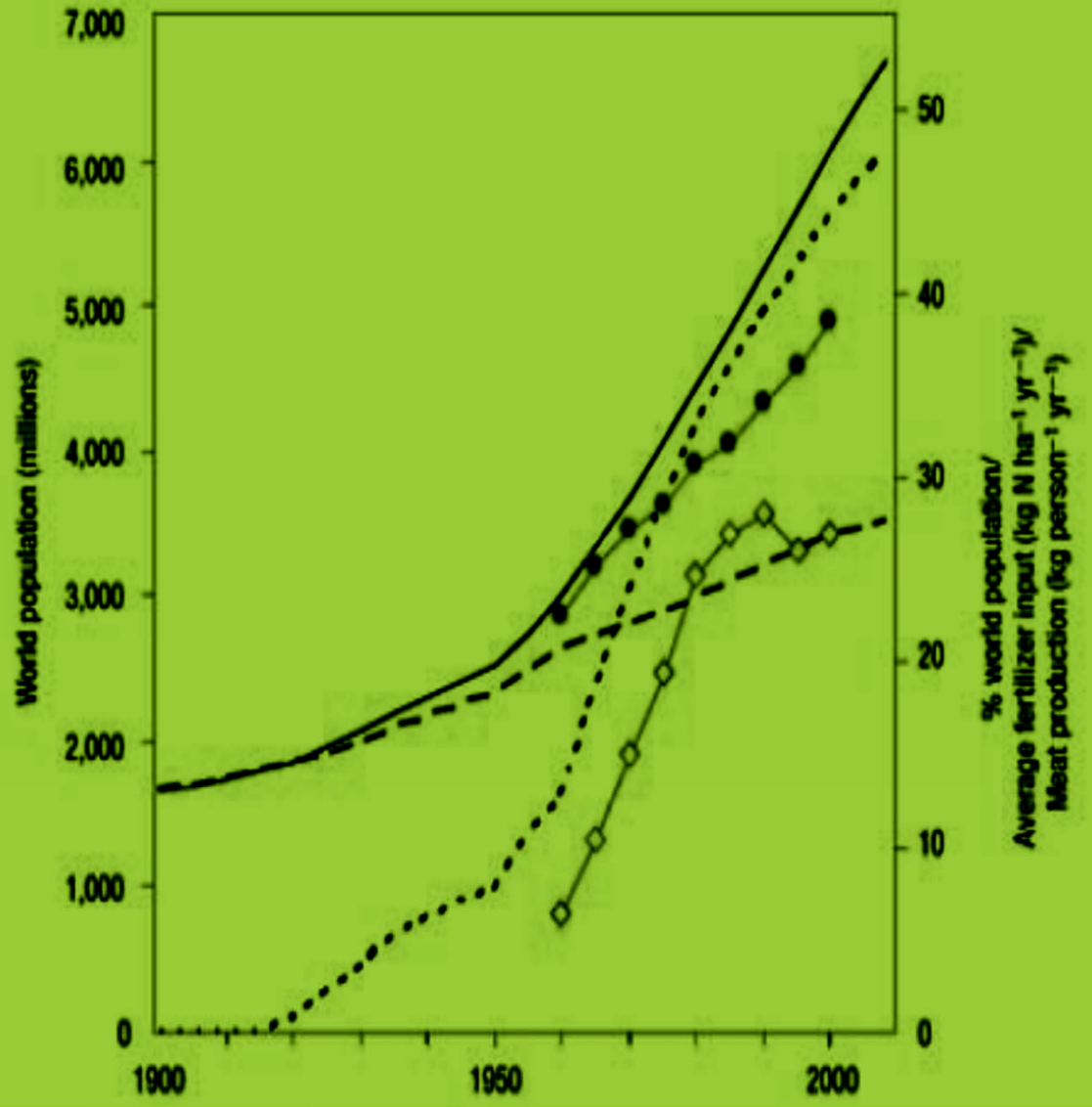
Five Key Threats of Too Much or Too Little Nutrients



WAGES

- Water Quality
- Air Quality
- Greenhouse Gases
- Ecosystem Services
- Soil Quality

Global Trends and Impacts of Nutrient Use



Population

Population, w/o H-B N

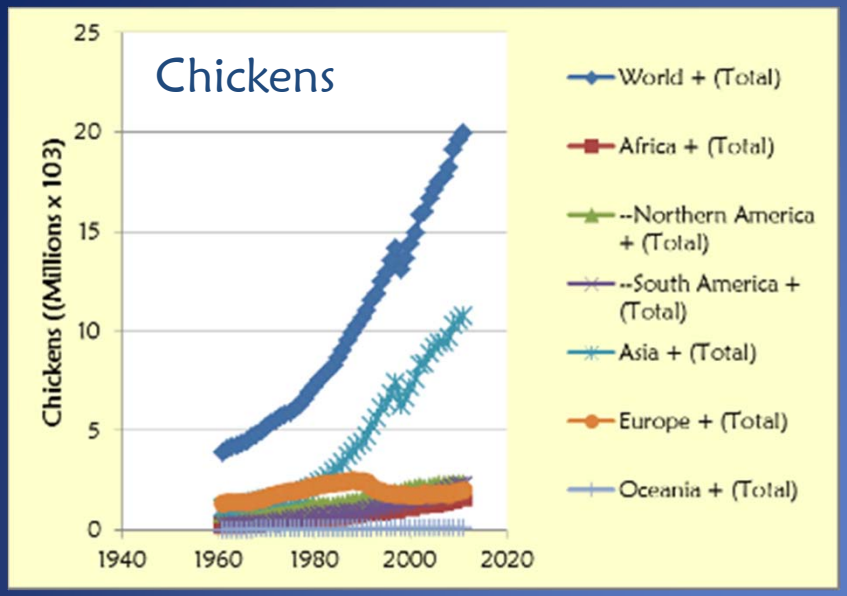
% Population fed by HB-N

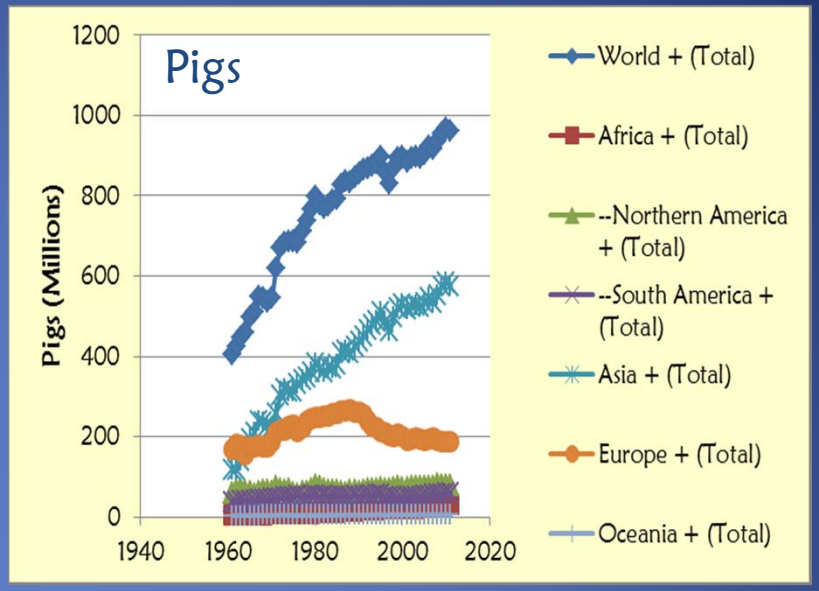
Average Fertilizer Input

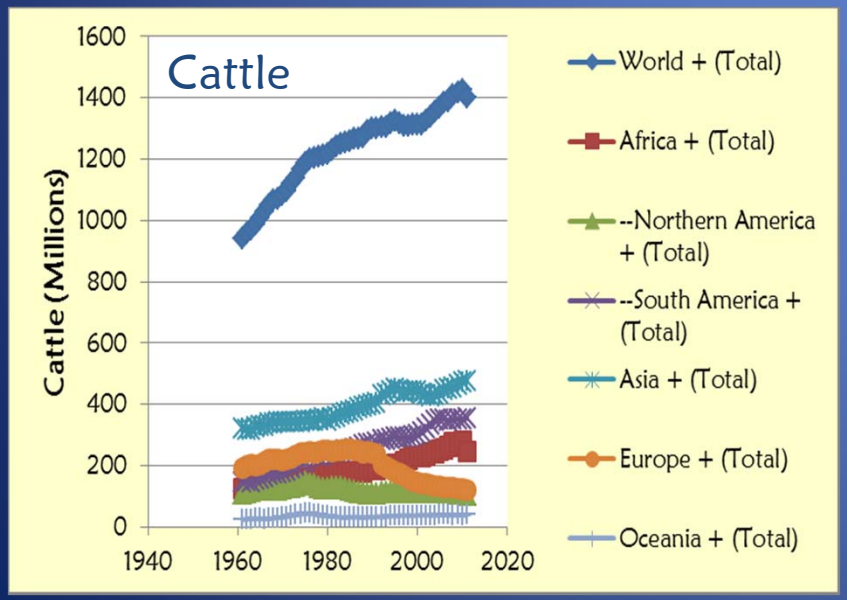
Meat Production

(Erisman et al, 2008)

Animal Agriculture, Nutrients, & Food Security



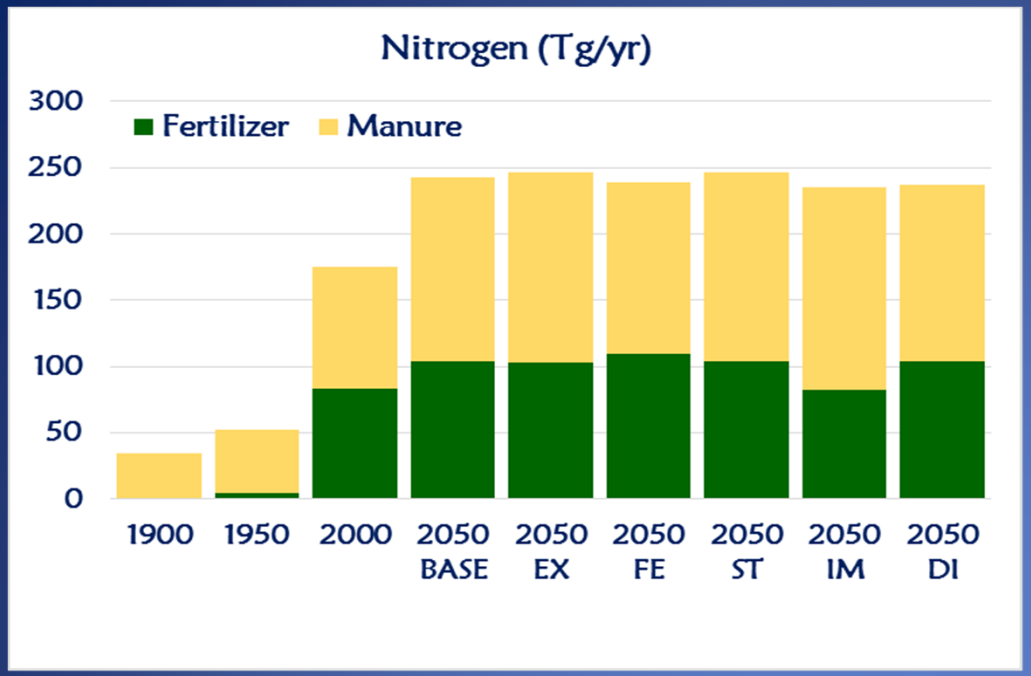


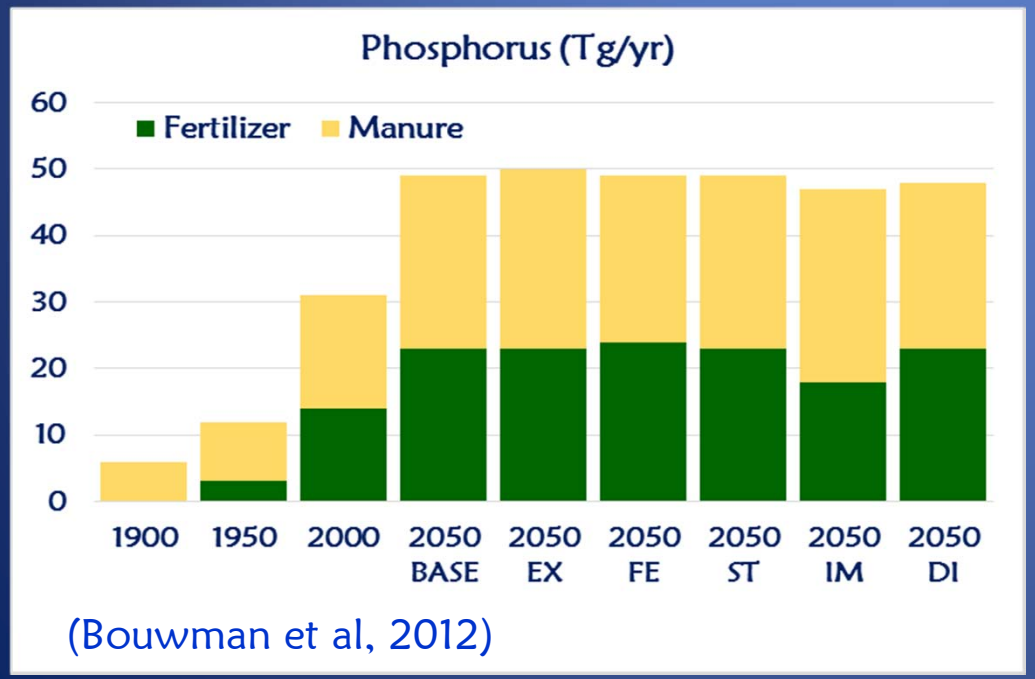


World Inventory (vs. 1961)

	1986	2011
Cattle	134%	149%
Chickens	232%	510%
Pigs	203%	237%

(FAOStat, 2013)





(Bouwman et al, 2012)

Global Scenarios

Nutrient Inputs to Agricultural Systems (2000-2050)

Base: IAASTD projection

EX: Extensification, 10% production in mixed systems to pastoral systems

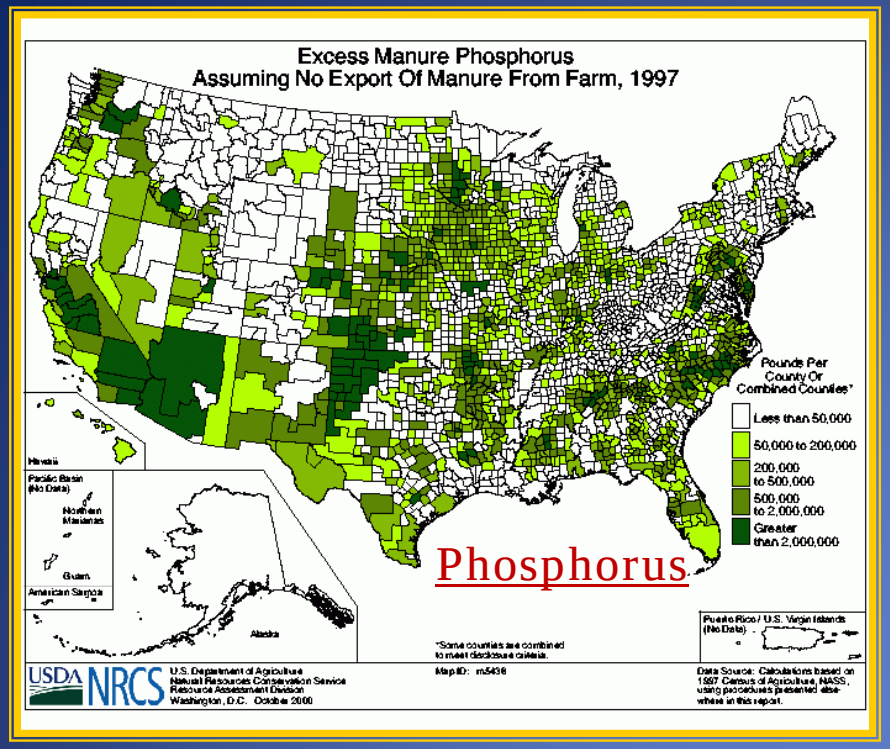
FE: Feed efficiency increases, 10% lower excretion rates in mixed and industrial systems

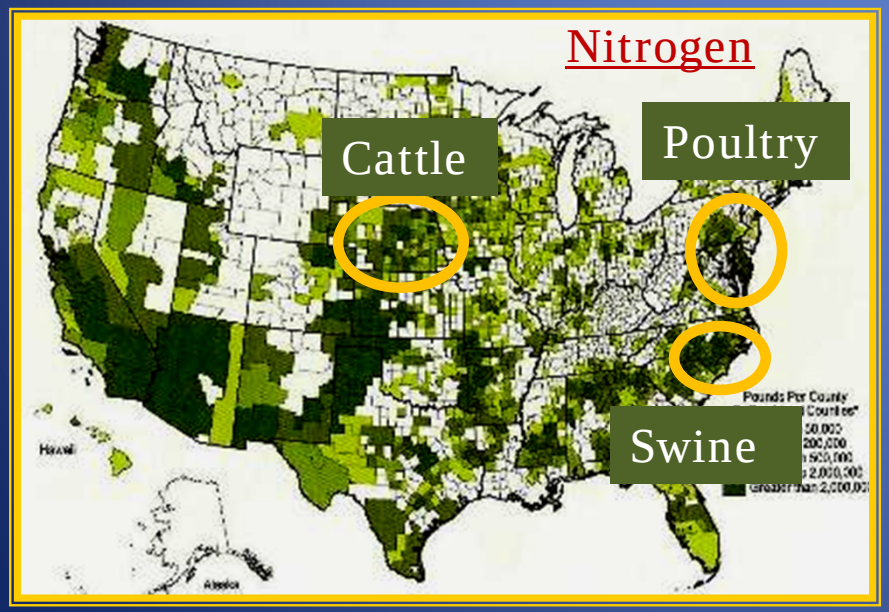
ST: Storage/housing, 10% reduced emissions from animal infrastructure

IM: Improved recycling, manure integration into mixed systems

DI: 10% ruminant meat replaced in human diets by poultry

Trends in Nutrient Generation by US Animal Agriculture

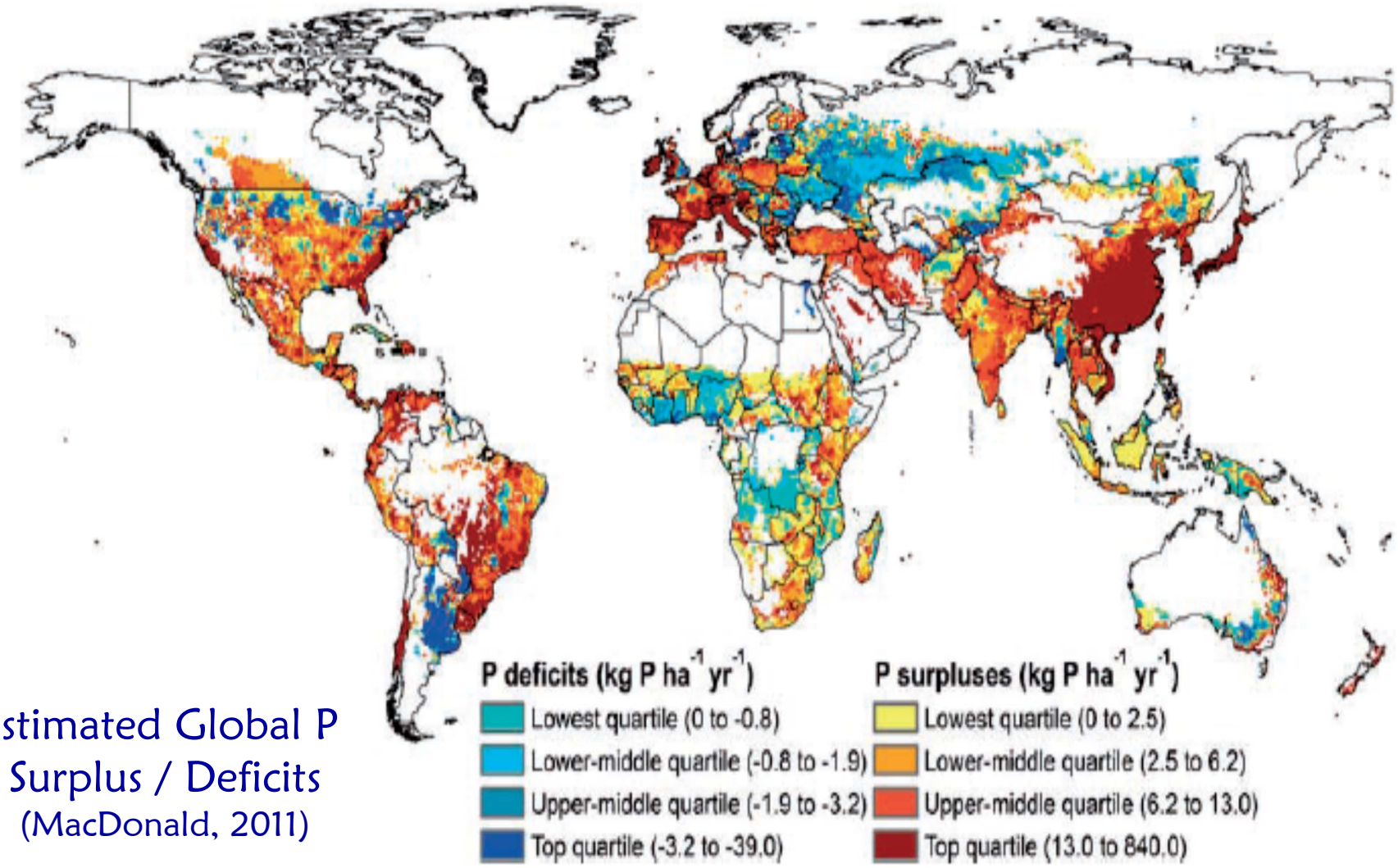




(Kellogg et al., 2000)

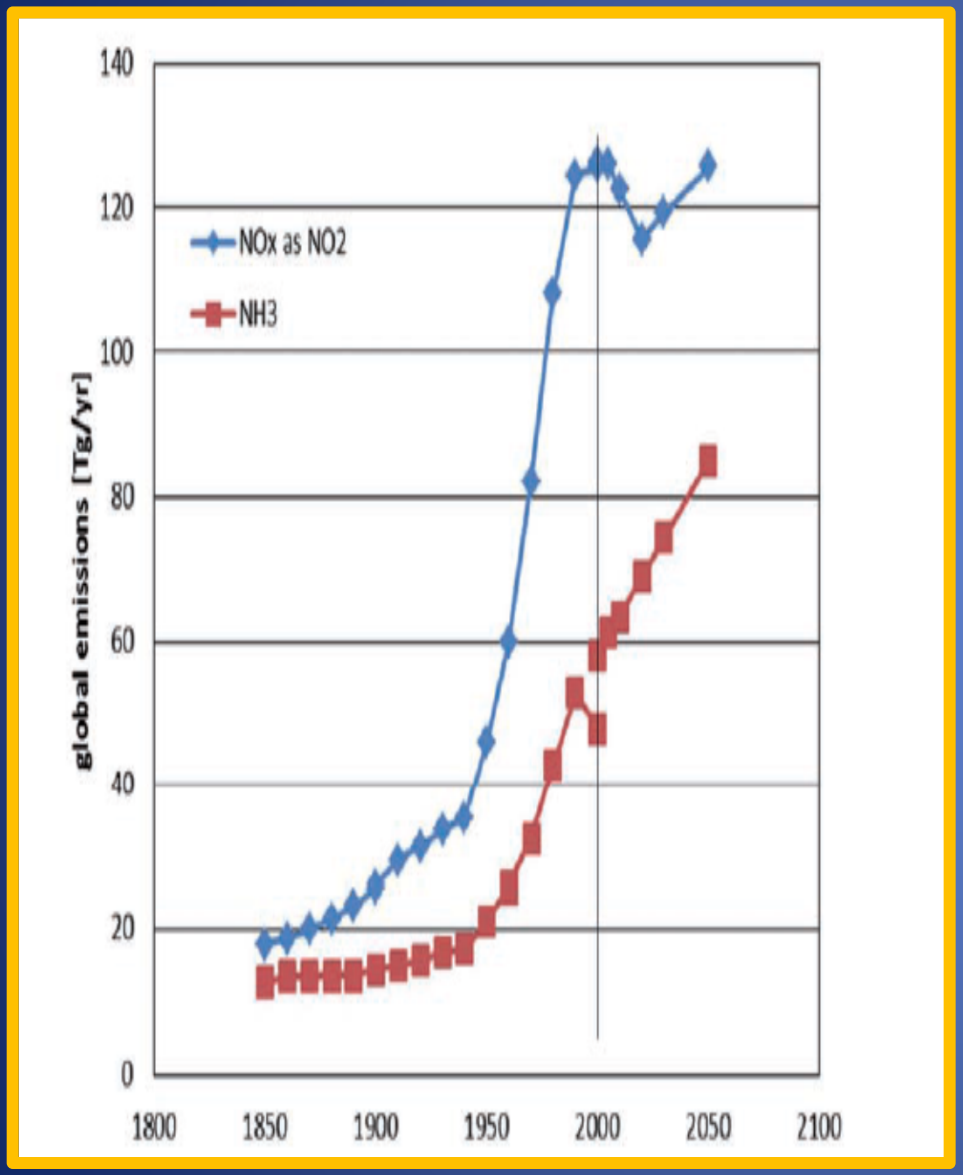
- ✓Geographic intensification of animal production has led to large N and P surpluses in many areas of the USA
- ✓Feed grain production has been largely disconnected from animal production
- ✓Regional problems with nonpoint nutrient pollution of water and air have grown into national concerns

Geospatial Nature of the Global Nutrient Challenges

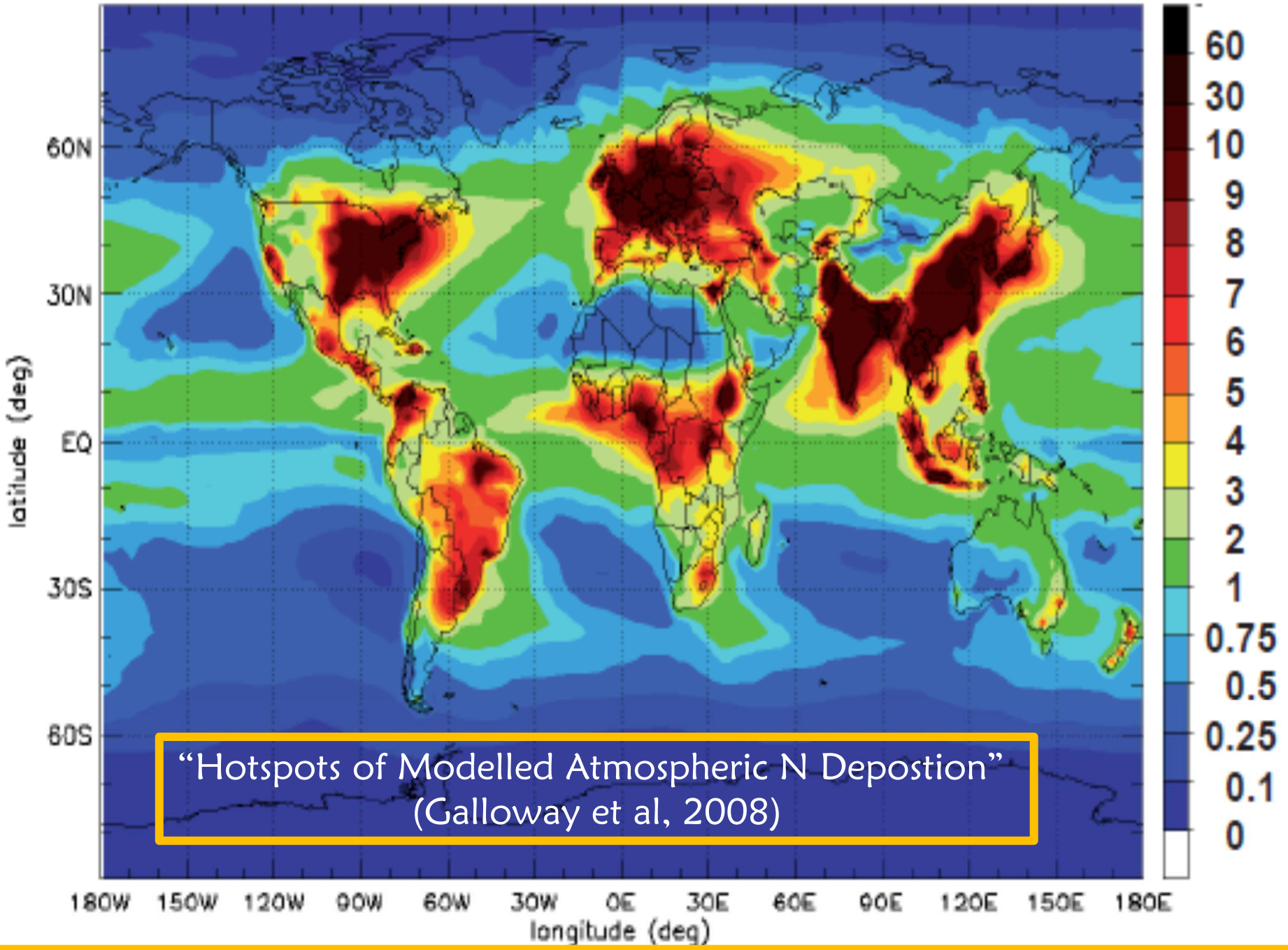


Estimated Global P Surplus / Deficits
(MacDonald, 2011)

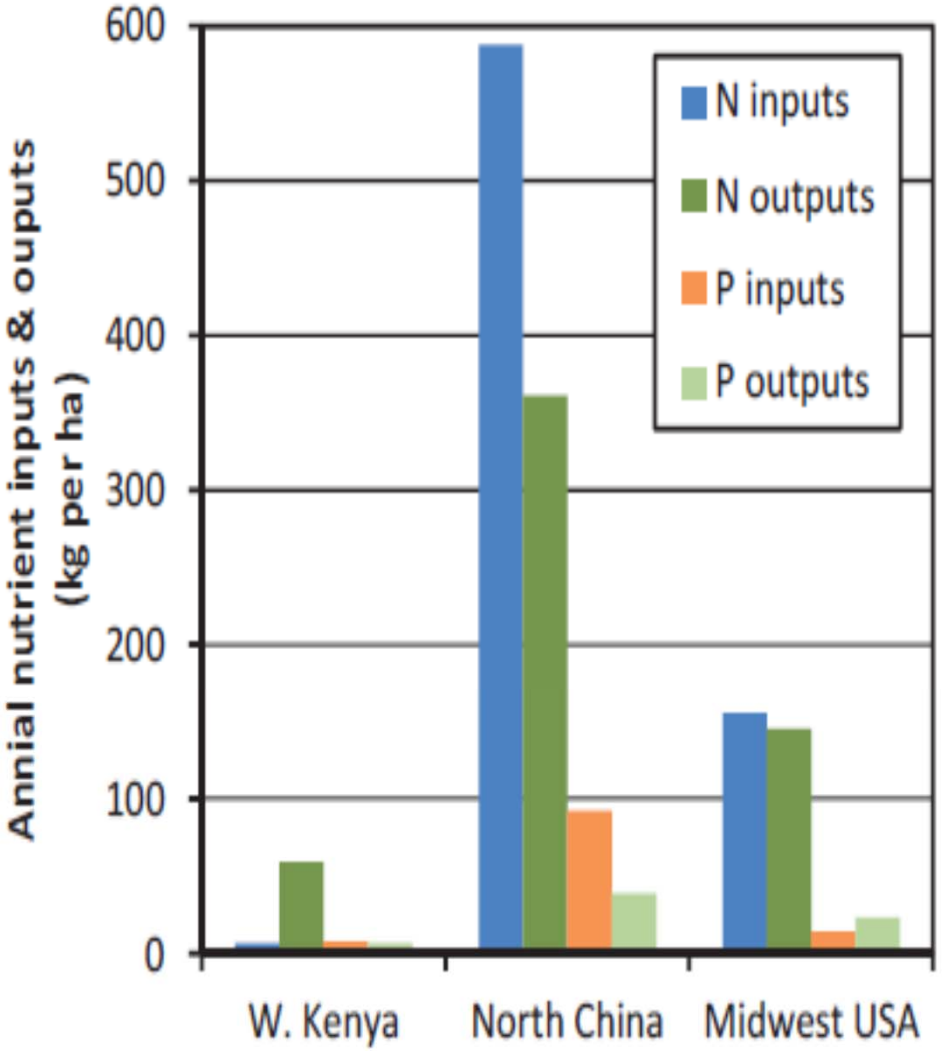
Global Impacts of "Altered" Nutrient Cycles

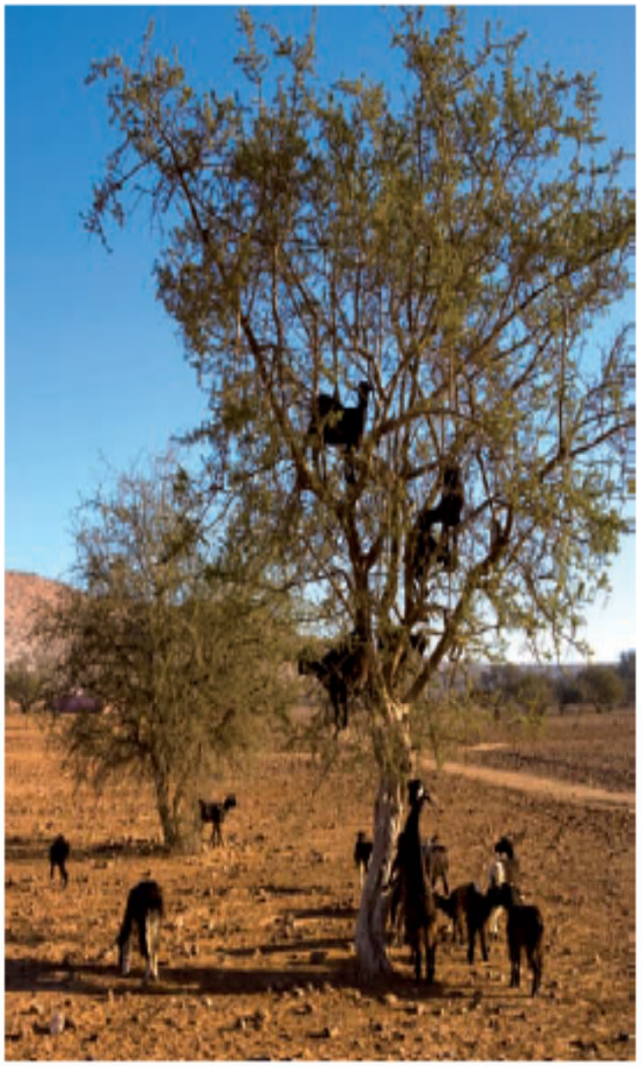


Trends in Global Emissions of NO_X and NH_3


60N
30N
EQ
30S
60S
latitude (deg)
180W 150W 120W 90W 60W 30W 0E 30E 60E 90E 120E 150E 180E
longitude (deg)
60
30
10
9
8
7
6
5
4
3
2
1
0.75
0.5
0.25
0.1
0
"Hotspots of Modelled Atmospheric N Depostion"
(Galloway et al, 2008)

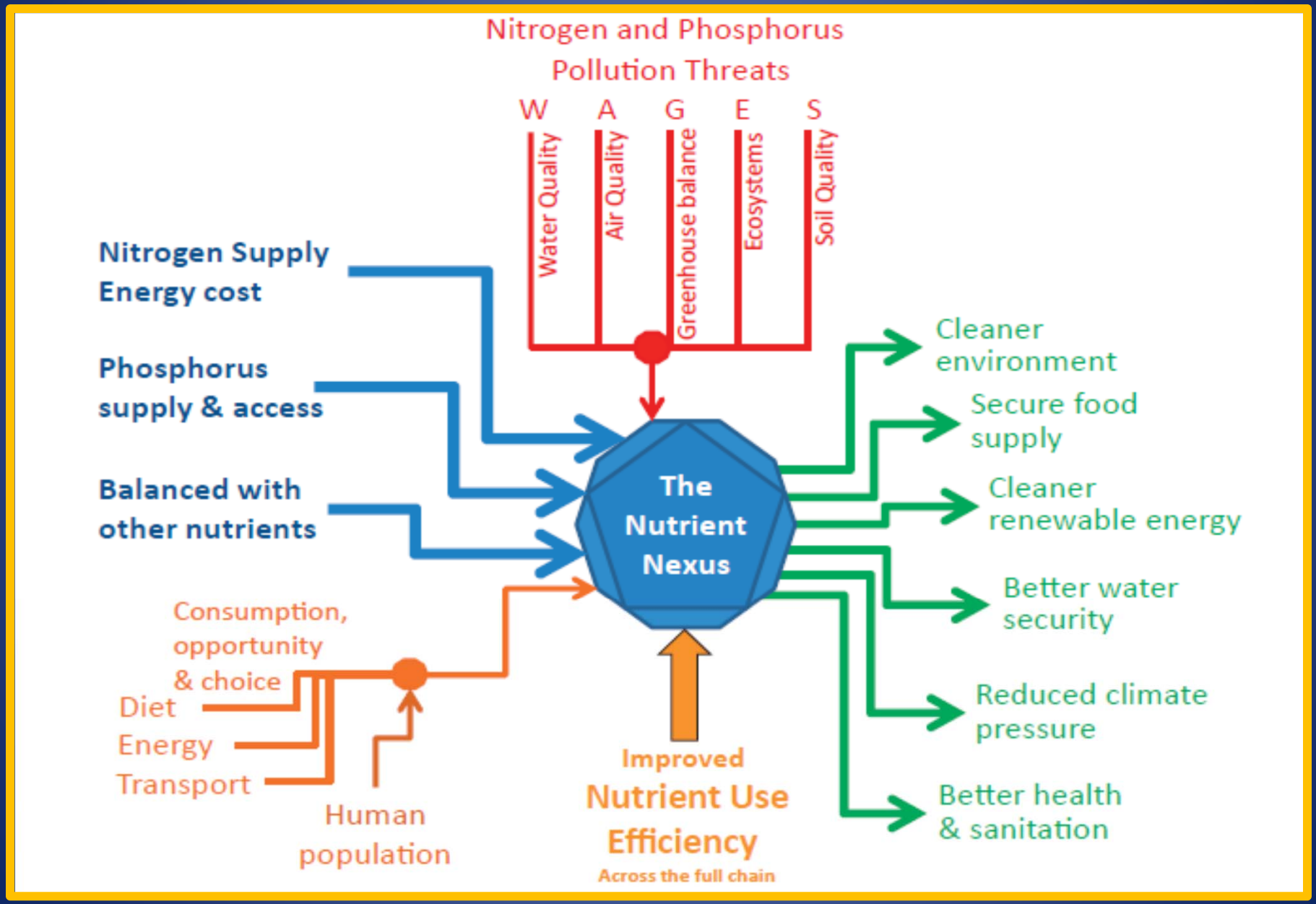
Nutrient Impacts on Soil Quality





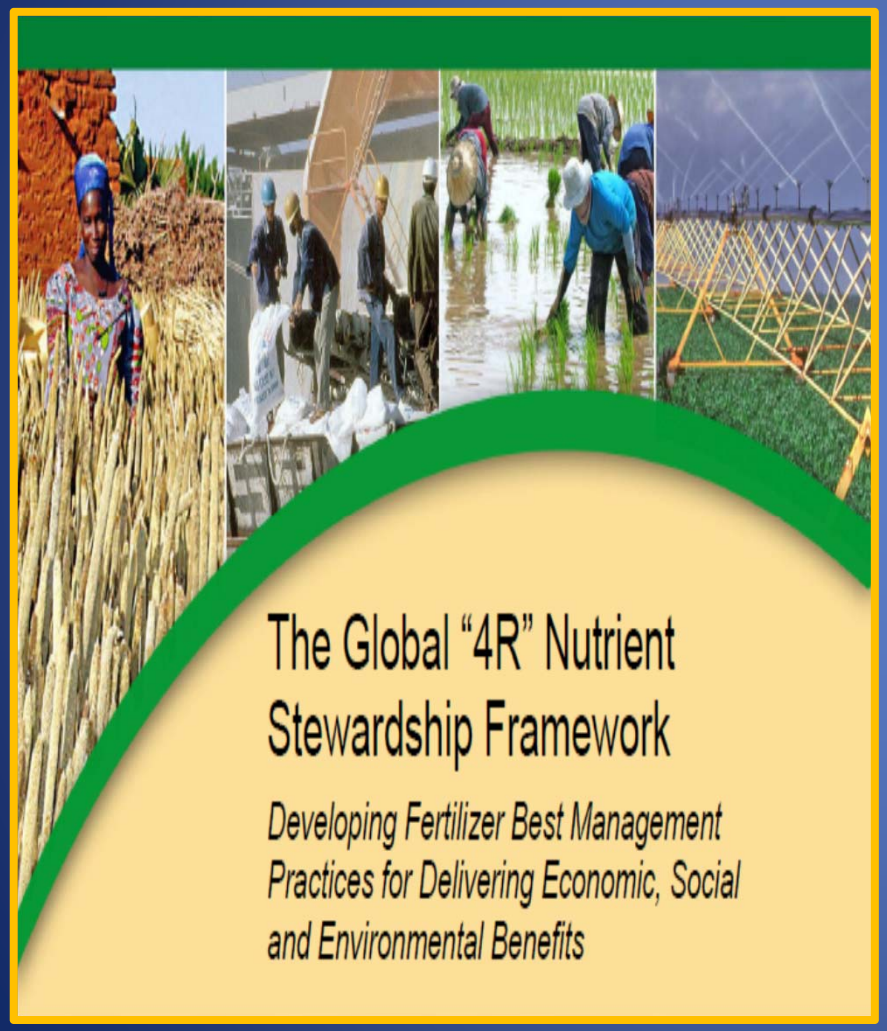
(Vitousek et al, 2009)

The "Nutrient Nexus"



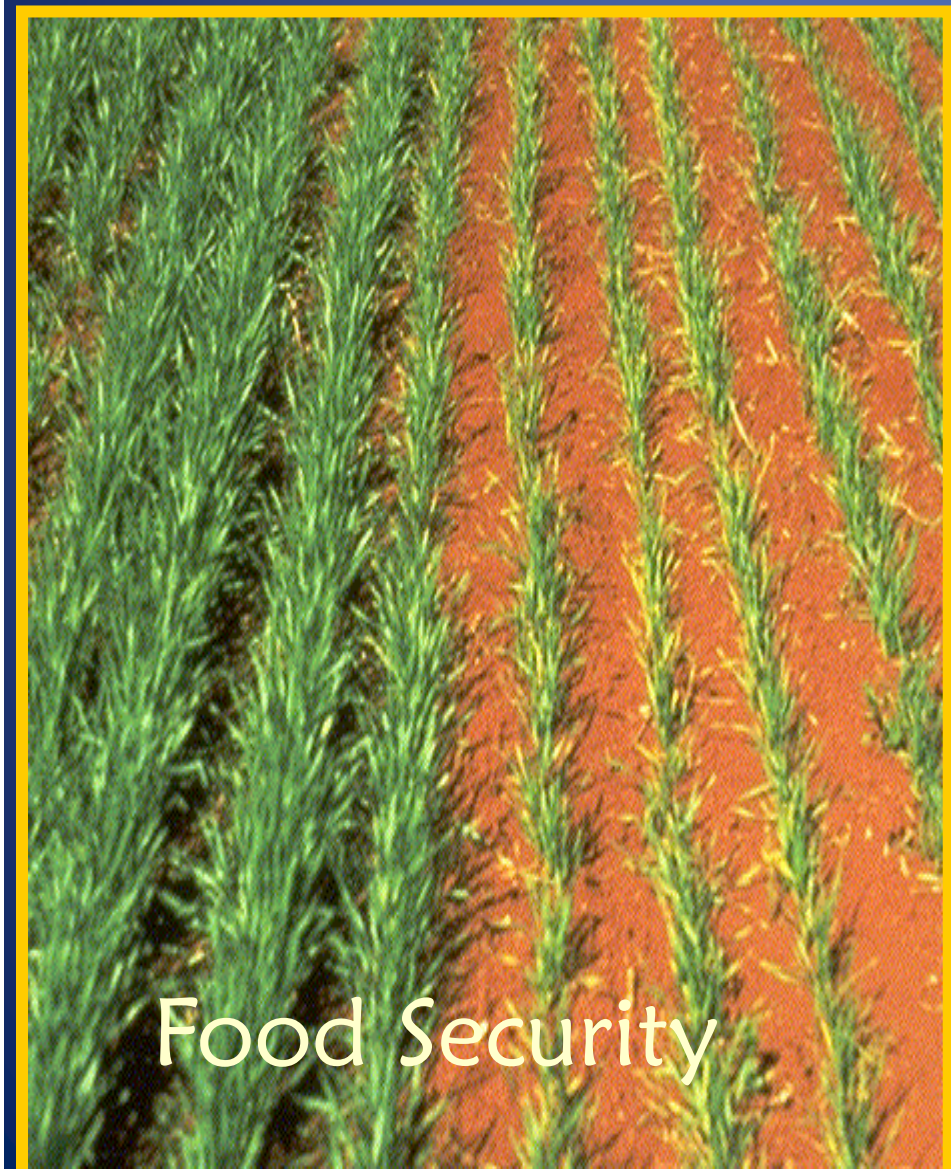
Our Nutrient World –Key Options to Improve Agricultural NUE

Improve NUE for (1) Crop Production and (2) Animal Agriculture

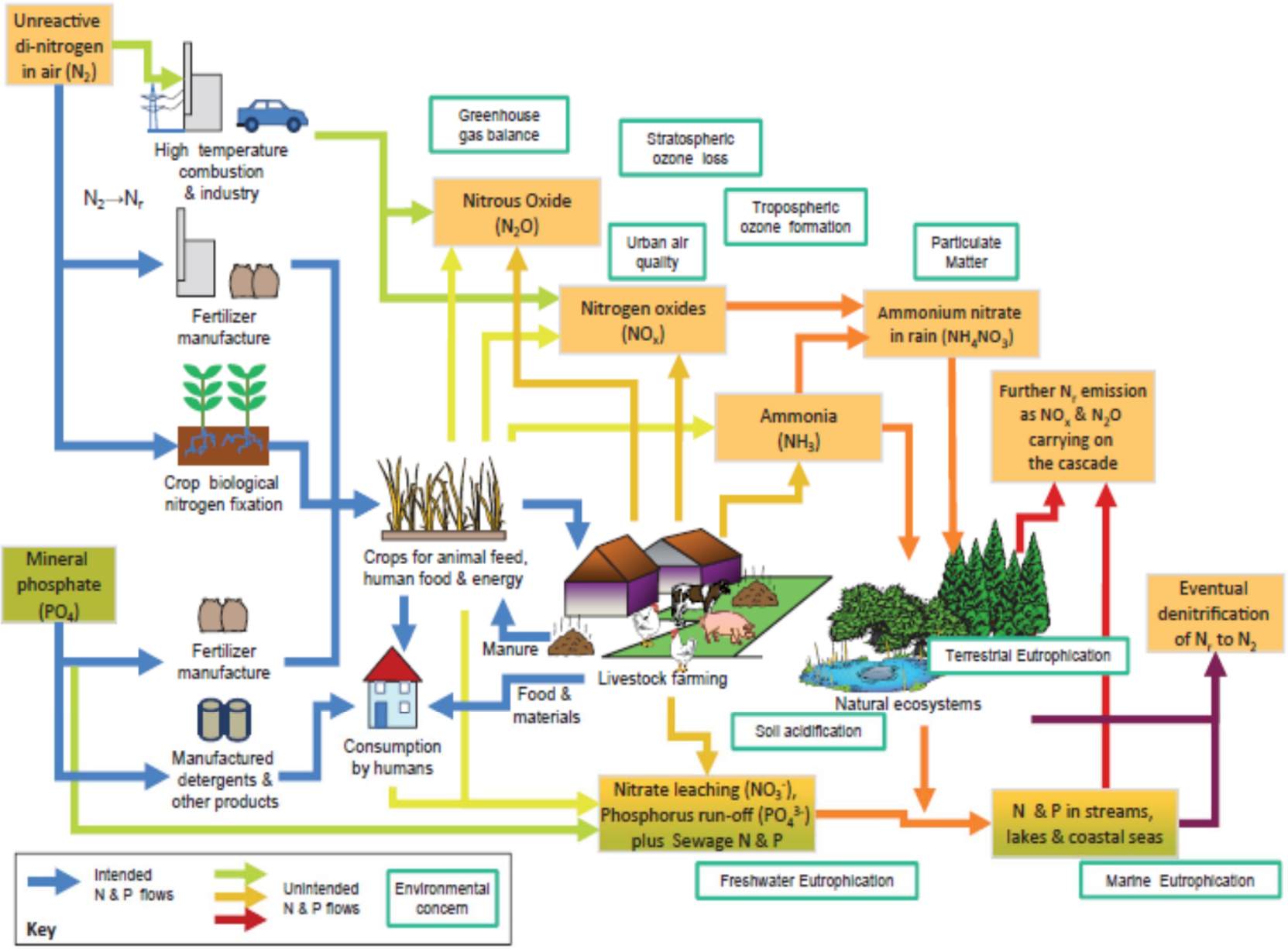


#3: Increase Animal Waste Fertilizer Equivalence

Innovations in Nutrient Management: Scientists' Challenges

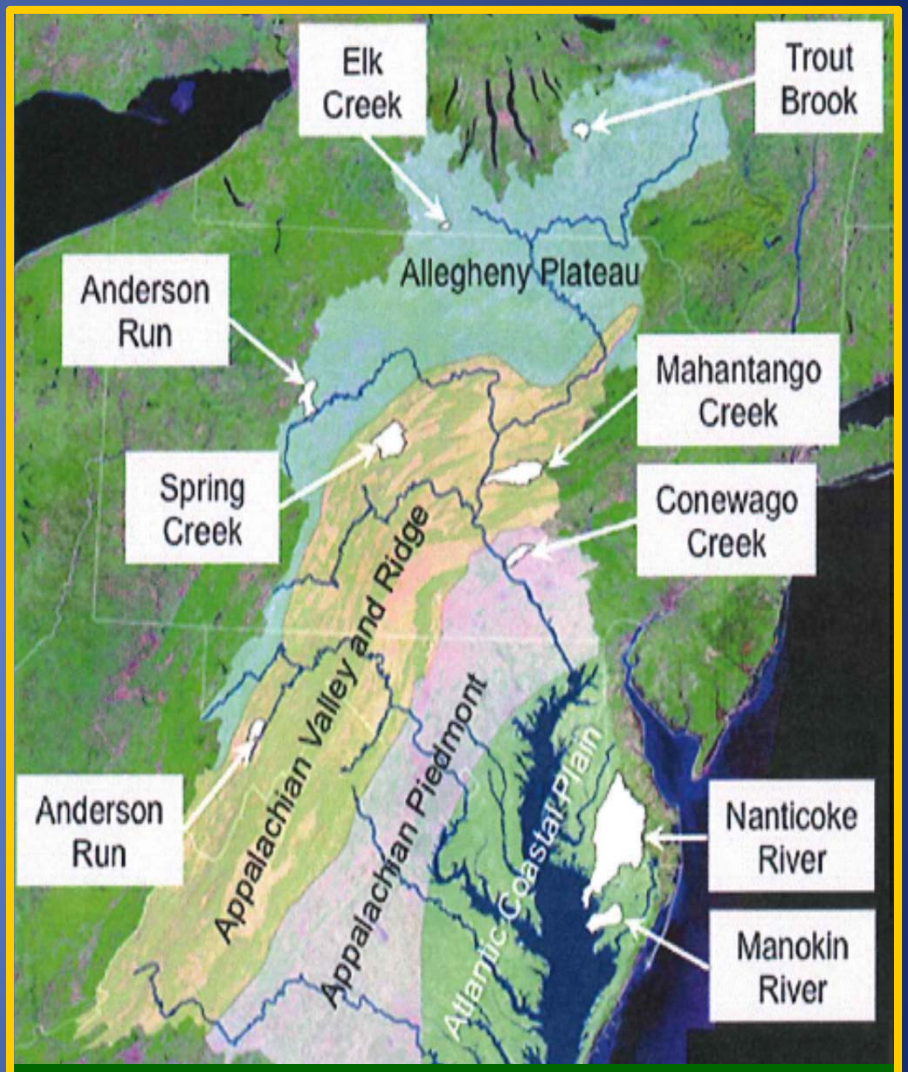


Advance Integrated, Basic & Applied Research



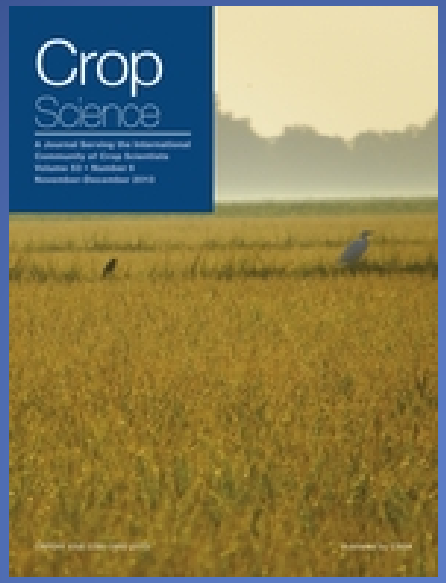
Build & Sustain "Trans-Disciplinary" Teams

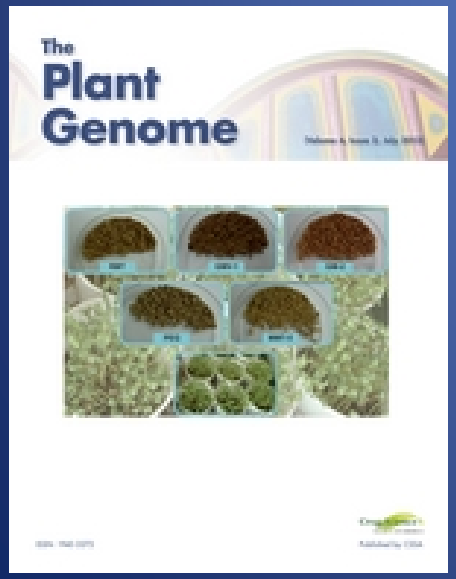
- ✓ Agronomists
- ✓ Animal Scientists
- ✓ Engineers
- ✓ Economists
- ✓ Environmental Scientists
- ✓ Farmers
- ✓ Geologists
- ✓ Information Scientists
- ✓ Lawyers
- ✓ Political Scientists
- ✓ Politicians
- ✓ **Stakeholders***
- ✓ Many others…

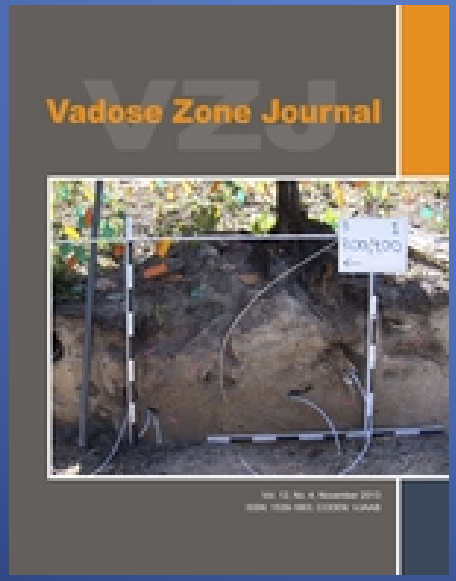


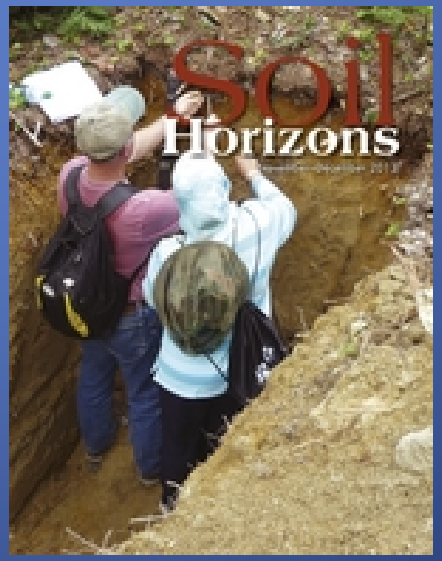
Chesapeake Bay USDA CIG
"Refining the Phosphorus Index"

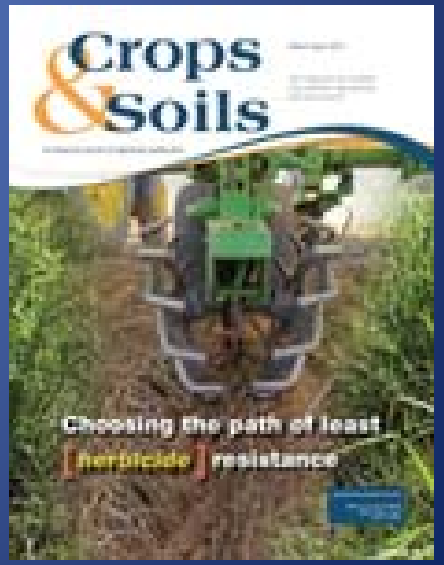
Systematic Reviews & "Meta-Analyses"











Legacy Issues and Nutrient Management

"Quantifying Groundwater's Role in Delaying Improvements to Chesapeake Bay Water Quality" (Sanford and Pope, ES&T 2013)

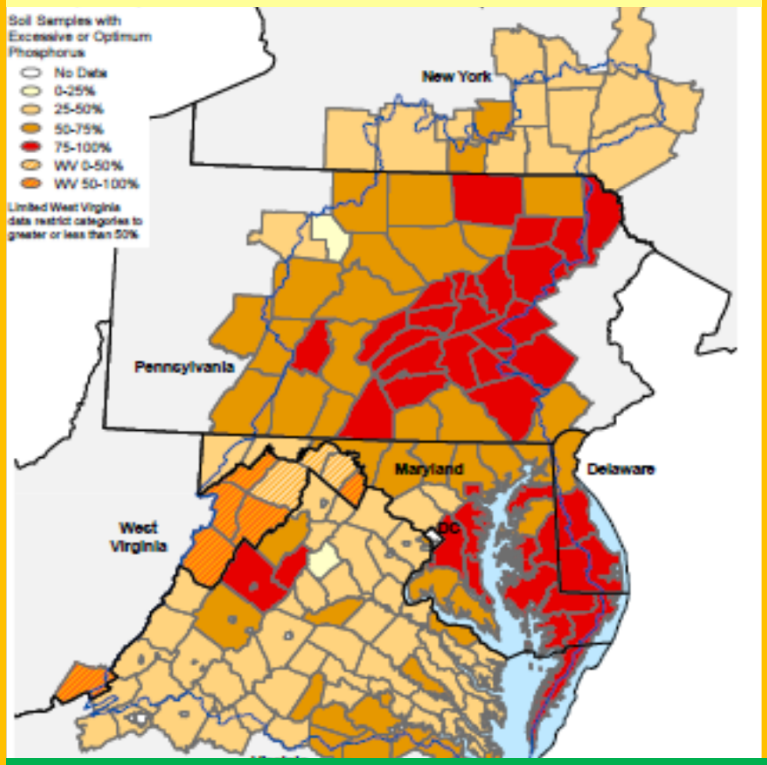
"…Results of this study highlight the large differences in times between USEPA's target of several years for BMPs to be in place and the many decades before these practices would lead to the desired reductions in N loading to the Bay"

"There are many stakeholders invested in restoring the health of the Chesapeake Bay and the delay that groundwater will cause in improvements to its water quality must be a well understood factor in its undertaking"

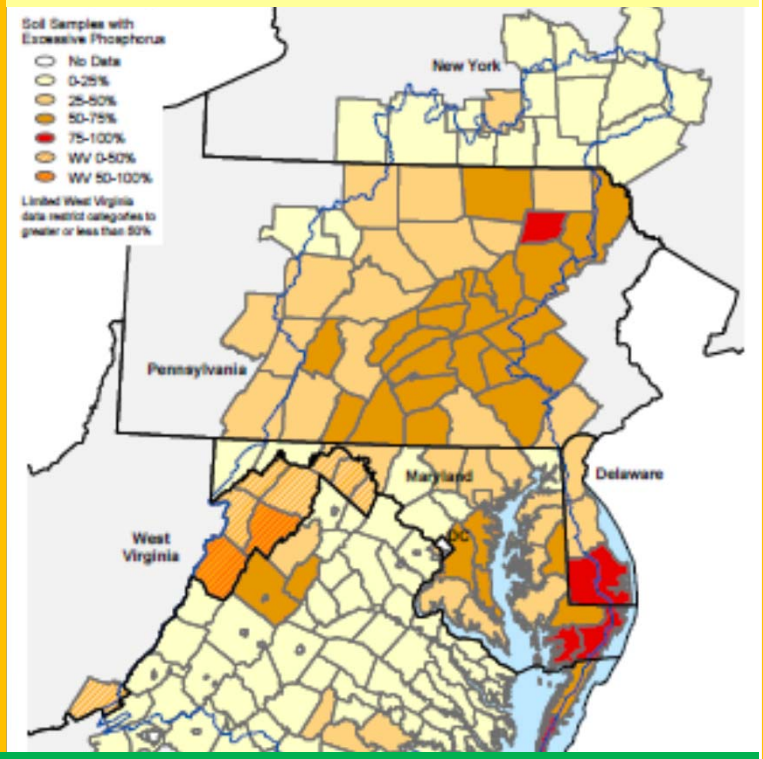
Agriculture and "Legacy Phosphorus"

Phosphorus that has accumulated in soils to values that are of concern for water quality and agricultural sustainabilty - from historic applications of inorganic fertilizers and organic residuals (manures, biosolids composts…)

Counties with Optimum/Excessive STP



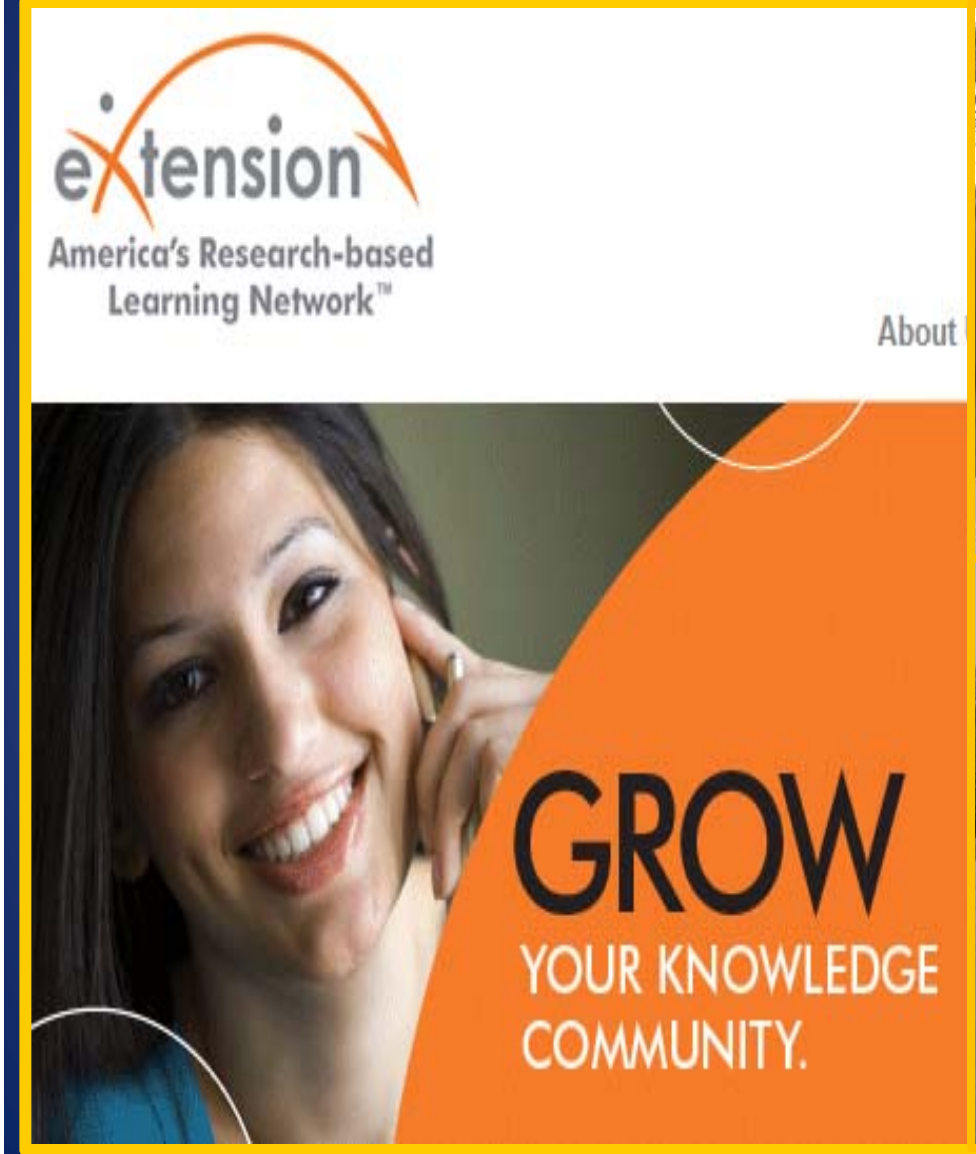
Counties with Excessive STP



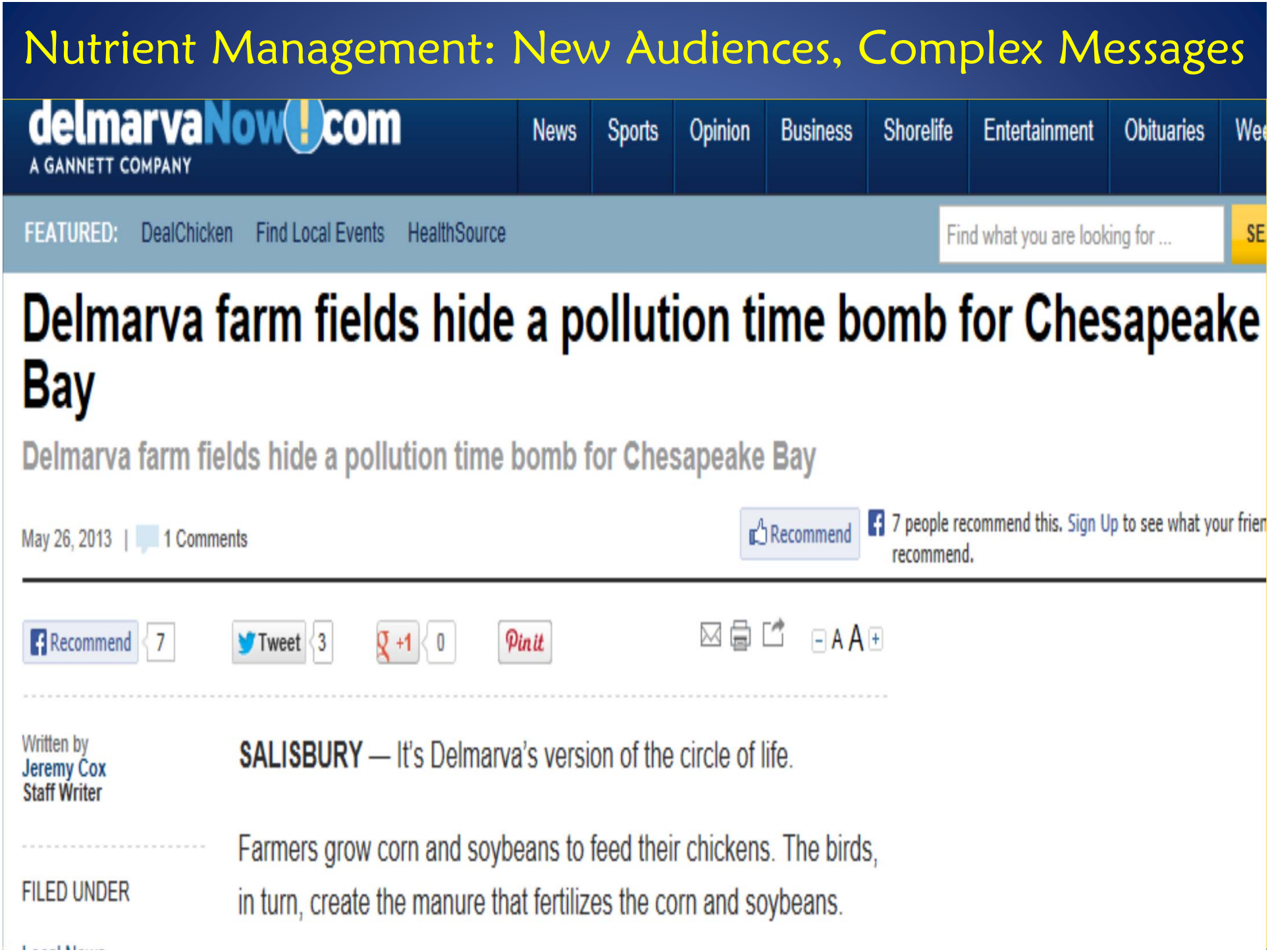
Chesapeake Bay Watershed, USA - 2010

Source: EWG, 2010

Communication, Education, and Technology Transfer



Nutrient Management: New Audiences, Complex Messages



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Delmarva farm fields hide a pollution time bomb for Chesapeake Bay

Delmarva farm fields hide a pollution time bomb for Chesapeake Bay

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Written by
Jeremy Cox
Staff Writer

SALISBURY — It's Delmarva's version of the circle of life.

Farmers grow corn and soybeans to feed their chickens. The birds, in turn, create the manure that fertilizes the corn and soybeans.

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Future Needs, Targets, and Opportunities ("Our Nutrient World", 2013)

- ✓ A "20:20 Aspirational Goal" – increase NUE by 20% by 2020, save 20 million tonnes of N annually?
- ✓ Establish a global NUE assessment process for N, P
- ✓ Establish internationally agreed upon targets
- ✓ Quantify benefits of meeting the targets ($, health)
- ✓ Achieve consensus on best NUE indicators, set benchmarks to track success
- ✓ Further investigate options to increase NUE
- ✓ Identify, address "barriers to change"
- ✓ Develop, implement monitoring approach for NUE

"Kansas City Consensus – 2013"

"How can modern agriculture meet the growing demand for nutritious and affordable food and biofuels while minimizing unintended environmental impacts"?

"What are the technical, economic, and social impediments and opportunities for increased Nitrogen use efficiency in crop and animal production systems"?

19 specific points/recommendations developed by ~160 agricultural scientists, extension agents, CCAs, farmers, seed and fertilizer industry, regulatory agencies, NGOs

Global Overview on Nutrient Management

Our Nutrient World

The challenge to produce more food and energy with less pollution

Prepared by the Global Partnership on Nutrient Management
in collaboration with the International Nitrogen Initiative

UNEP Global Partnership Nutrient Management, 2013