Manure: Pillar of Soil Fertility Match or Mismatch?

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

Global Conference on Nutrient Management
Beijing, China – June 19-20, 2013

Manure and Agriculture

- Linked to farming throughout history of civilization
- Primary nutrient source for food production until 20th 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

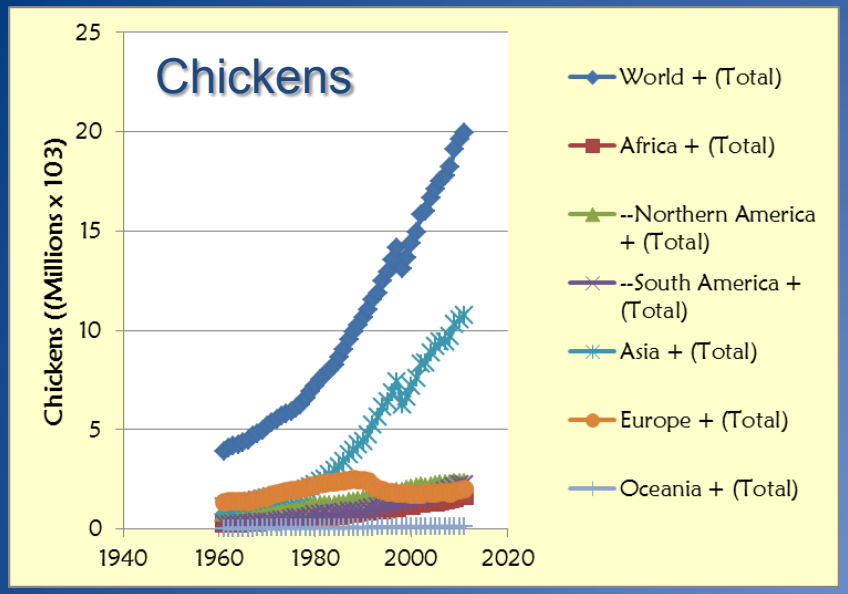
Manure and Soil Fertility

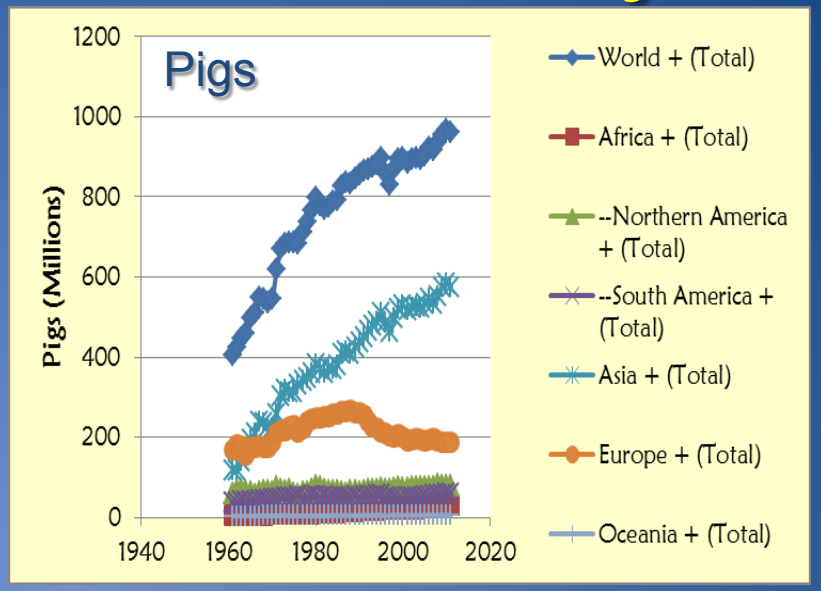
Fertility:

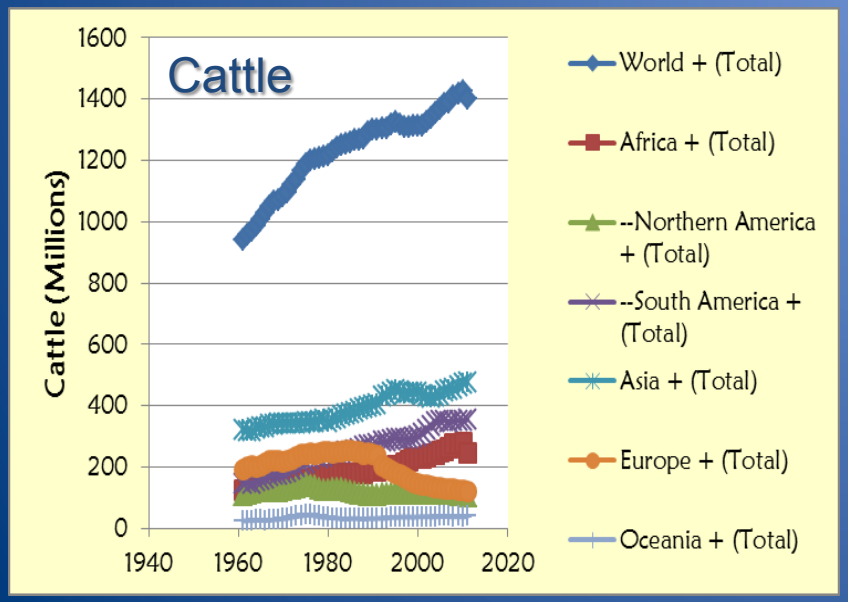
"The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants"

Nature and Property of Soils (2012)

Global Animal Inventory







World Inventory (vs. 1961)

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

(FAOStat, 2013)

Manure: A Match to Soil Fertility?

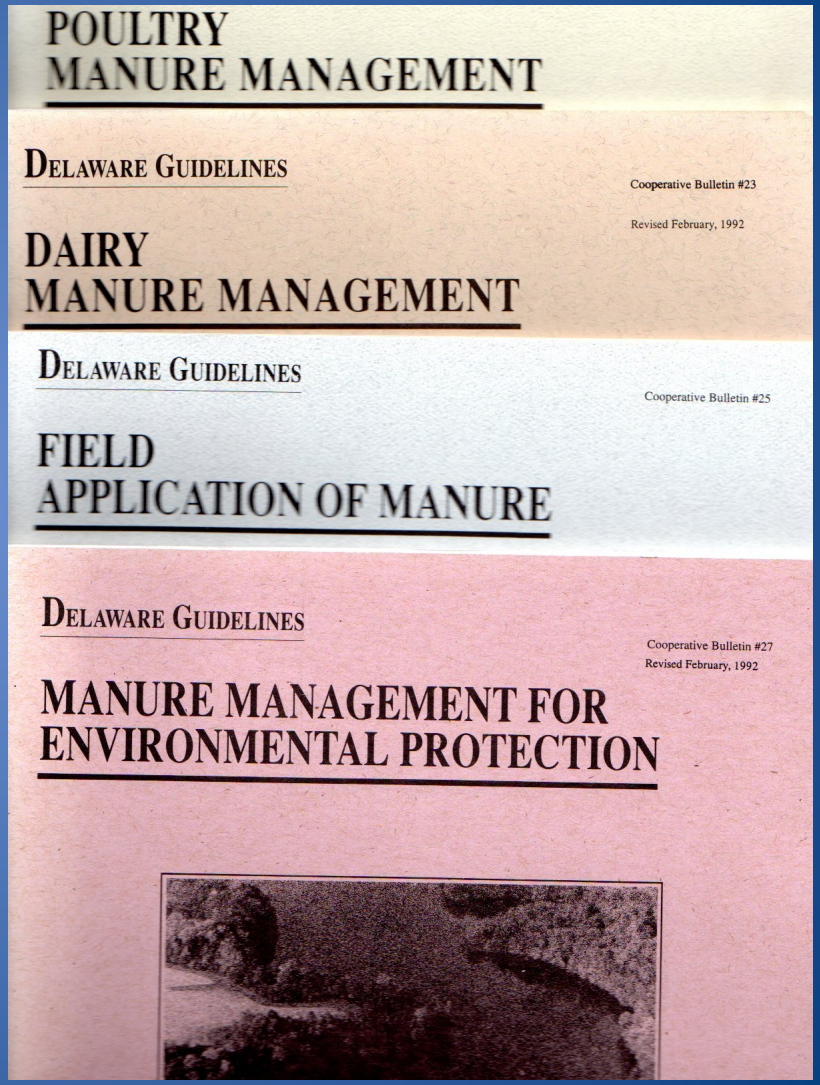
IPNI: "The 4Rs"

1) Right Source

2) Right Rate

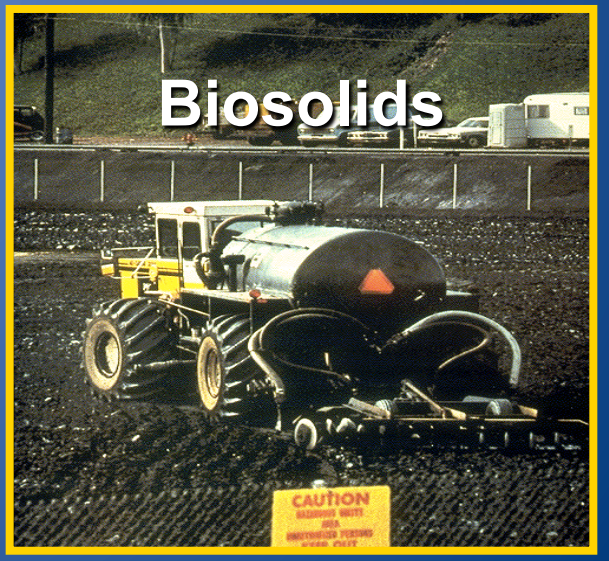
3) Right Time

4) Right Place



University of Delaware - 1992

Right Source



Right Rate: “PAN-P” and “PSC”

Plant Available N and P: Function of N, P forms, soil type, environment, microbial activity, management …

Phosphorus Solubility: Function of manure properties, treatment processes, soil type, management …

Manure Nitrogen Availability Factors: Penn State "Agronomy Guide"

A. Current Year

To use this table, find the ***planned manure application season*** in the left column, then move to the right in that row and select the PAN tilization. Continue to the right in that row to find the ***nitrogen availability factor*** for the ***planned manure application management***.

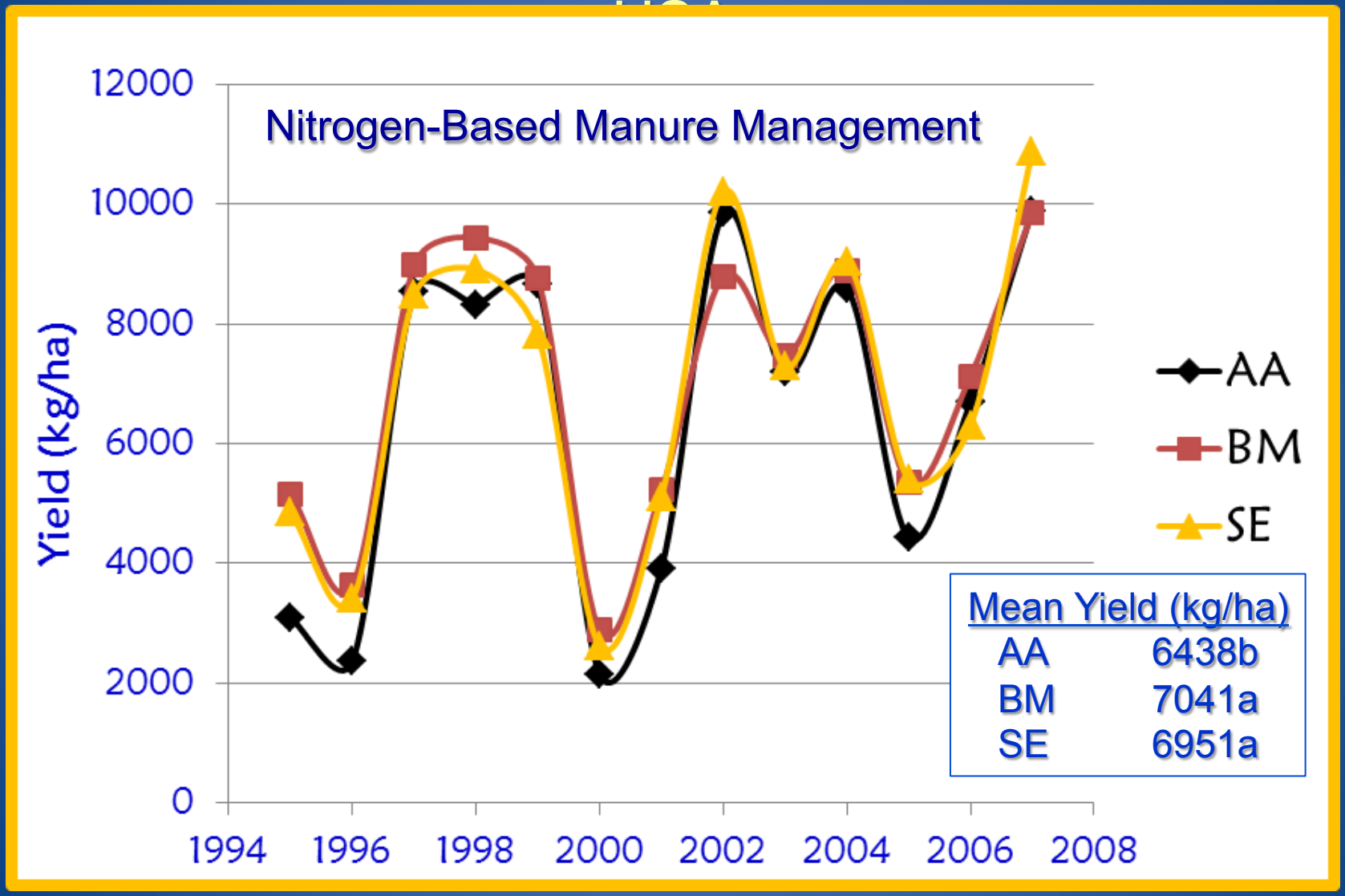
The manure nitrogen availability factor is the fertilizer equivalence of the manure N or the lb of fertilizer N equivalent per pound of total manure N. For

Table 1. First-year nutrient availability for different animal manure sources.

(Iowa State, 2008)

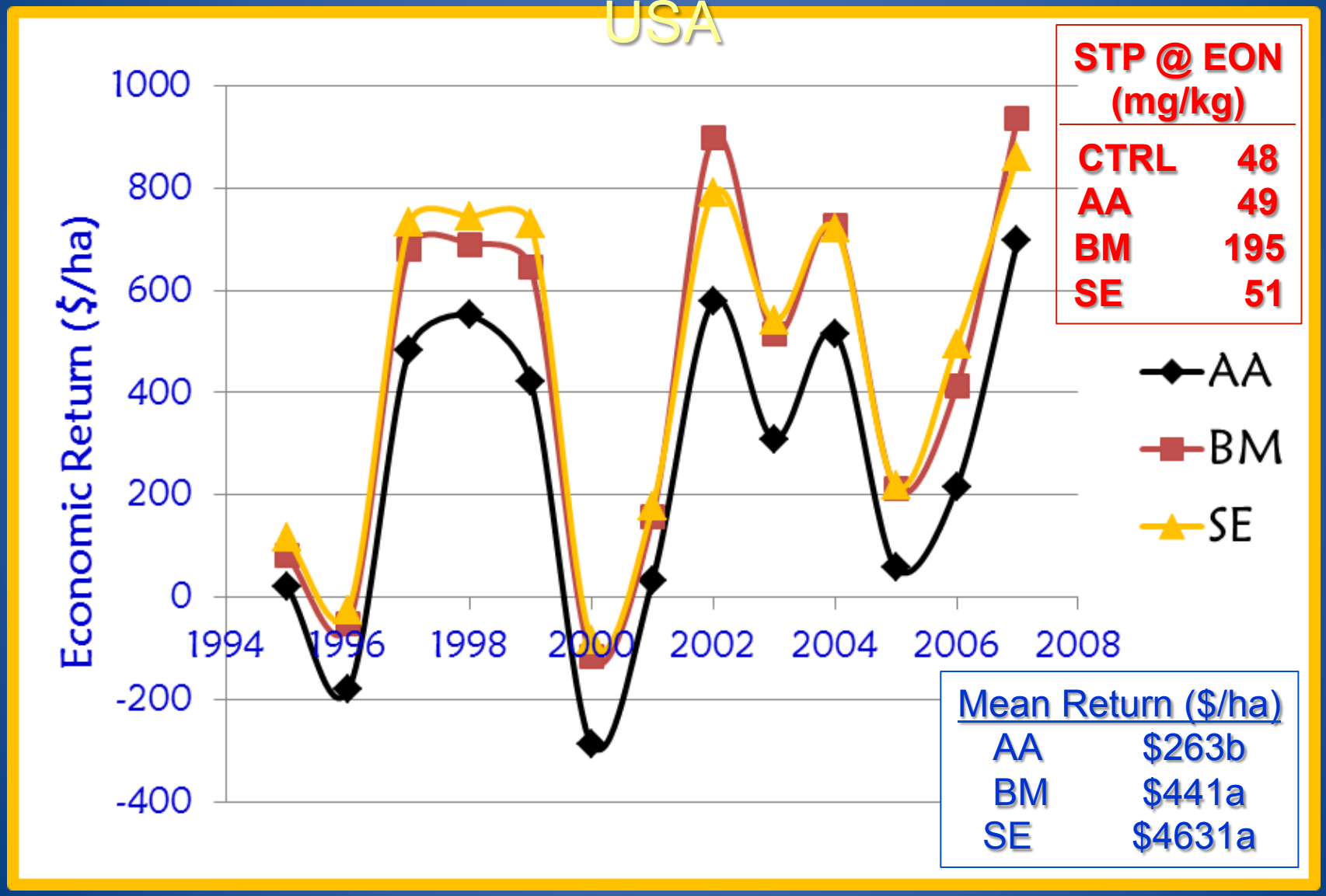
Manure Source	Nitrogen[1]	Phosphorus[2]	Potassium[2]
	---------- Percent of Total Nutrient Applied ----------		
Beef cattle (solid or liquid)	30–40	60–100	90–100
Dairy (solid or liquid)	30–40	60–100	90–100
Liquid swine (anaerobic pit)	90–100	90–100	90–100
Liquid swine (anaerobic lagoon)	90–100[3]	90–100[3]	90–100
Poultry (all species)	50–60	90–100	90–100

Effects of Anhydrous Ammonia, Beef Manure and Swine Effluent on Irrigated Corn Yields, Oklahoma,



Park, et al., 2010

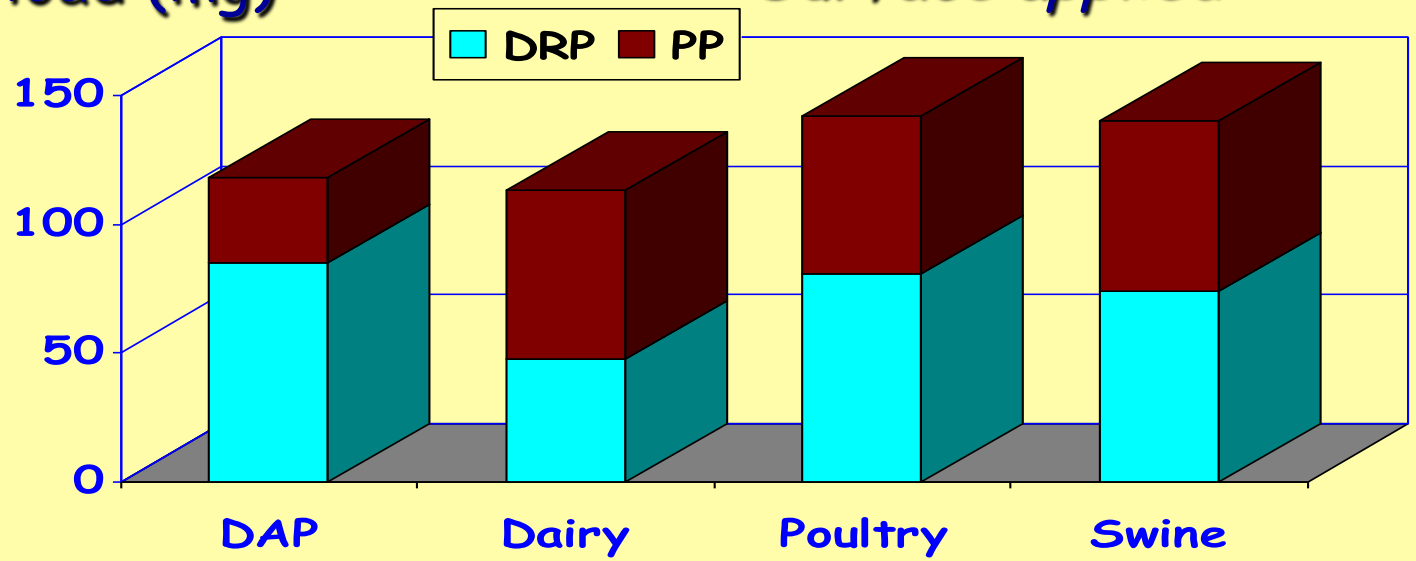
Effects of Anhydrous Ammonia, Beef Manure and Swine Effluent on Irrigated Corn Profitability, Oklahoma, USA



Park, et al., 2010

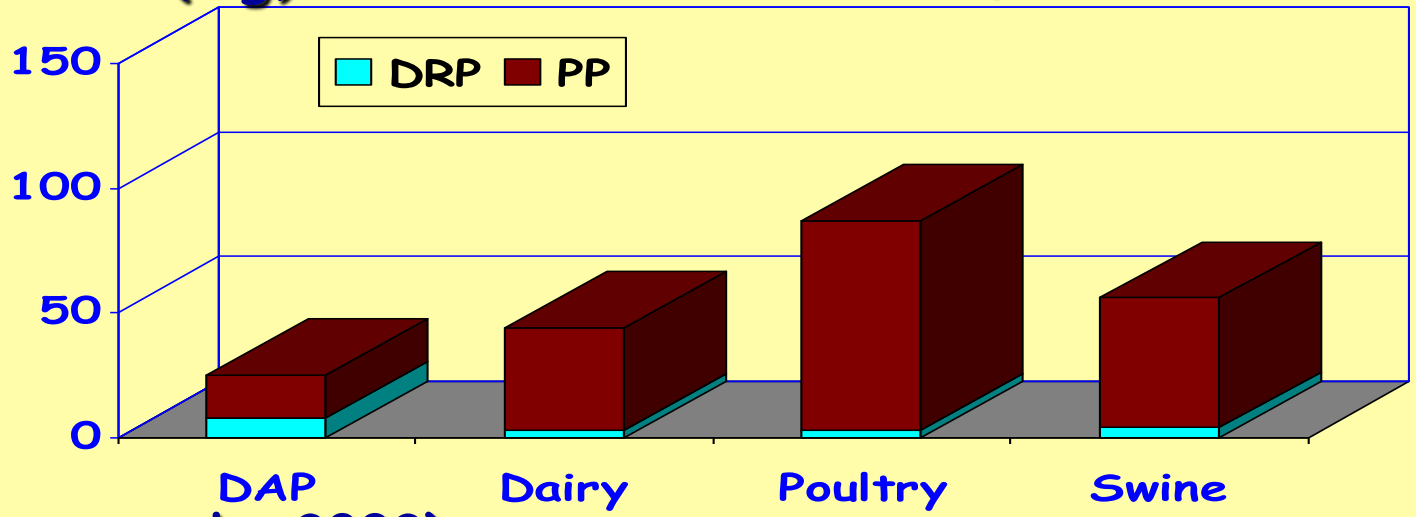
TP load (mg)

Surface applied



TP load (mg)

Incorporated



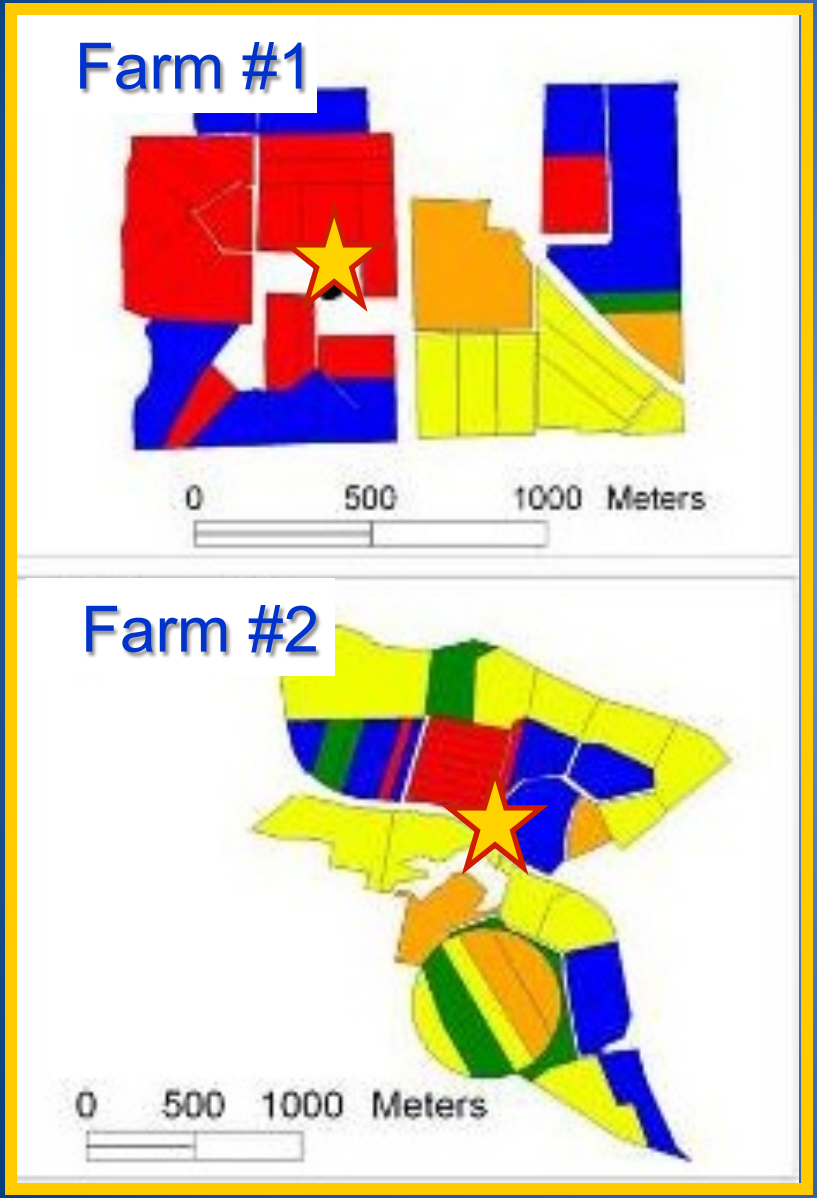
(Kleinman et al., 2002)

Manure: A Mismatch to Soil Fertility

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

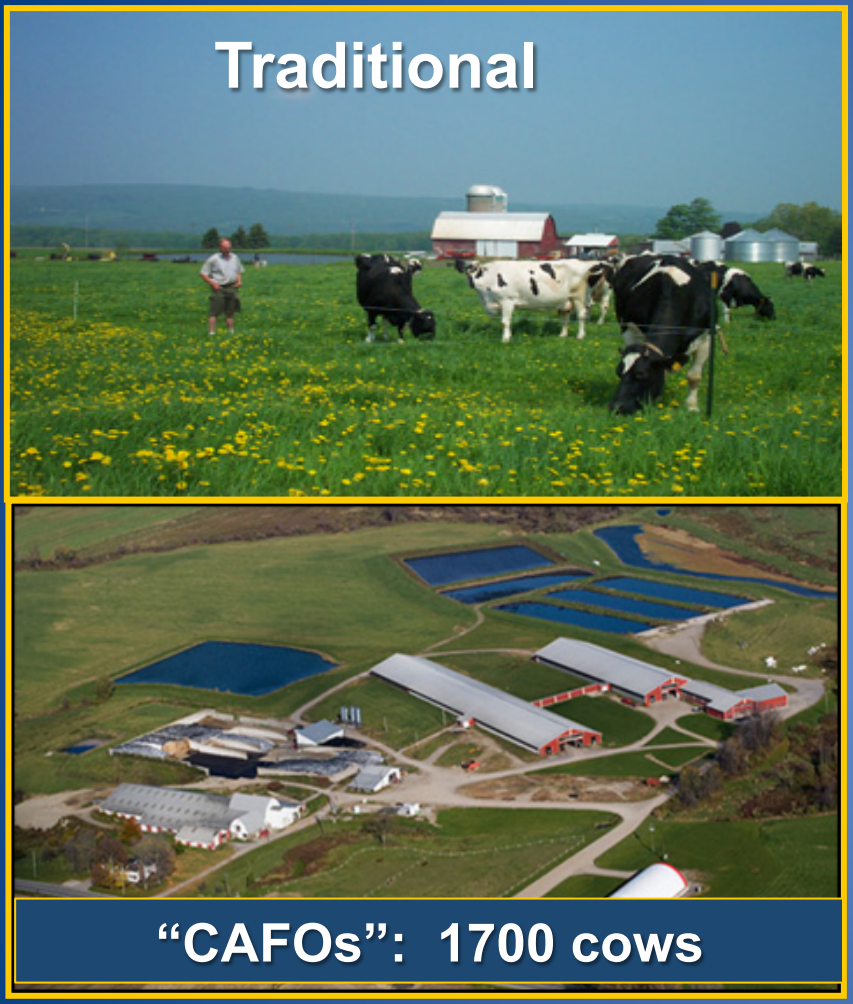
Balancing Manure and Soil Fertility?

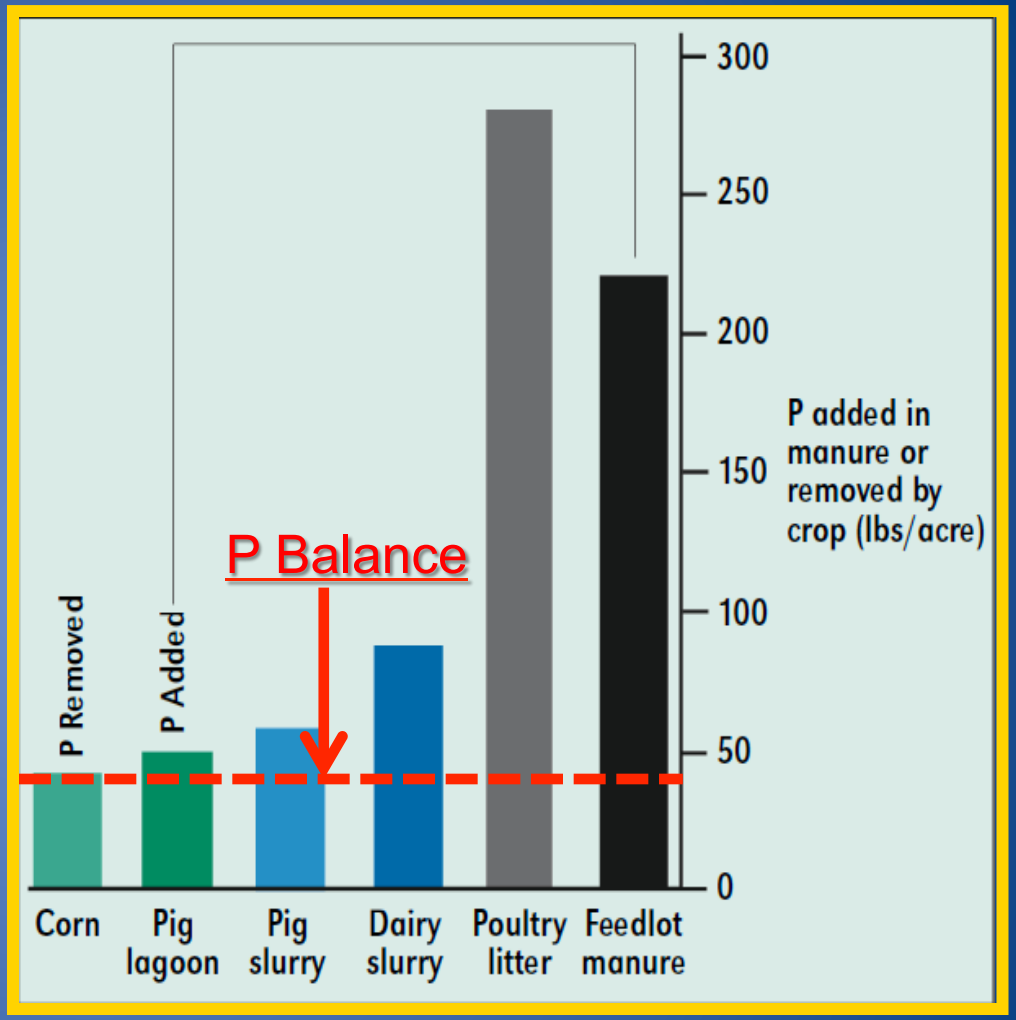


- Soil test P maps of Australian dairy farms highlight practical challenges of distributing manure nutrients uniformly on farms
- Uneven distribution impacts yields, enhances risk of P loss to water

("Accounting for Nutrients" Australian DPI, 2011)

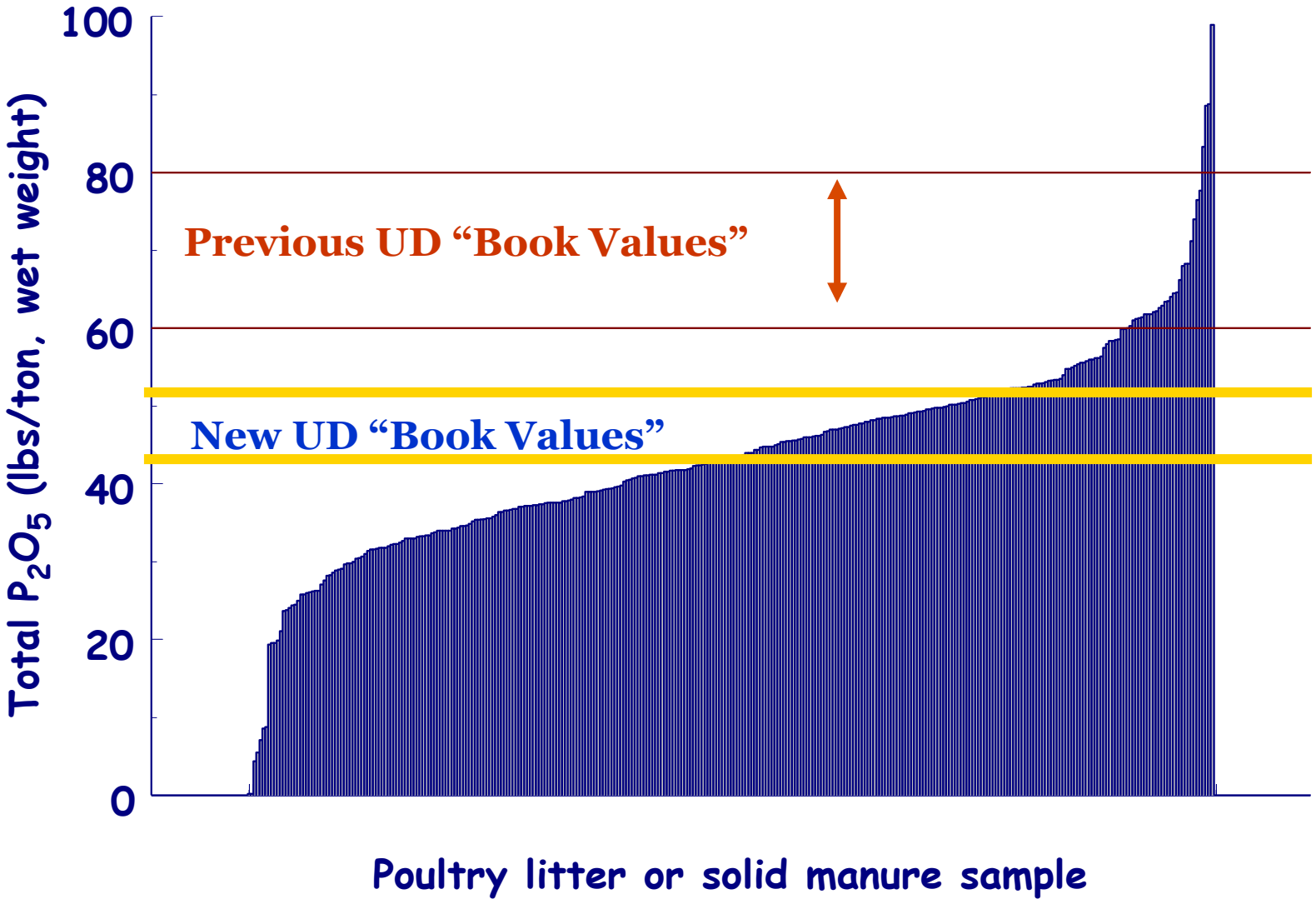
Animal Nutrition, Manure, and Soil Fertility



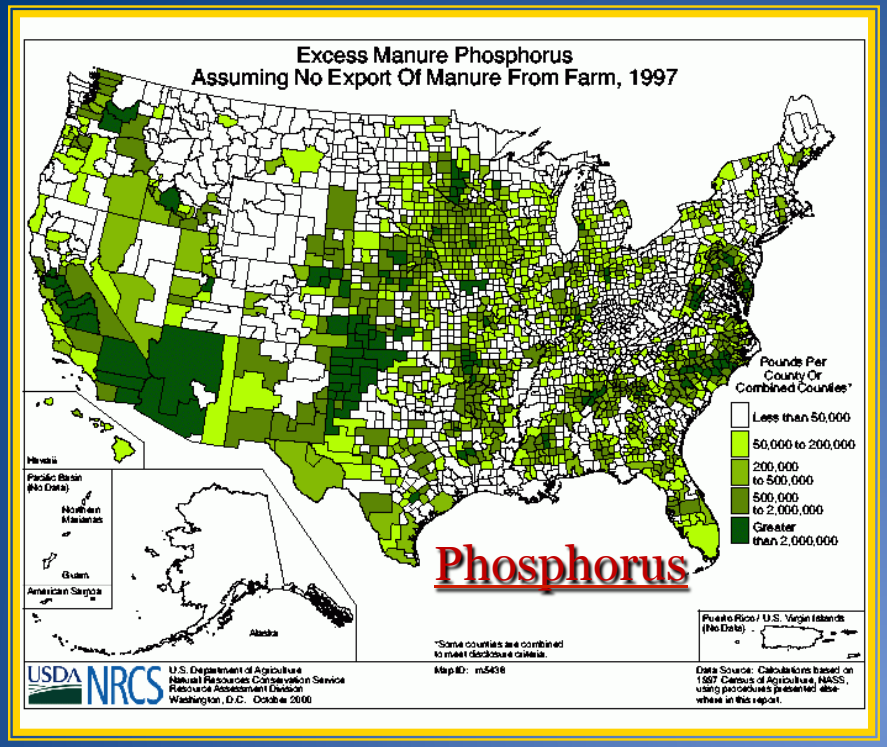


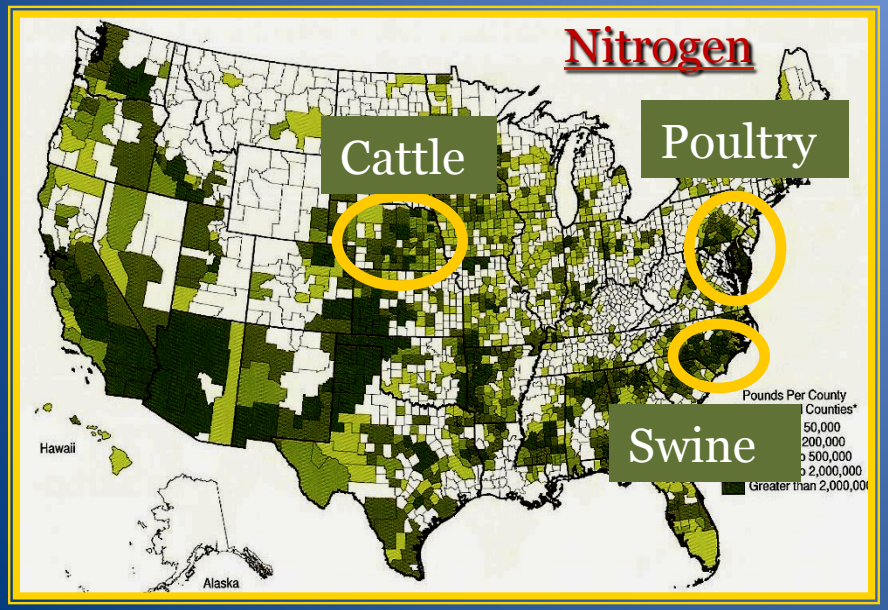
Balancing soil fertility in manured soils must integrate crop and animal nutrition (N:P ratios)

DE Department of Agriculture Poultry Manure Analyses



Trends in Nutrient Generation by US Animal Agriculture

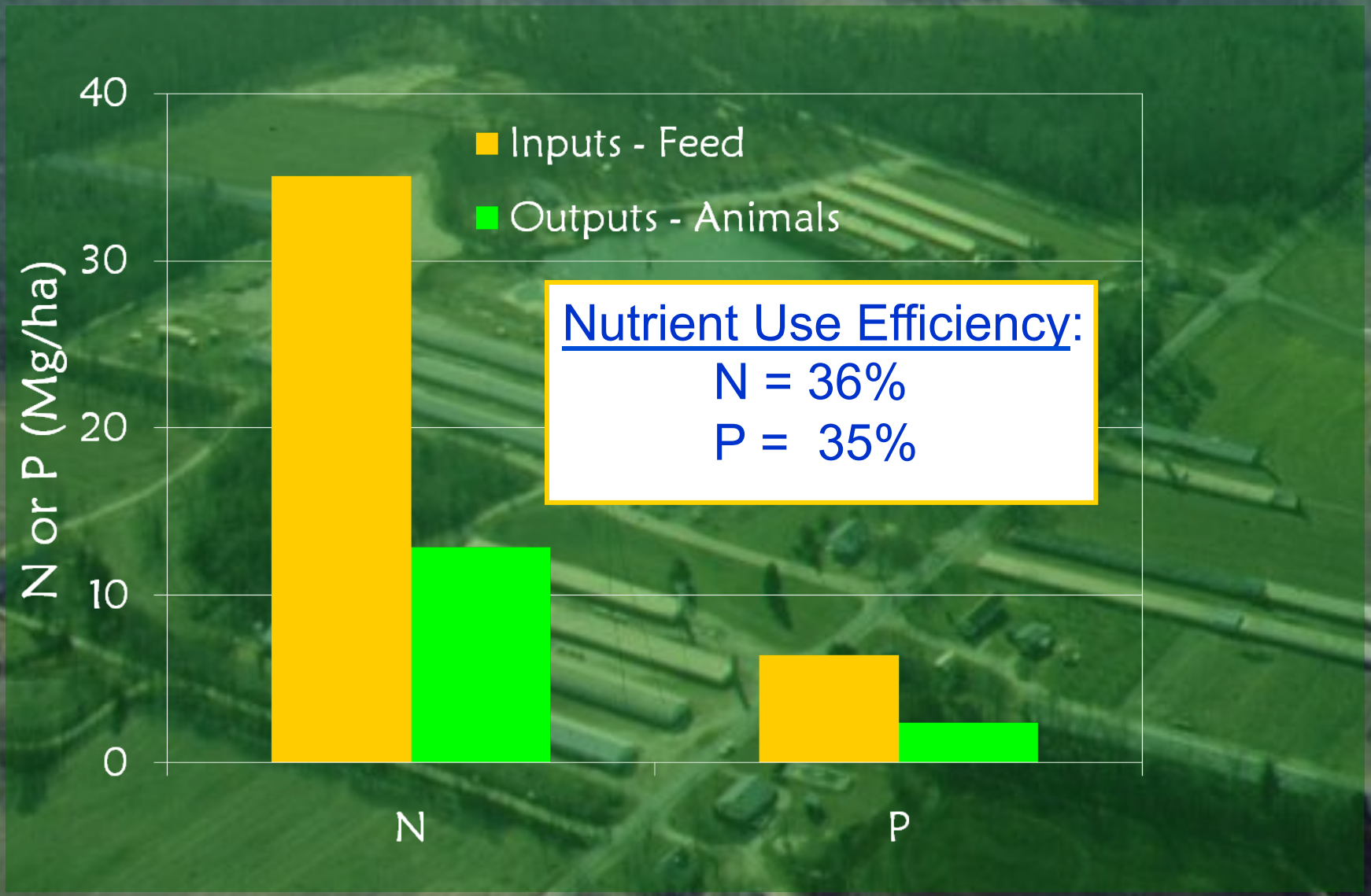




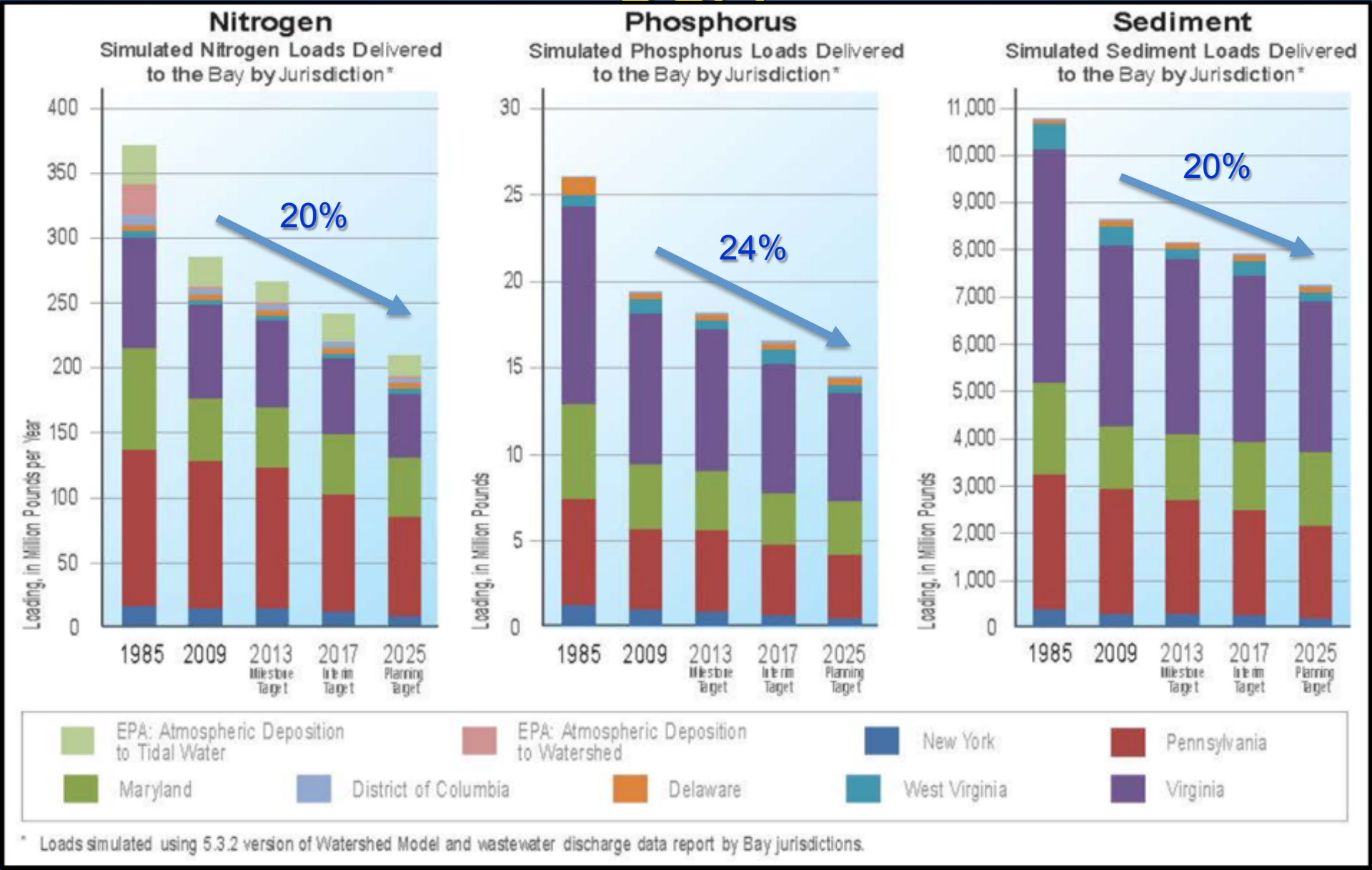
(Kellogg et al., 2001)

- ✓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

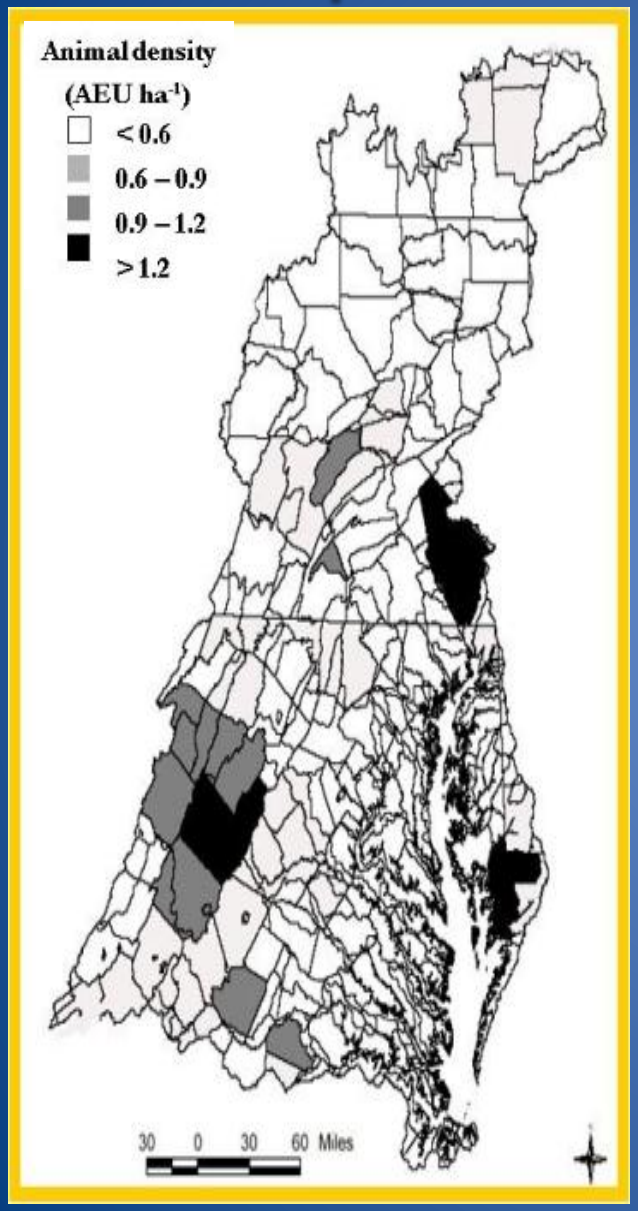
Intensive Animal Production: 1000s animals, little or no cropland

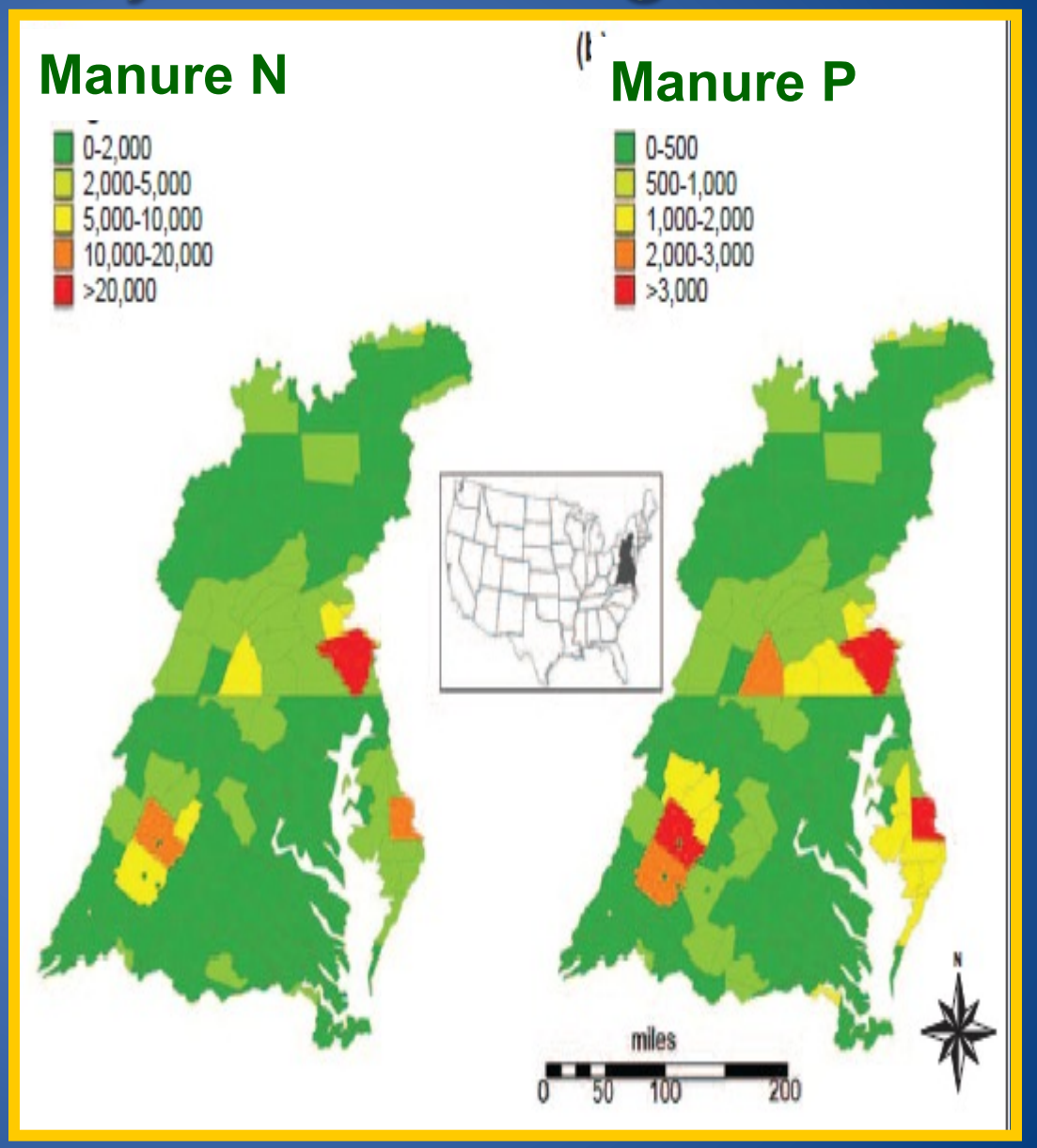


Case Study: Chesapeake Bay, USA



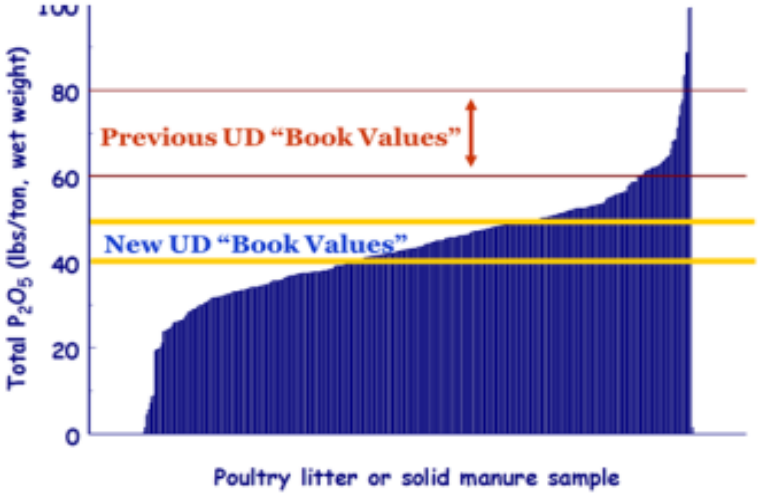
Chesapeake Bay: Animal Agriculture





Chesapeake Bay: 2010 Manure

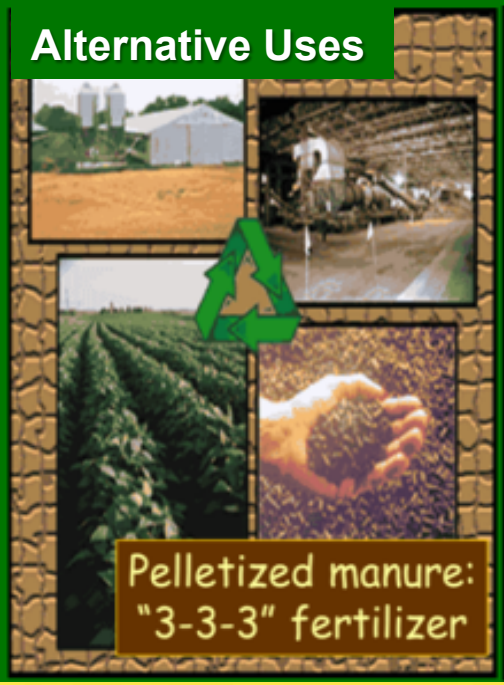
Dietary Modification
(phytase use decreases manure P)



Manure Storage

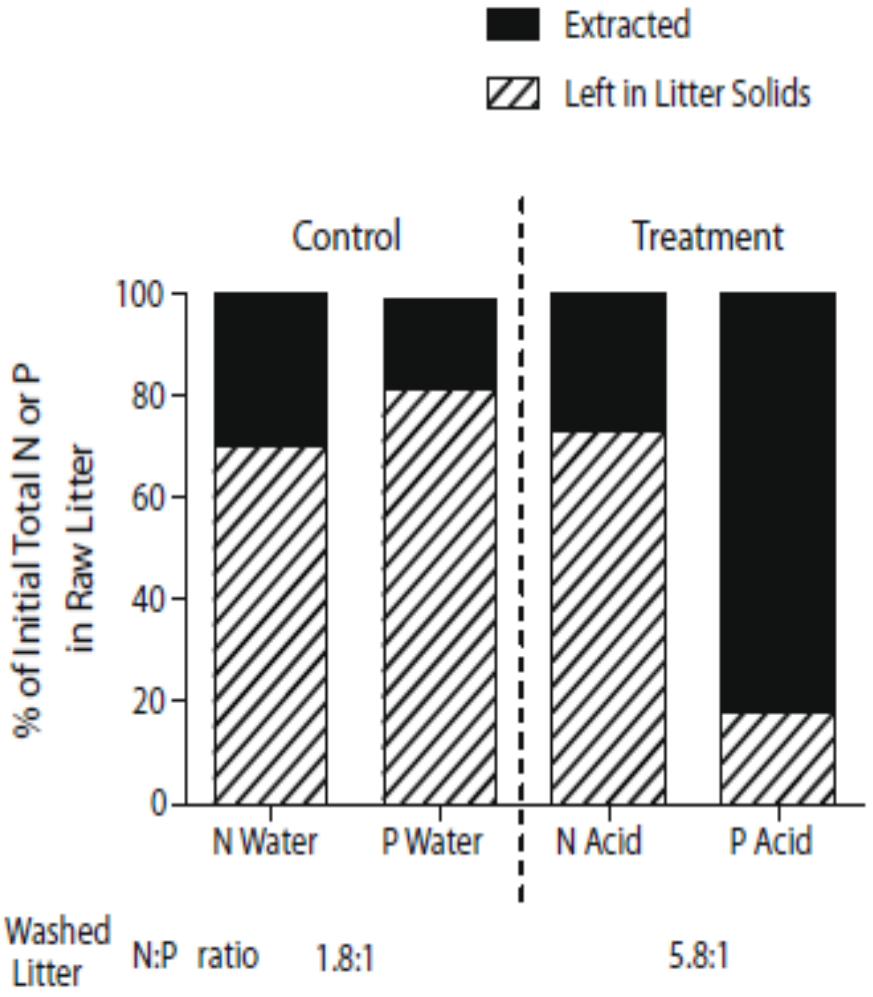
Application
(Manure "subsurfer")

Alternative Uses



Manure-Based Inorganic Fertilizers

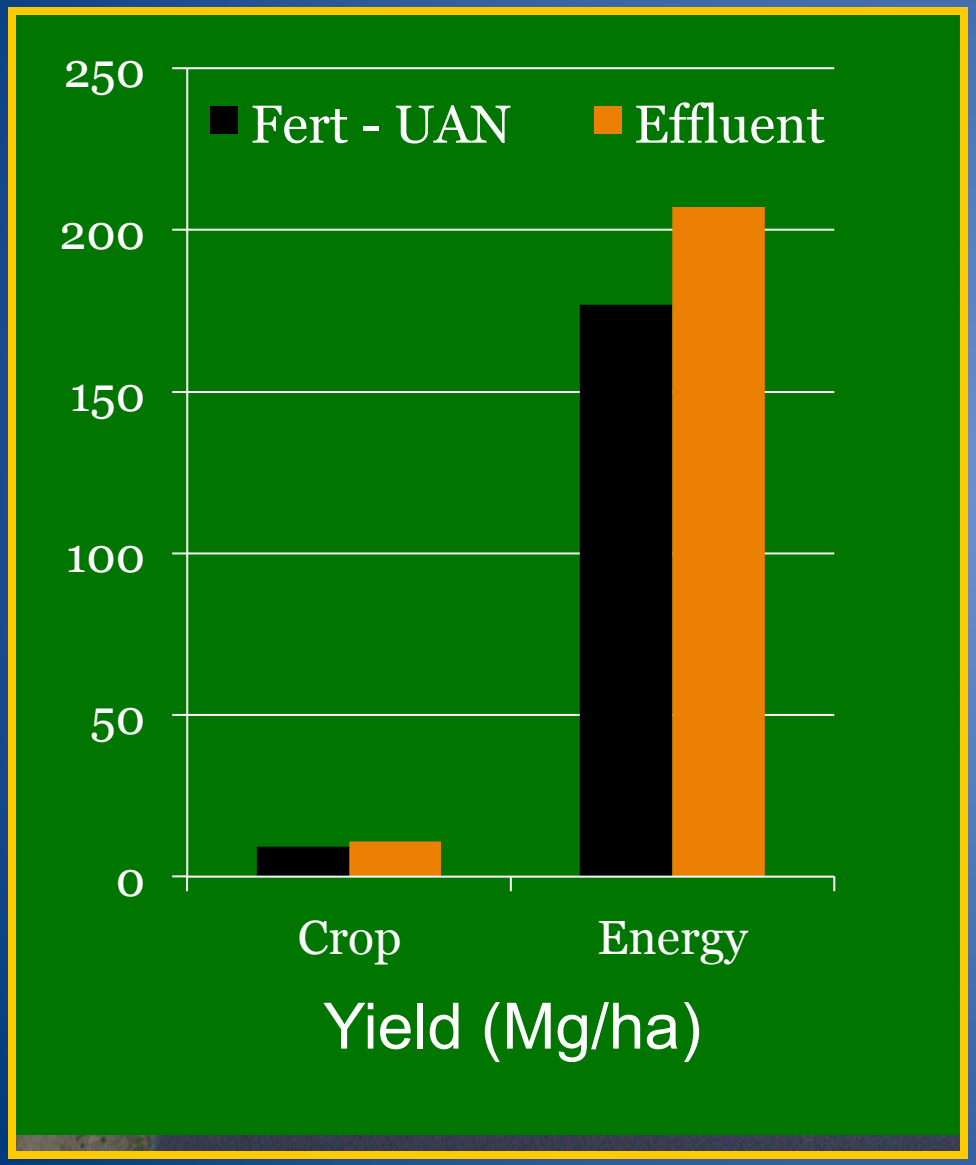
Recycling P from poultry and swine manures by use of chemical treatment (liming, acid extraction), solids separation, polymer dewatering, filtration produces high quality P fertilizers (~20% P_2O_5)
Szogi et al, (2009)

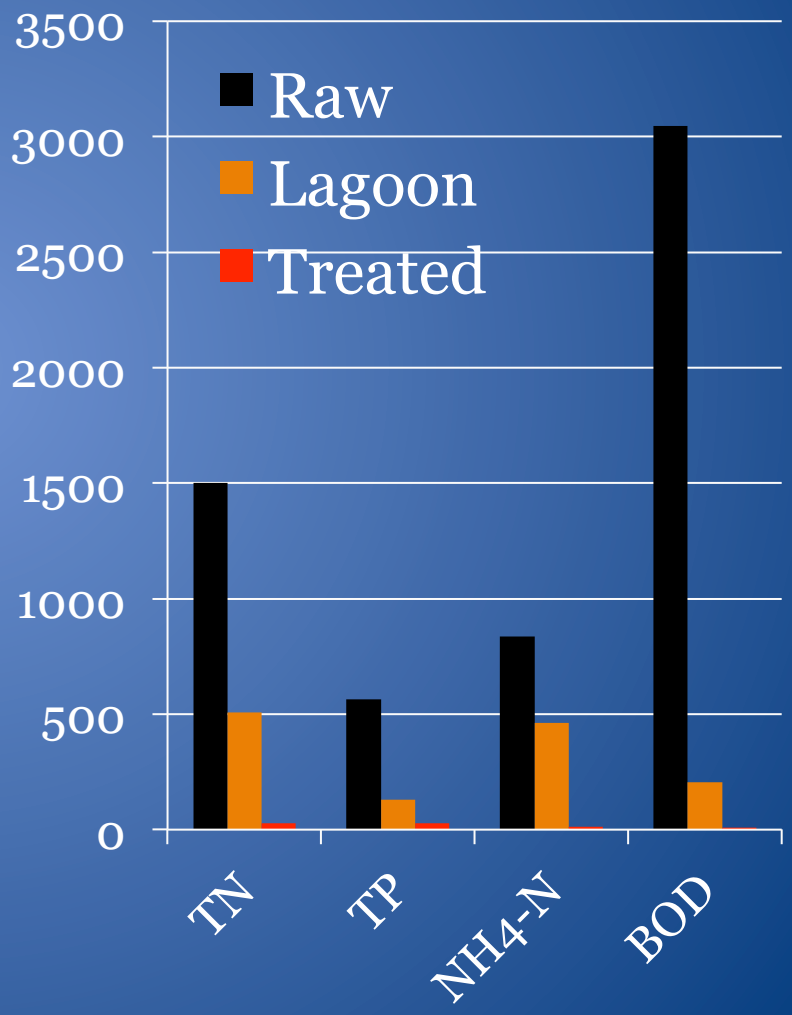


Crop N:P ratio
Maize: 7.5:1
Cotton: 6.2:1

Alternative Options for Swine Manure

Irrigating Bioenergy Crops with Swine Effluent from Advanced Treatment Systems





(Cantrell al., 2009)

Manure & Soil Fertility: Match or Mismatch?

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?

Yes

Potentially