

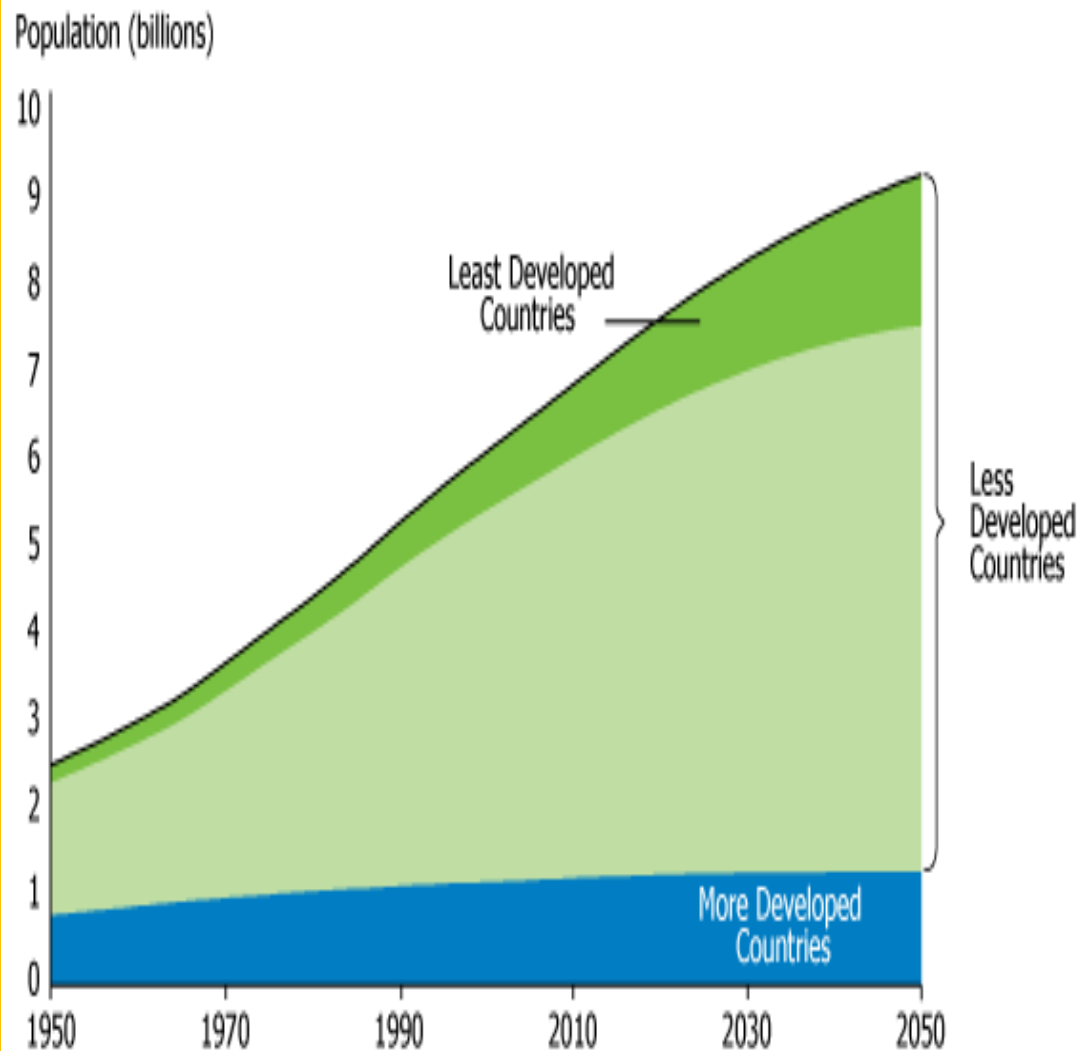
# Improving Nutrient Management for Animal Production Systems

Dr. Tom Sims

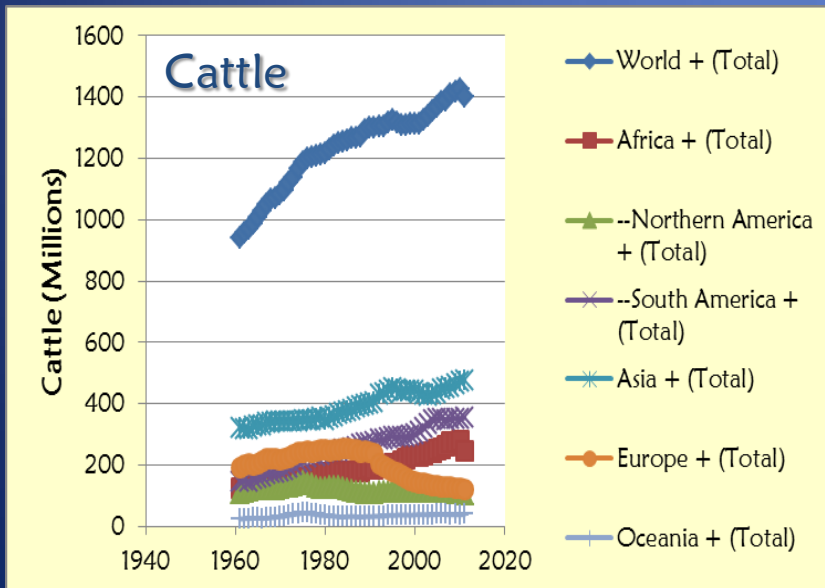
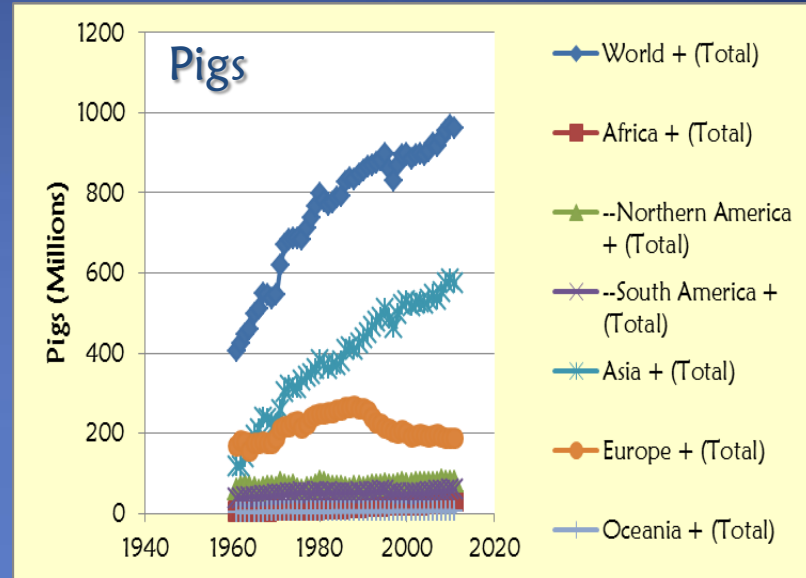
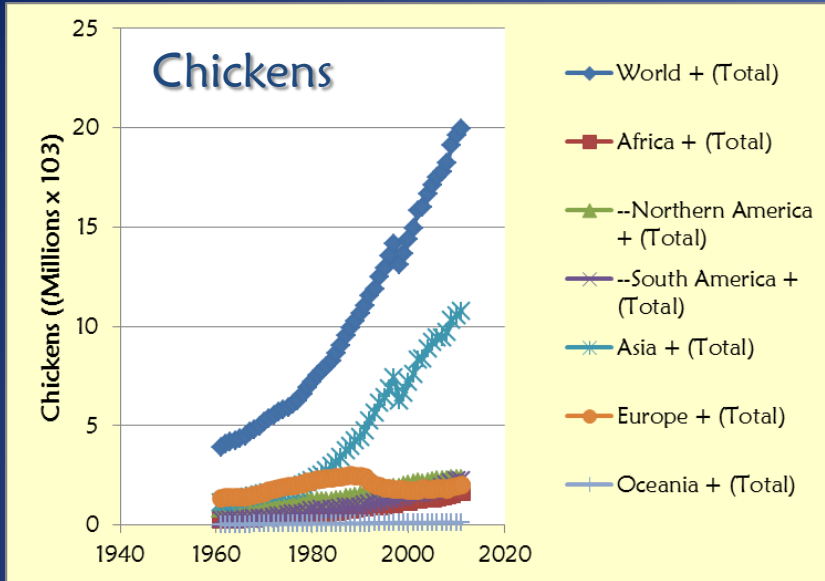
College of Agriculture & Natural Resources  
University of Delaware

Second Global Conference on Land Ocean Connections  
Montego Bay, Jamaica – October 2-4, 2013

# Global Population Growth Drives Demand for Food Security, Nutrient Management



# Animal Agriculture, Nutrients, & Food Security

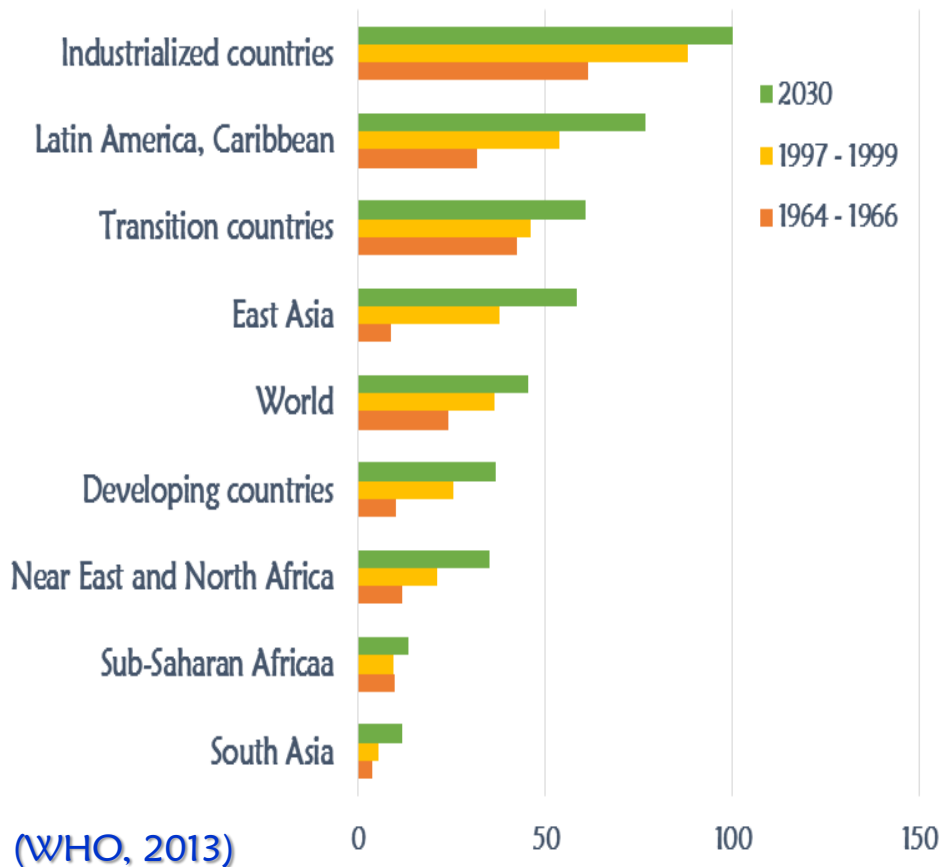


**World Inventory (vs. 1961)**

	<u>1986</u>	<u>2011</u>
Cattle	134%	149%
Chickens	232%	510%
Pigs	203%	237%

# Animal Agriculture, Nutrient Management and Global Food Security

Projected Global Trends in Meat Consumption:  
1965-2030 (kg/capita/yr)



# Animal Production Transforms Nutrients from Natural Resources, Fertilizers, Soils into “Manure”



# Manure and Agriculture

- Linked to farming throughout history of civilization
- Primary nutrient source for food production until 20<sup>th</sup> century, still important today
- Environmental concerns about manures emerge in 1970s, now worldwide issue for water, air quality
- Global trends in systems of animal agriculture, human diets now forcing changes, demanding innovations in manure management



# Global Scenarios (2000-2050)

Base: IAASTD projection

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

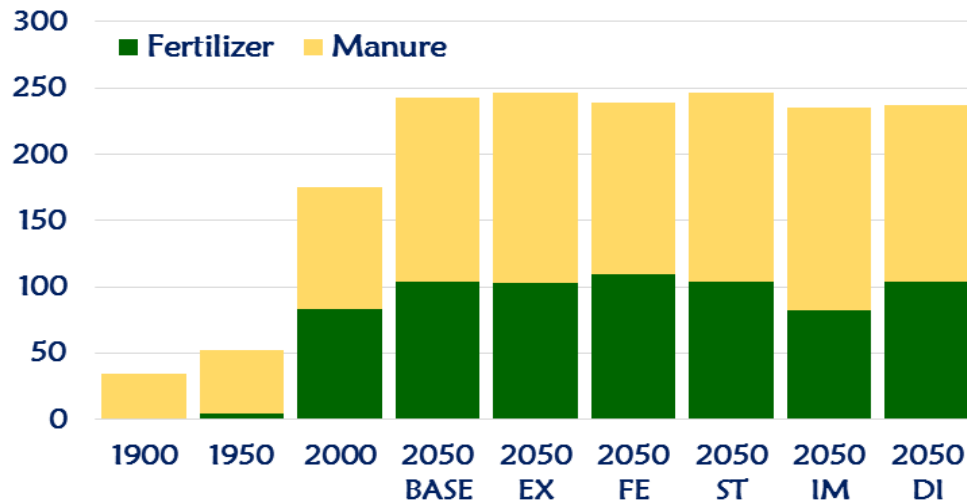
FE: Feed efficiency increases, 10% lower excretion rates in mixed and industrial systems

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

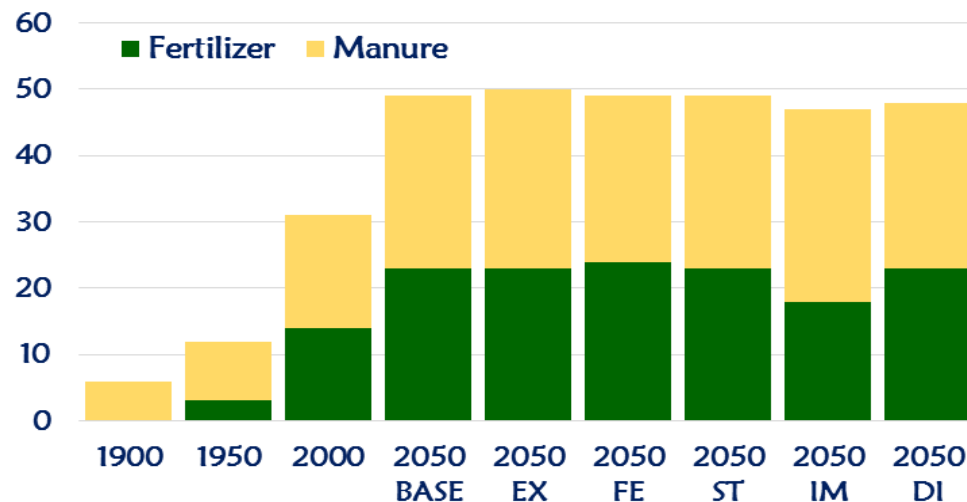
IM: Improved recycling, manure integration into mixed systems

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

### Nitrogen (Tg/yr)



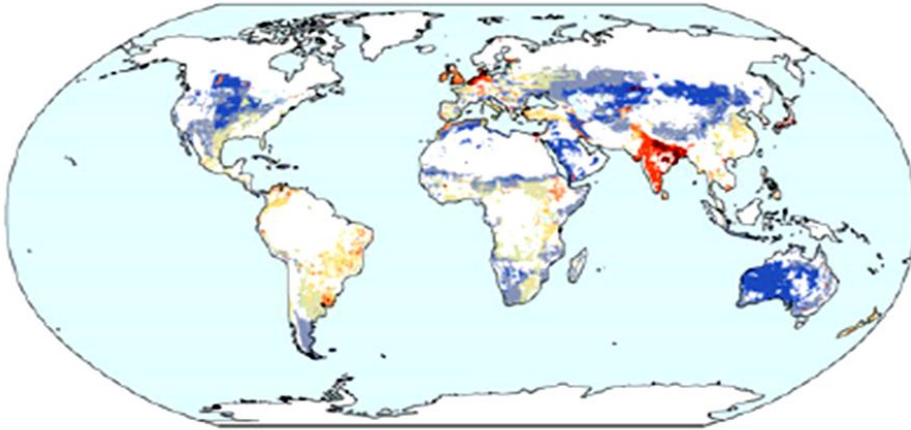
### Phosphorus (Tg/yr)



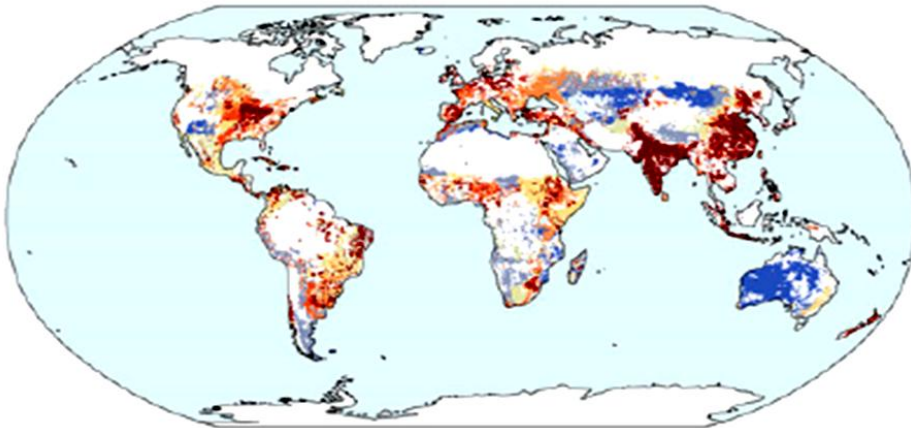
(Bouwman et al, 2012)

# Global Trends in Nitrogen Budgets

1950



2050



kg N km<sup>-2</sup> yr<sup>-1</sup>



IAASTD 2050:

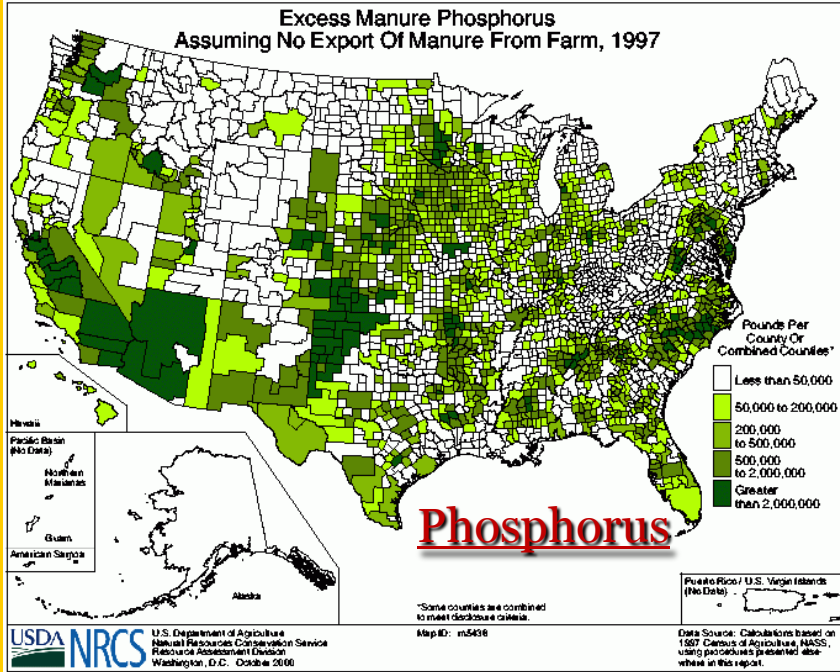
“...a world with an increasing population, continuous economic growth, increasing per-capita consumption, and important shifts in human diets to more meat and milk consumption”

“...a 117% increase in global livestock production, which is inherently inefficient compared with crop production ..an increase in global N and P surpluses of 23% and 54% respectively”

(Bouwman et al, 2012)



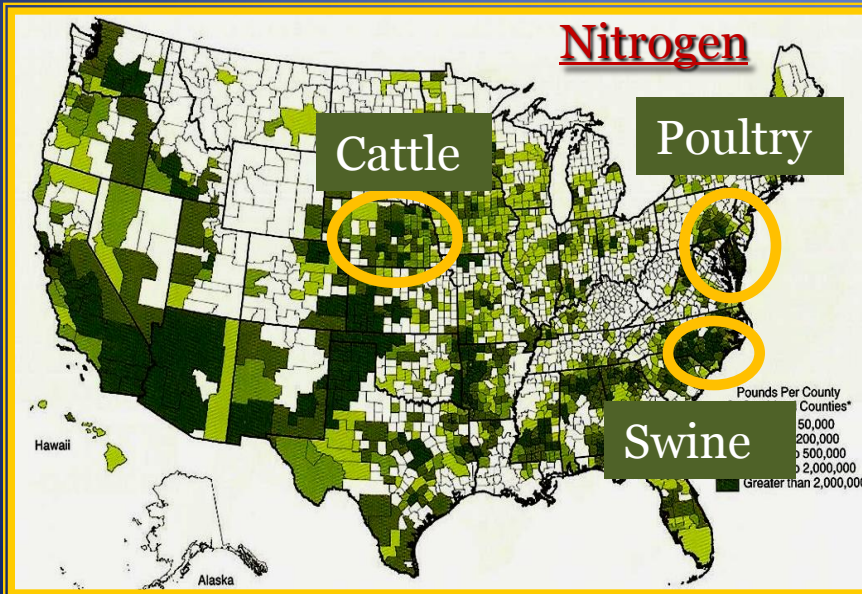
# Trends in Nutrient Generation by US Animal Agriculture



✓ Geographic intensification of animal production has led to large N and P surpluses in many areas of the USA

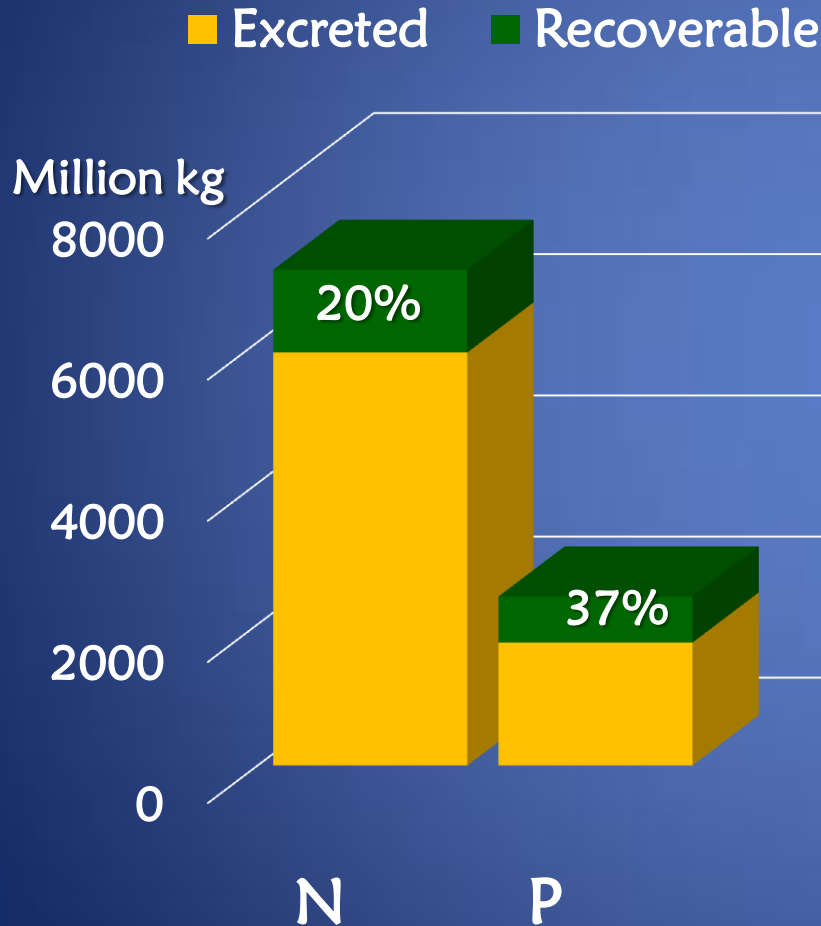
✓ Feed grain production has been largely disconnected from animal production

✓ Regional problems with nonpoint nutrient pollution of water and air have grown into national concerns



(Kellogg et al., 2000)

# “Recovery” of Manure Nutrients? (All USA Livestock, 1997)

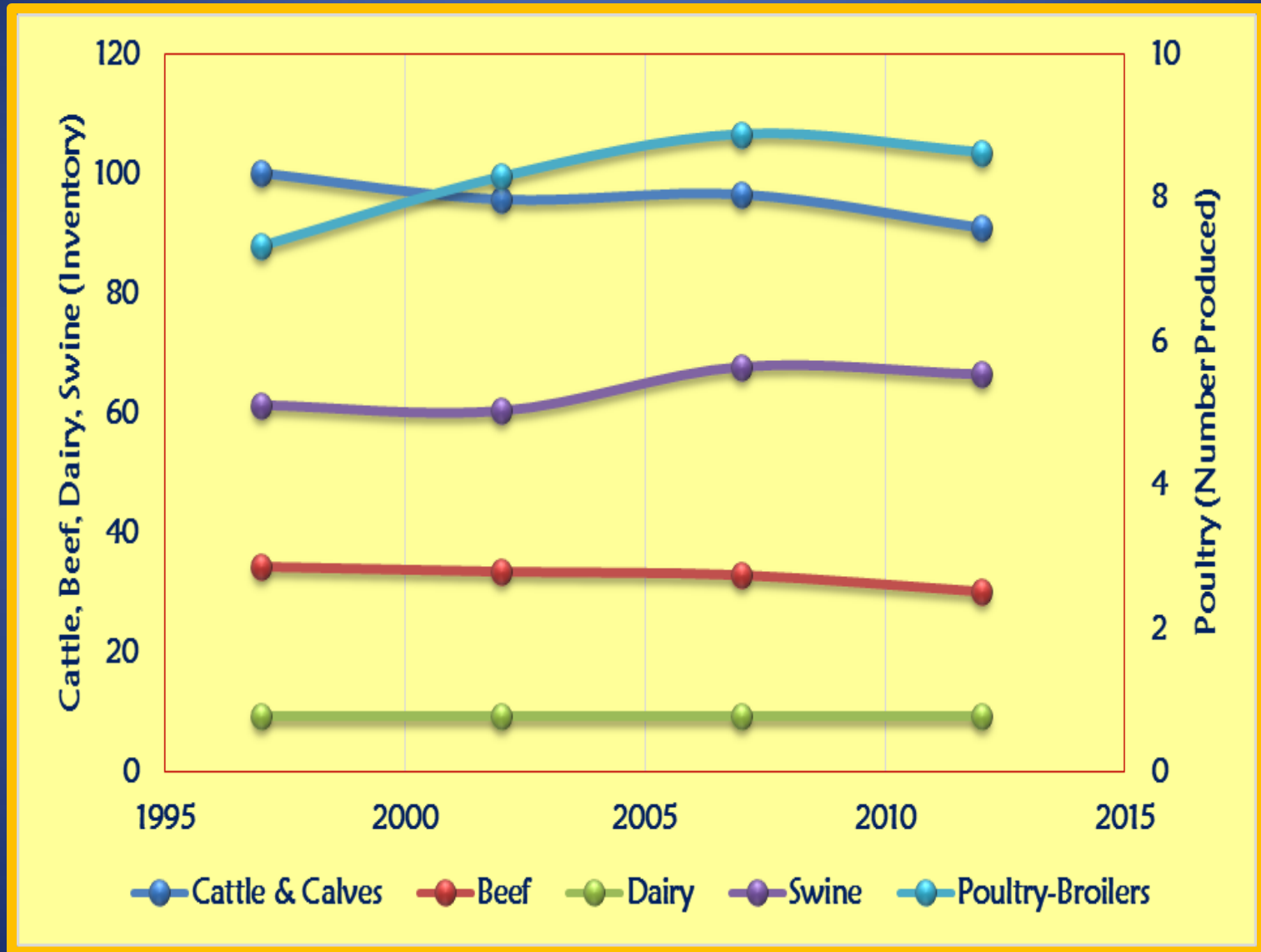


## Potentially Recoverable N, P (% Available for Application)

	N	P
Poultry	58	83
Fattened cattle	35	74
Milk Cows	32	68
Swine	23	78
Other beef/dairy*	2	5

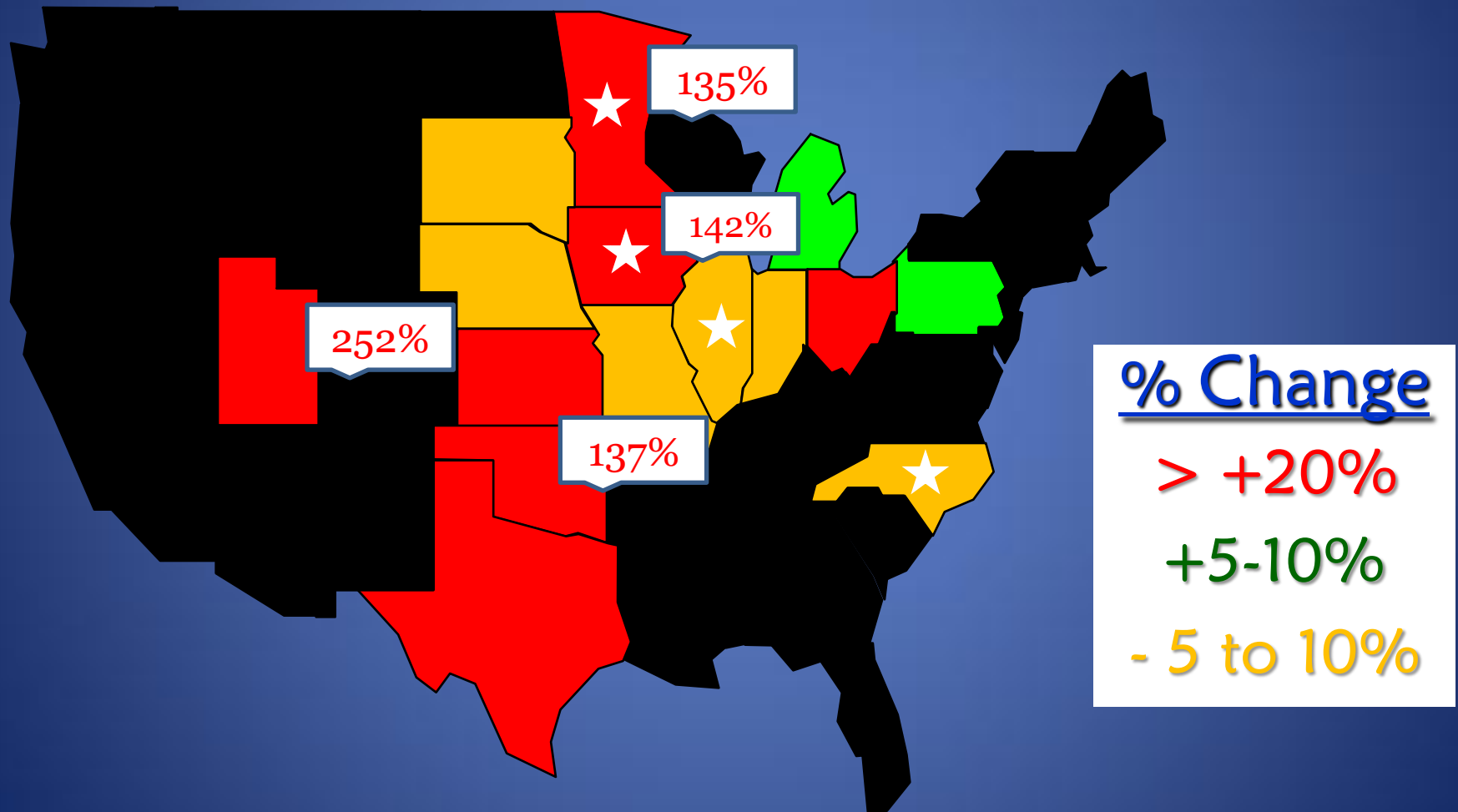
\*Primarily not confined (grazing, etc.)

# USA Animal Production Trends (1997-2012)



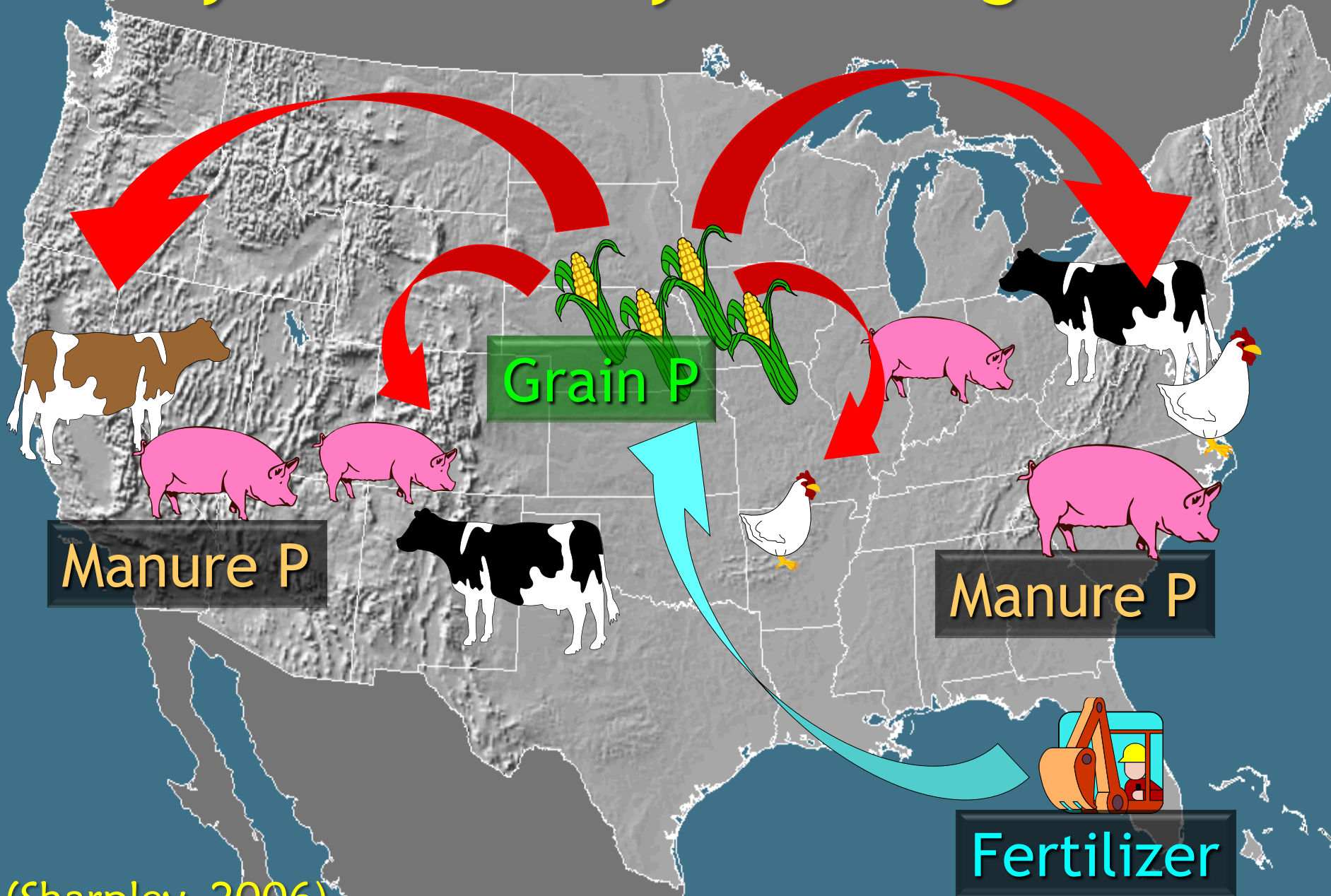
# Hogs & Pigs Inventory: 1997 vs. 2012

(Top 15 States – 94% Inventory of 68 million)



★ 4 states = 64% of US hogs and pigs inventory

# Today's nutrient cycle is fragmented



(Sharpley, 2006)

# How Can We Improve Nutrient Use Efficiency by Animal Agriculture?

## A “Global Framework” ?

- 1) Strategic, sustainable agri-environmental policies, tactics, and practices
- 2) Animal breeding, nutrition and health
- 3) Comprehensive nutrient management plans – for the farmstead and cropland
- 4) Alternative uses for animal by-products – technological solutions

(Sims and Saylor, 2<sup>nd</sup> International Nutrient Management Workshop, Beijing, China, 2008)

# Nutrient Management & Animal Agriculture: Perspectives, Strategies and Policies

## 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

Global Overview on Nutrient Management

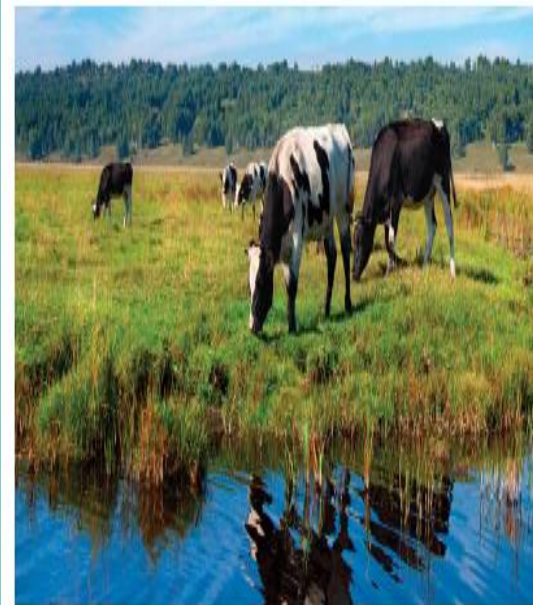
## livestock's long shadow environmental issues and options



## CAST Issue Paper

Number 50  
August 2012

## Water and Land Issues Associated with Animal Agriculture: A U.S. Perspective



The most prominent recent U.S. national policy issue related to livestock, land, and water has been the effect of livestock production on the quality of surface water and groundwater. (Photo from Shutterstock.)

UNEP Global Partnership  
Nutrient Management, 2013

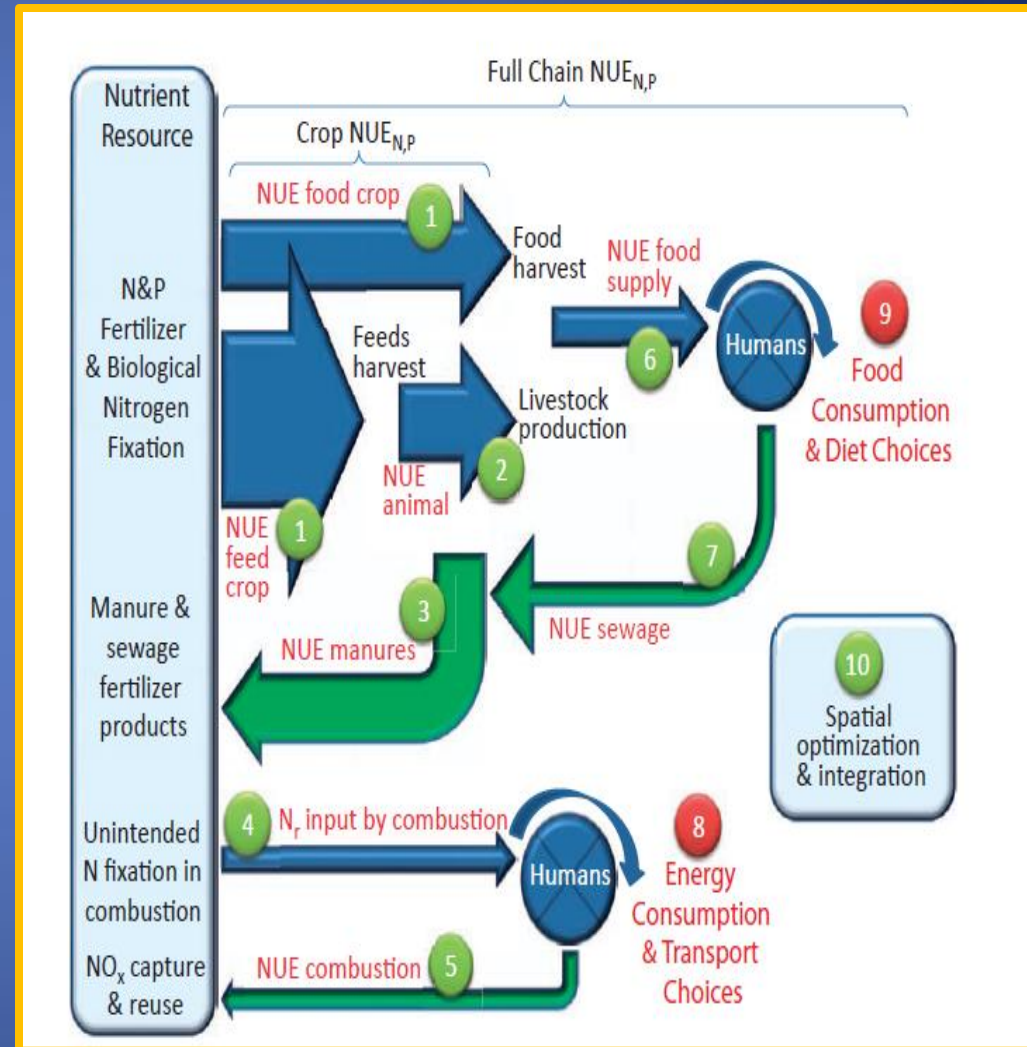
(FAO, 2006)

(CAST, 2012)

# Our Nutrient World: The Problem

“The inclusion of livestock in the food chain substantially reduces overall nutrient use efficiency, leading to large pollution releases to the environment and requiring more N and P to sustain the human population than would be required by plant-based foods.”

“Globally, the 80% of N and P in crop and grass harvests that feeds livestock ends up providing ~20% (15-35%) of the N and P in human diets”





# Our Nutrient World: Key Actions

---

## Key Action #2: Improve NUE for Animal Agriculture

- ✓ Animal breeding, housing, and health
- ✓ Dietary management
- ✓ Nutrient management planning

## Key Action #3: Improve Fertilizer Value of Manure

- ✓ Reduce production, storage, and application losses
- ✓ Enhance fertilizer value via manure processing

## Key Action #6: Integration and Optimization

- ✓ “...integrate nutrient flows ... such as through spatial integration of livestock and arable agriculture, improving NUE for animal manures”

# Nutrient Management Policies-USA's Changing View



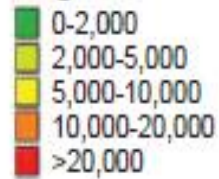
## U.S. judge upholds Chesapeake Bay plan

District Judge Sylvia Rambo ruled that the EPA was within its authority (September 13, 2013)

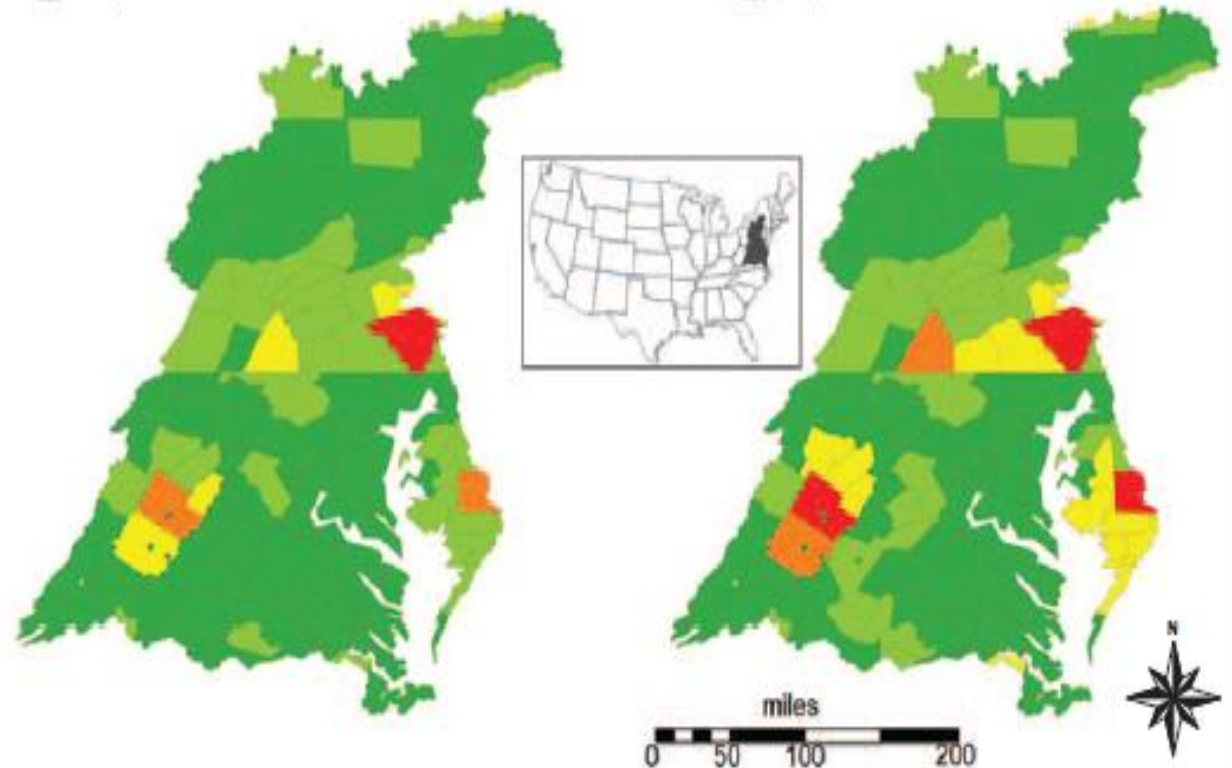
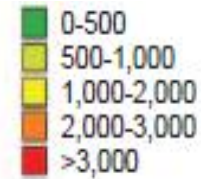
# Case Study: Chesapeake Bay, USA “A National Treasure”



## Manure N



## Manure P



# Chesapeake Bay: 2010 Manure Summit

## Priority Manure Management Challenges & Actions

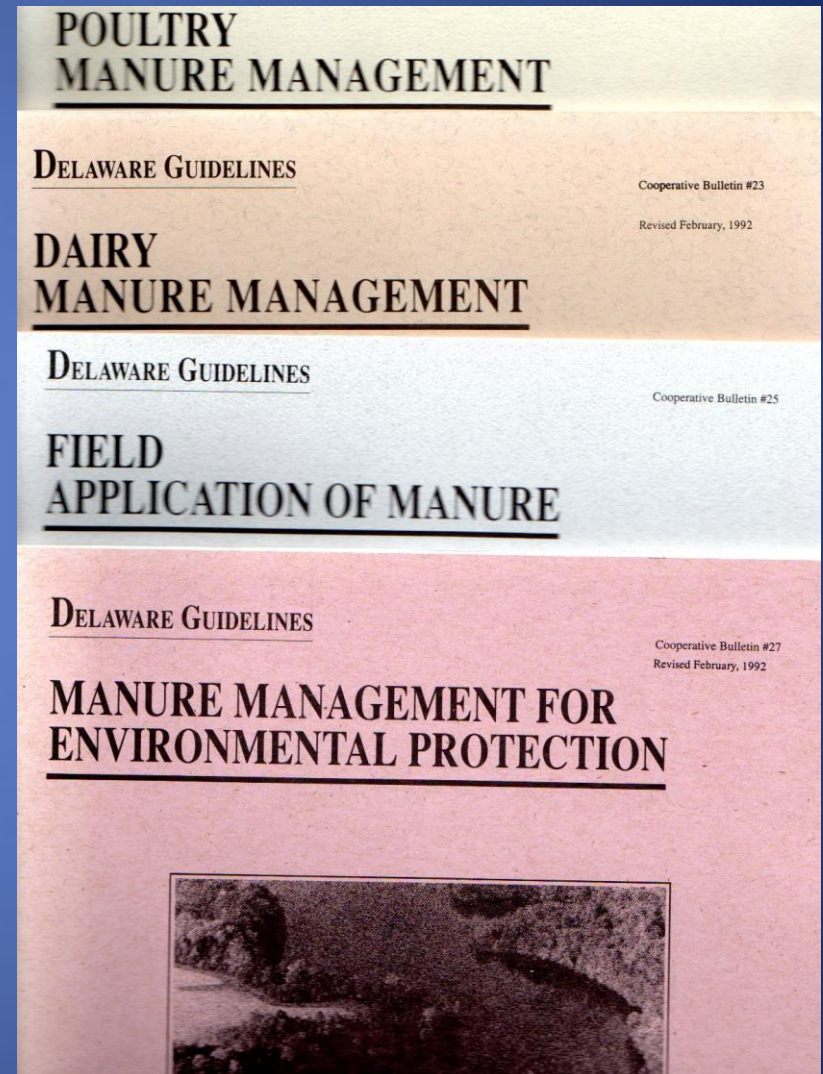
- 1) Achieve nutrient balance on farms, in sub-watersheds
- 2) Develop markets to sustain manure management practices and systems
- 3) Improve compliance with manure, erosion, and sediment control rules
- 4) Improve on-farm infrastructure
- 5) Advance technologies for manure application
- 6) Develop and sustain manure processing industries

(Kleinman, et al., 2012)

# Manure Nutrient Management

## IPNI: “The 4Rs”

- 1) Right Source
- 2) Right Rate
- 3) Right Time
- 4) Right Place



University of Delaware - 1992

# Manage All Manure Consitutents



Literature Review of  
Contaminants in Livestock and  
Poultry Manure and  
Implications for Water Quality

July, 2013

## Manure “Contaminants”

- 1) Pathogens
- 2) Antimicrobials
- 3) Hormones
- 4) Impacts
- 5) Management
  - ✓ Land application
  - ✓ Storage
  - ✓ Treatments
  - ✓ Subsidies
  - ✓ Regulations



# CNMP Watch

A Project of NASDA Research Foundation

## Home

### What We're All About

### News

Find out the latest news affecting CAFOs and animal manure management

### Events

Upcoming events that can help you out

### Tools

The latest tools to help you develop nutrient management plans and CNMPs

### Technology

See what technology is being developed for manure management and utilization



## Guidelines and Regulations

[Land Treatment Practices](#)

[Brief History of CAFO Regulations](#)

[Feed Management](#)

[Other Utilization Activities](#)

[What do you need to know to be a CNMP provider?](#)

## Welcome to CNMP Watch

CNMP Watch is the complete Web source for manure and nutrient management planning information. It is designed to get you started and assist you with helping livestock producers prepare their nutrient management plans in the many forms they might take – whether that is a Manure Management Plan (MMP), an NMP for a federal CWA NPDES permit, or a USDA-NRCS Comprehensive Nutrient Management Plan (CNMP). A livestock producer might want a nutrient management plan just to improve their water quality performance, or to qualify for funding assistance, or to meet a federal or state regulatory requirement. Some producers will want a nutrient management plan prepared to the NRCS

# Manure Nutrient Management: Challenges

- 1) Inefficient animal manure management practices in settings where sustainable manure use is possible
- 2) Agricultural systems highly efficient at animal production, but inefficient at or disconnected from sustainable manure use for (local) crops



Nutrient Use Efficiency  
(Output/Input):  
N = 36%  
P = 35%

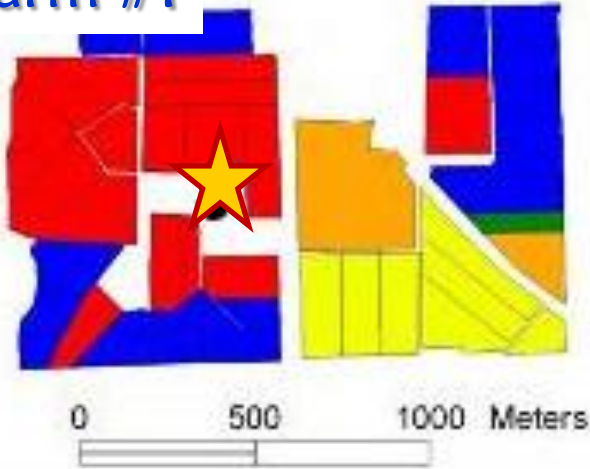


# Manure Storage and Application

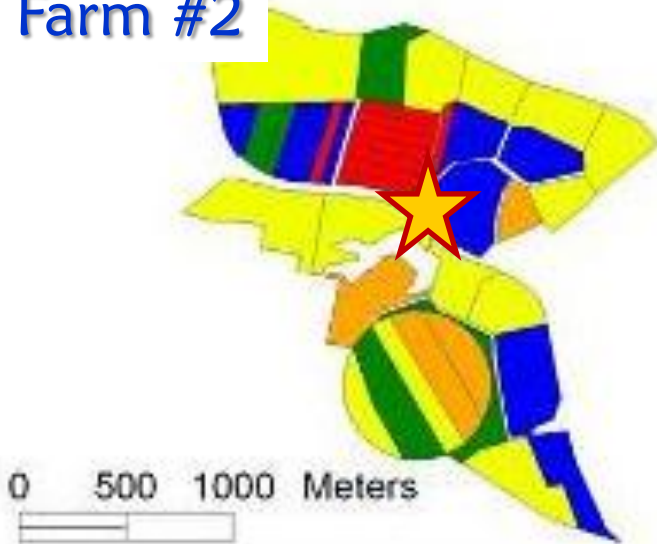


# Balancing Manure and Soil Fertility?

Farm #1



Farm #2



- Soil test P maps of Australian dairy farms highlight practical challenges of distributing manure nutrients uniformly on farms
- Uneven distribution impacts yields, enhances risk of P loss to water

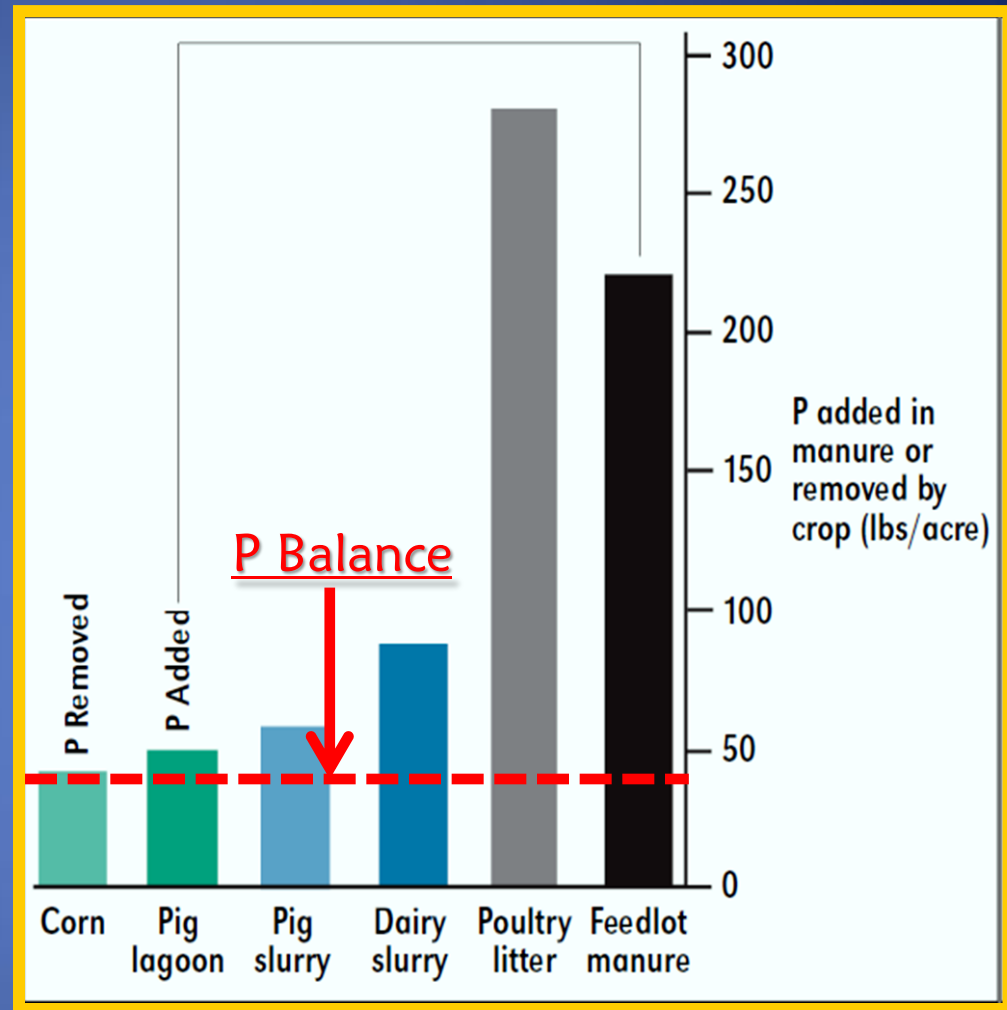
(“Accounting for Nutrients”  
Australian DPI, 2011)

# Animal Nutrition, Manure, and Environment

Traditional

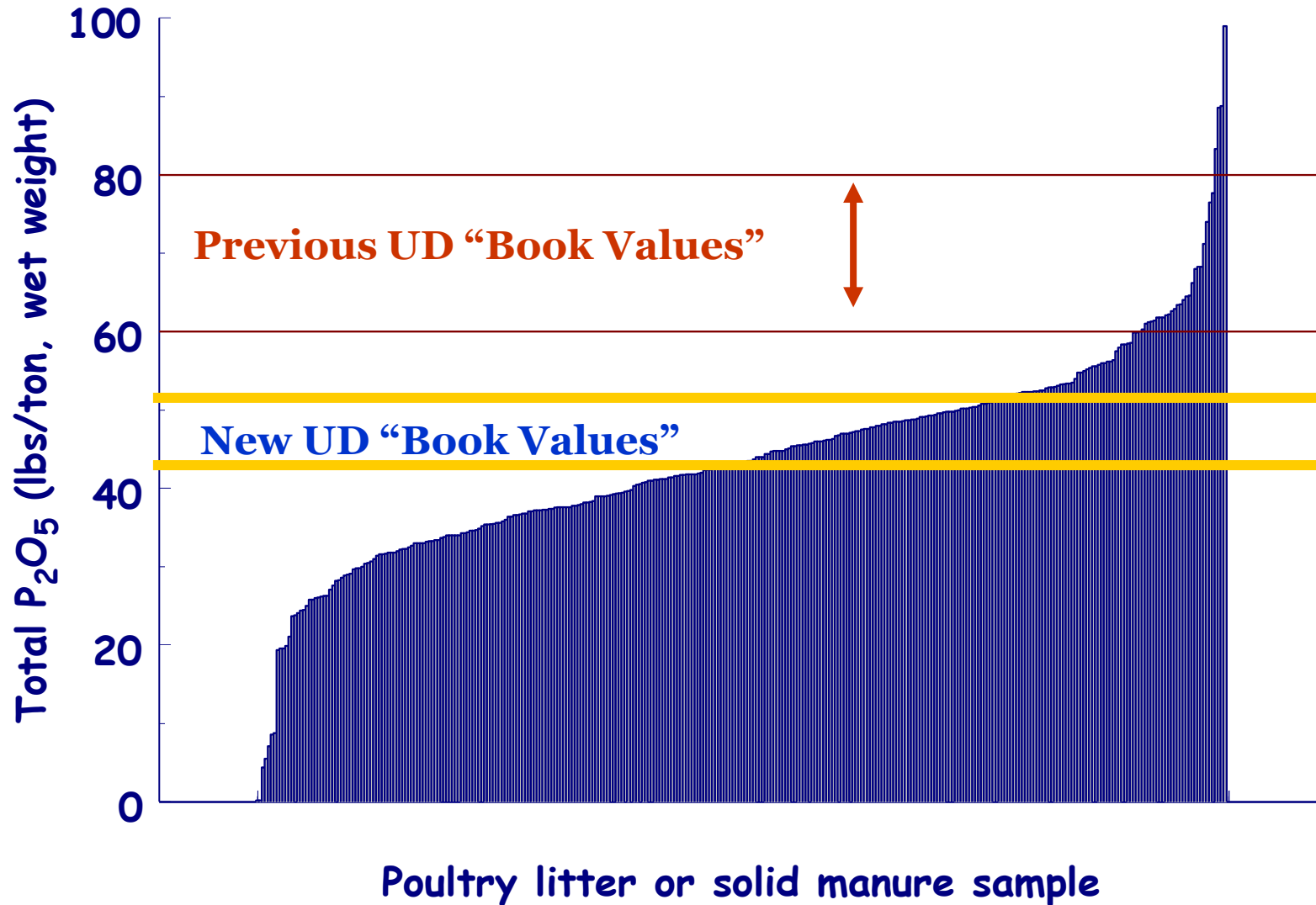


“CAFOs”: 1700 cows

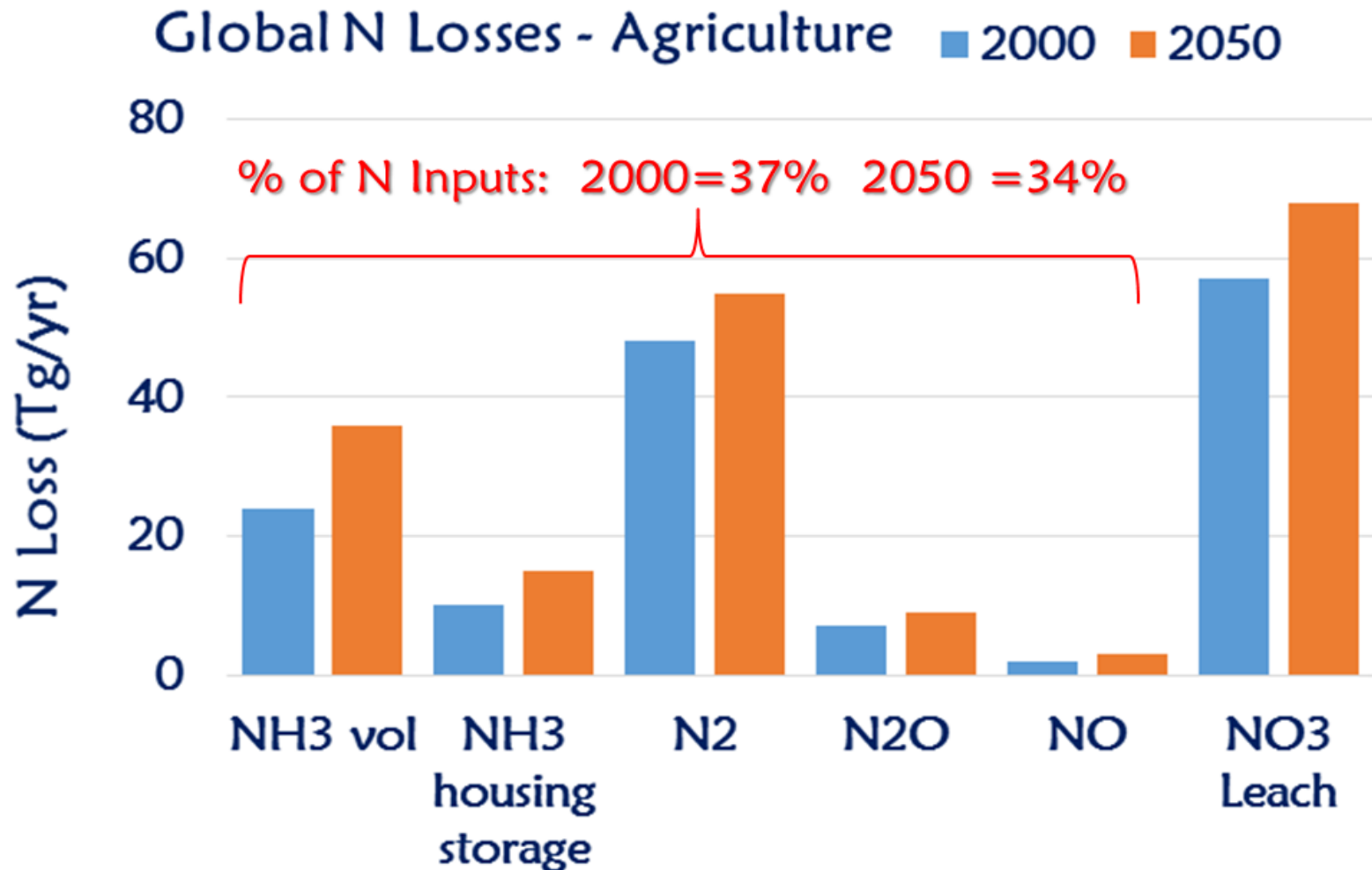


Balancing soil fertility in manured soils must integrate crop and animal nutrition (N:P ratios)

# DE Department of Agriculture Poultry Manure Analyses



# Mitigate Gaseous Emissions from Animal Agriculture (NH<sub>3</sub>, N<sub>2</sub>O, NO, CH<sub>4</sub>, VOC, Odors, PM<sub>10</sub>....)



(Bouwman et al, 2012)

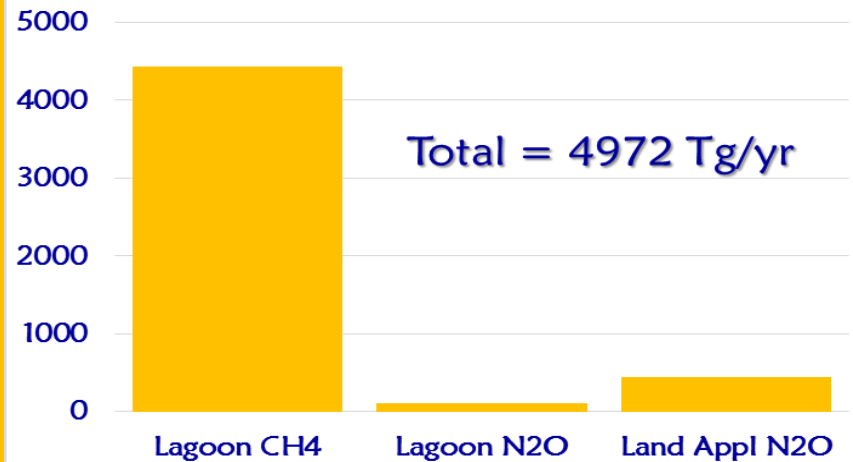
# Alternative Options for Swine Manure

Advanced wastewater  
Treatment for irrigation

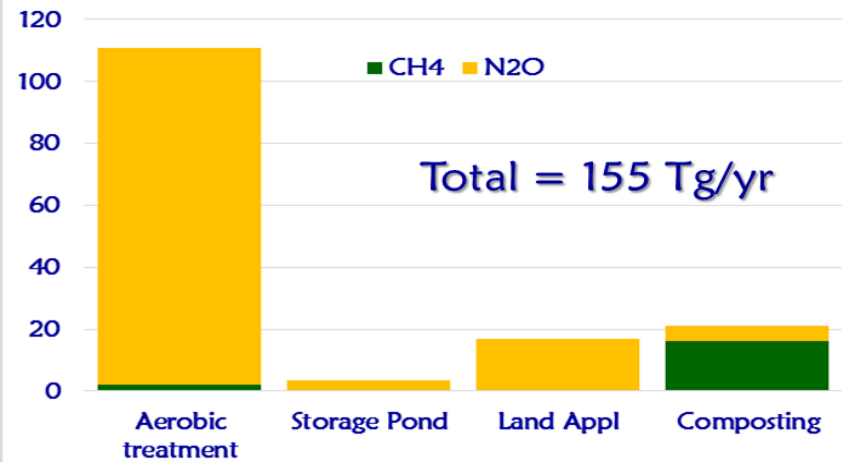


Organic fertilizers

Baseline Emissions (Tg CO<sub>2</sub>-eq/yr)



New Technology Emissions (Tg CO<sub>2</sub>-eq/yr)



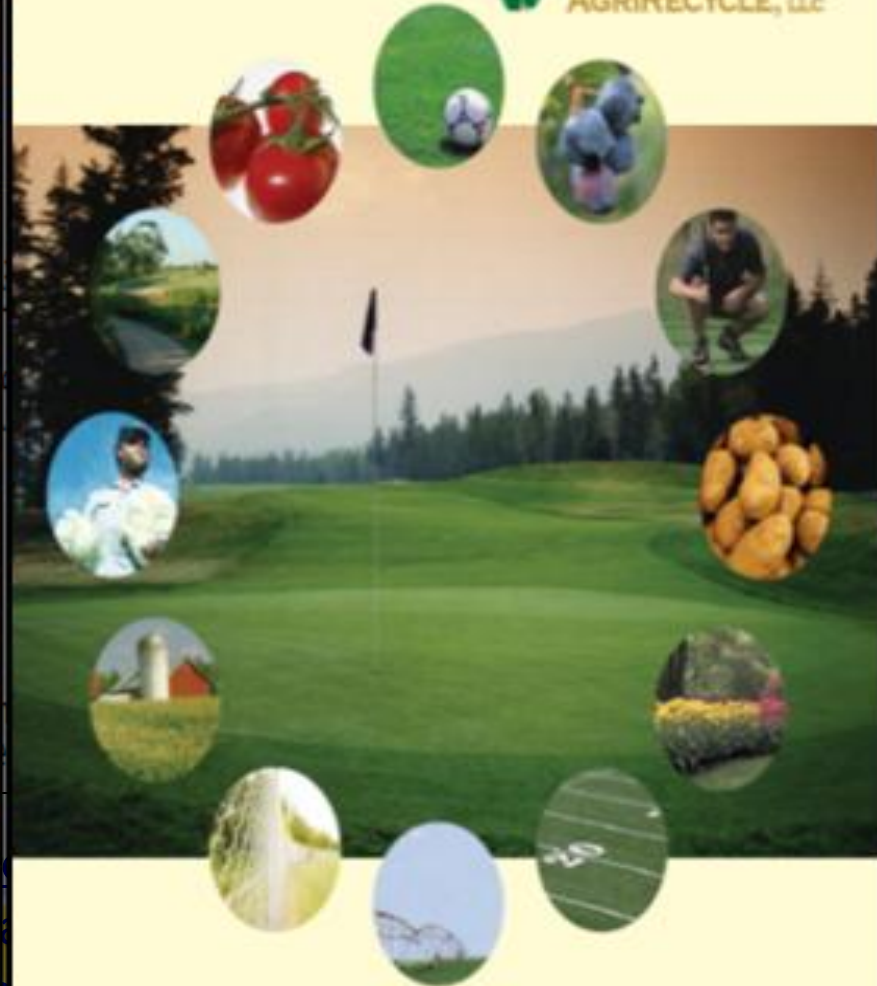
(Vanotti et al., 2008)



Pelletized manure:  
"3-3-3" fertilizer

*In any field,  
you couldn't pick a better organic fertilizer.*

 **PERDUE<sup>®</sup>**  
**AGRIRECYCLE,<sup>™</sup> LLC**



# Can We Improve Nutrient Management for Global Animal Agriculture?



- 1) Agricultural and environmental policy frameworks and sustained financial support?
- 2) Systematic, effective education and technology transfer to our farming communities?
- 3) Integrated, basic and applied nutrient management research?
- 4) Global strategy for “CAFO”s to “recouple” animal and crop production systems?



Bottom Line: GPNM should be a leading force in global efforts to improve nutrient use efficiency by animal agriculture