Potential Impact of Manure on Surface and Groundwater Quality: Why Should You Care?

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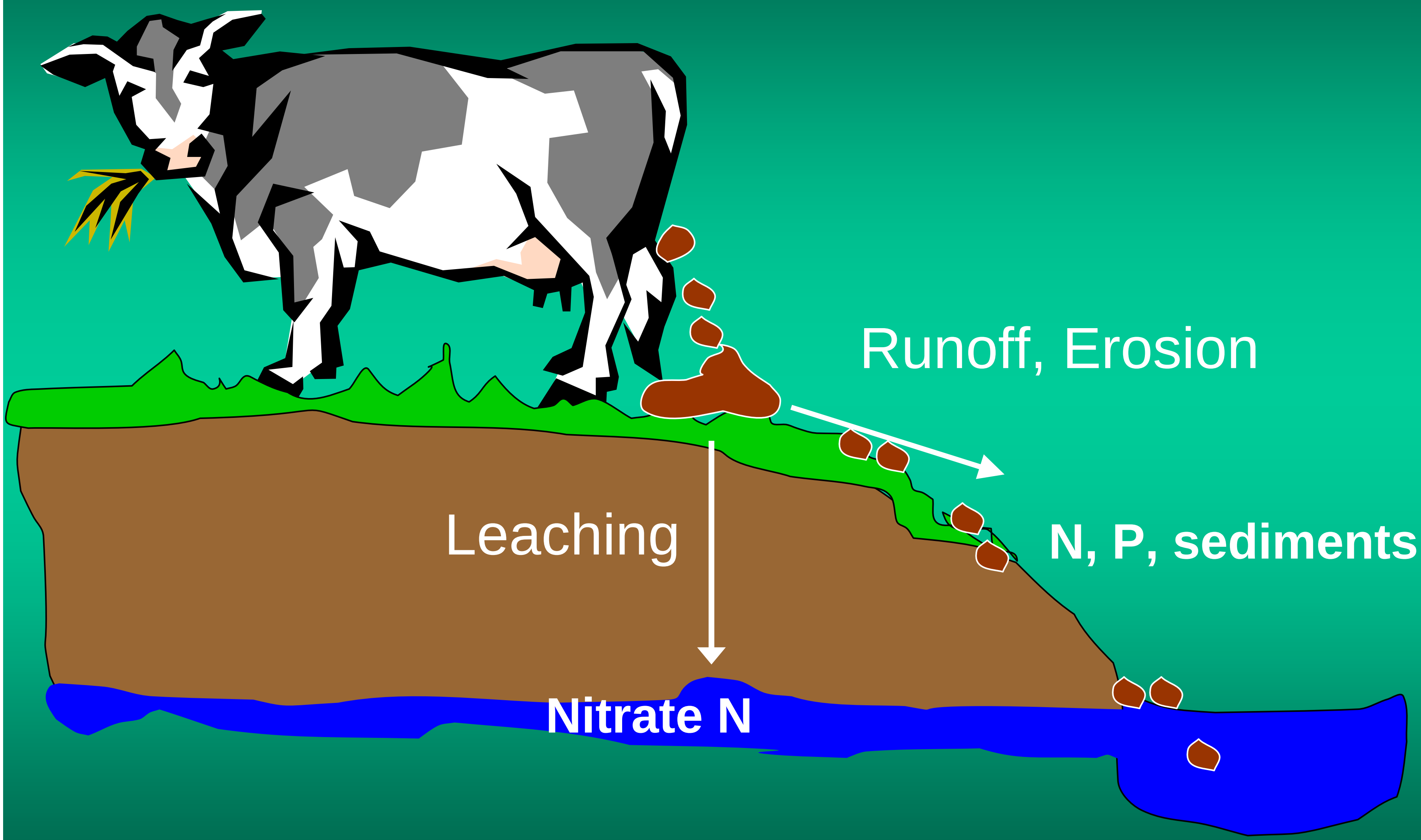
Non-point Pollution from Livestock Manure



Non-Point Pollution Issues Are Real

- Nitrate leaching to ground water affects human and animal health
- Nitrogen in surface waters of Mississippi River Basin linked to hypoxia in Gulf of Mexico, “The Dead Zone”
- Phosphorus in surface waters causes algal blooms$\Rightarrow$impacts suitability for fishing, swimming, drinking
- P and N concentrations in surface waters linked to cyanobacterial blooms $\Rightarrow$fish kills, production of neurotoxins that threaten human and animal health

External Pressures on Livestock Agriculture

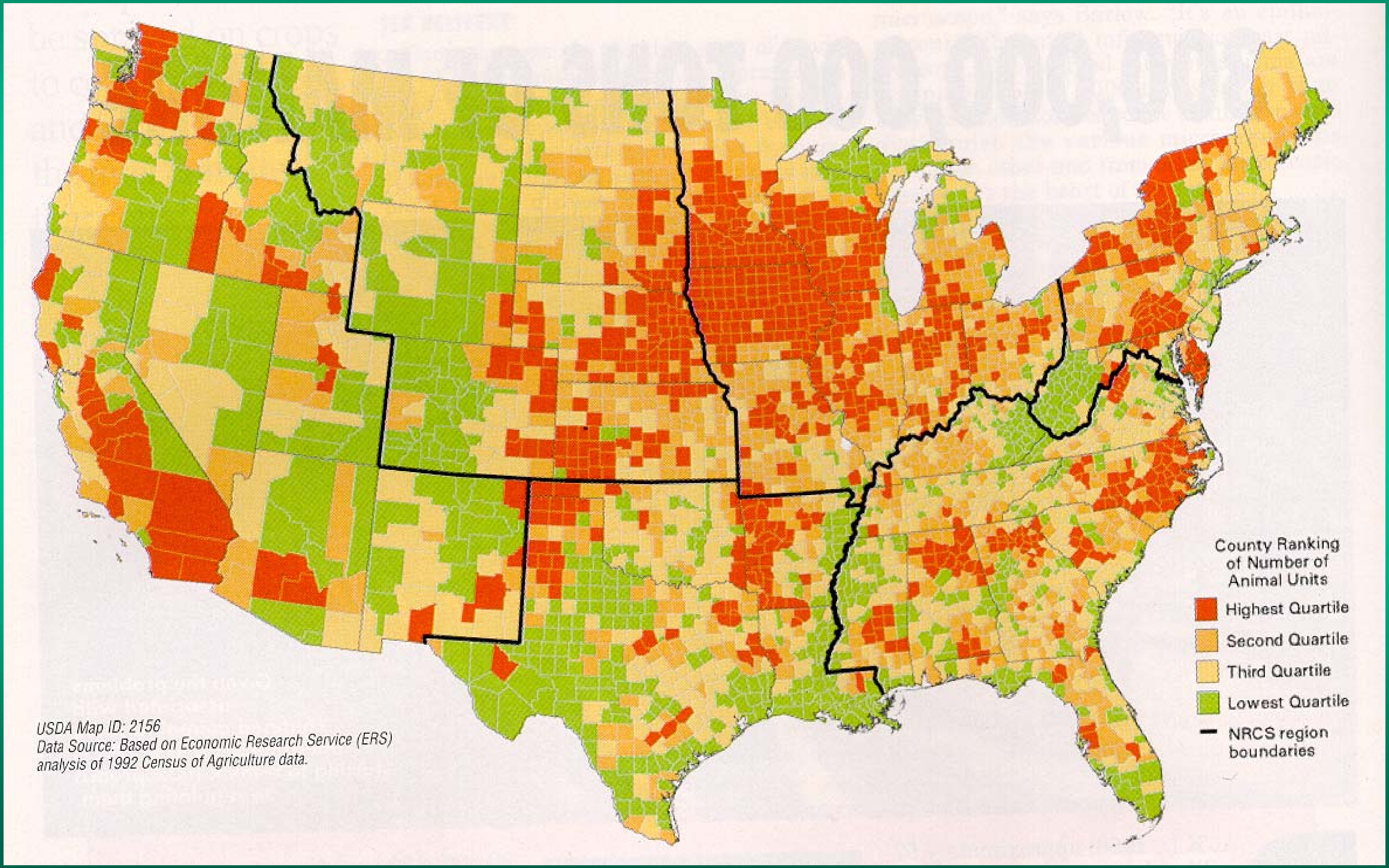
- Increased focus on “Ecological Risk Assessment” in addition to human health impacts
- Environmental groups moving from Superfund and point sources to nonpoint sources of pollution: law suits against EPA, DNR
- Joint USDA-EPA CAFO-AFO Initiative established regulatory and voluntary guidelines for manure management

What is the connection between livestock production and non-point pollution of surface and ground waters?

Trends in Livestock Production Over the Past 20 Years

- Hog operations of 500 AUs or more increased from 40-77%
- Inventory controlled by largest dairies (>100 cows) increased from 30-50% of national inventory
- National sales of broiler chickens produced in operations >100,000 birds increased from 70-97%
- Sales from beef feedlot operations with >1000 cattle increased from 62-78%

U.S. Confined Livestock Concentrations, 1992 Ag. Census



Consequences of Livestock Production Intensification

- More nutrients imported than exported on given livestock farm
- Increased separation of crop production and livestock production
- Amount of on-farm cropland available for land spreading manure declines
- More livestock operations in close proximity to urbanizing areas
- Increased costs and labor for manure storage and disposal

Issues to Consider for Minimizing Farm Nutrient Contributions to Non-point Pollution

- Nutrient budgets for inputs, outputs and manure
- Trust nutrient credits for manure
- Accurate land spreading of manure on fields with nutrient needs
- P versus N based manure application rates
- Manure handling and storage systems that simplify recovery of manure nutrients
- Moving manure off farm or processing manure to add value for other uses

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Needs for Environmentally Sound Manure Management

- Regional assessment of manure and nutrient distributions
- Determine “hot spots” or areas with greatest potential to pollute
- Manure testing that includes environmental and agronomic evaluation for land spreading
- Cost effective alternative uses for excess manure
  - Processing wastes into fertilizers
  - Composting
  - Animal feed production
  - Biofuels production
- Economic incentives for adoption of alternative uses

Achieving a Balance of Nutrients On Farm

Input = Output

Input >>>> Output

Input >> Output

Input < Output

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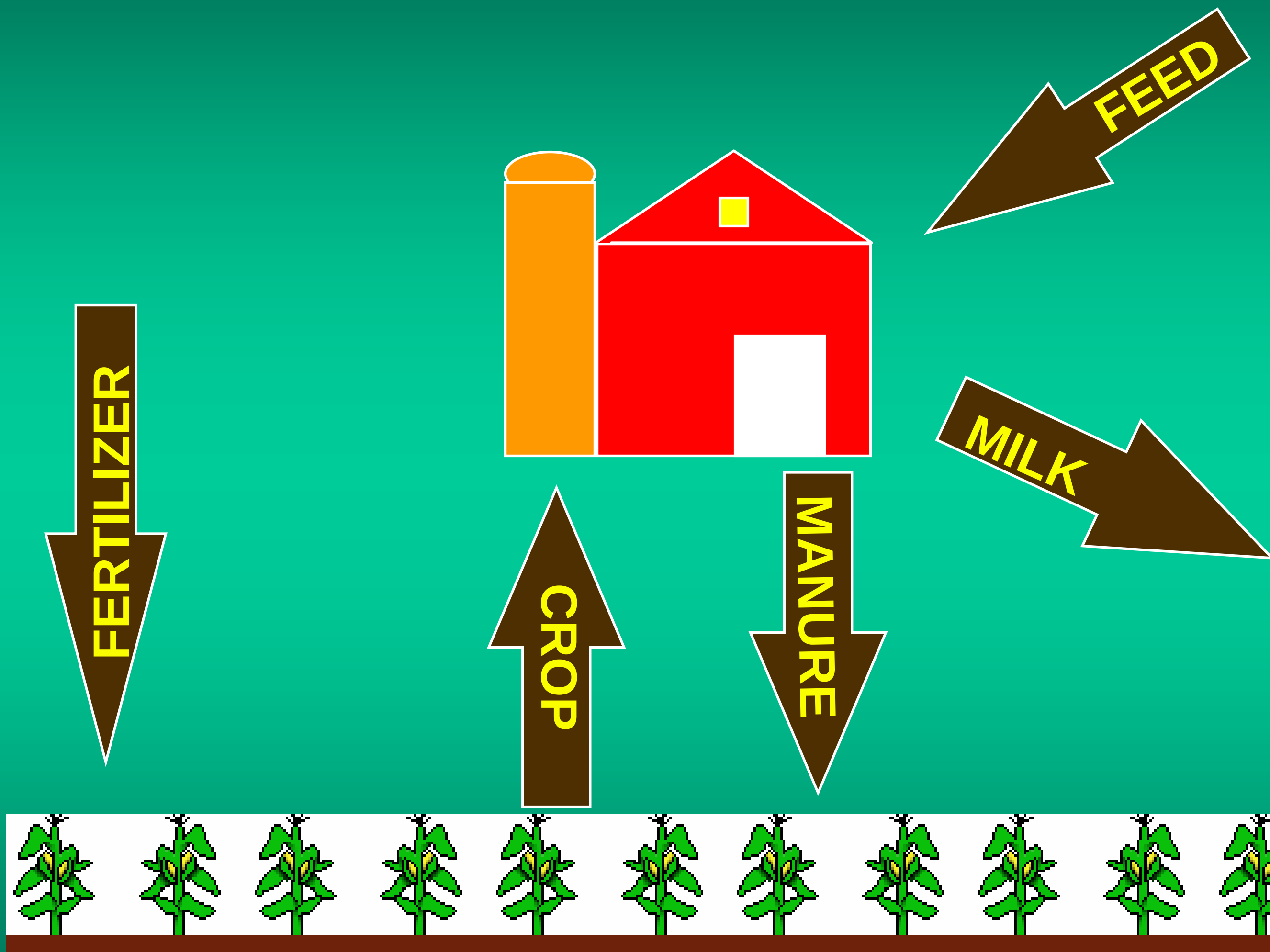
Generalized Phosphorus Budget for Wisconsin

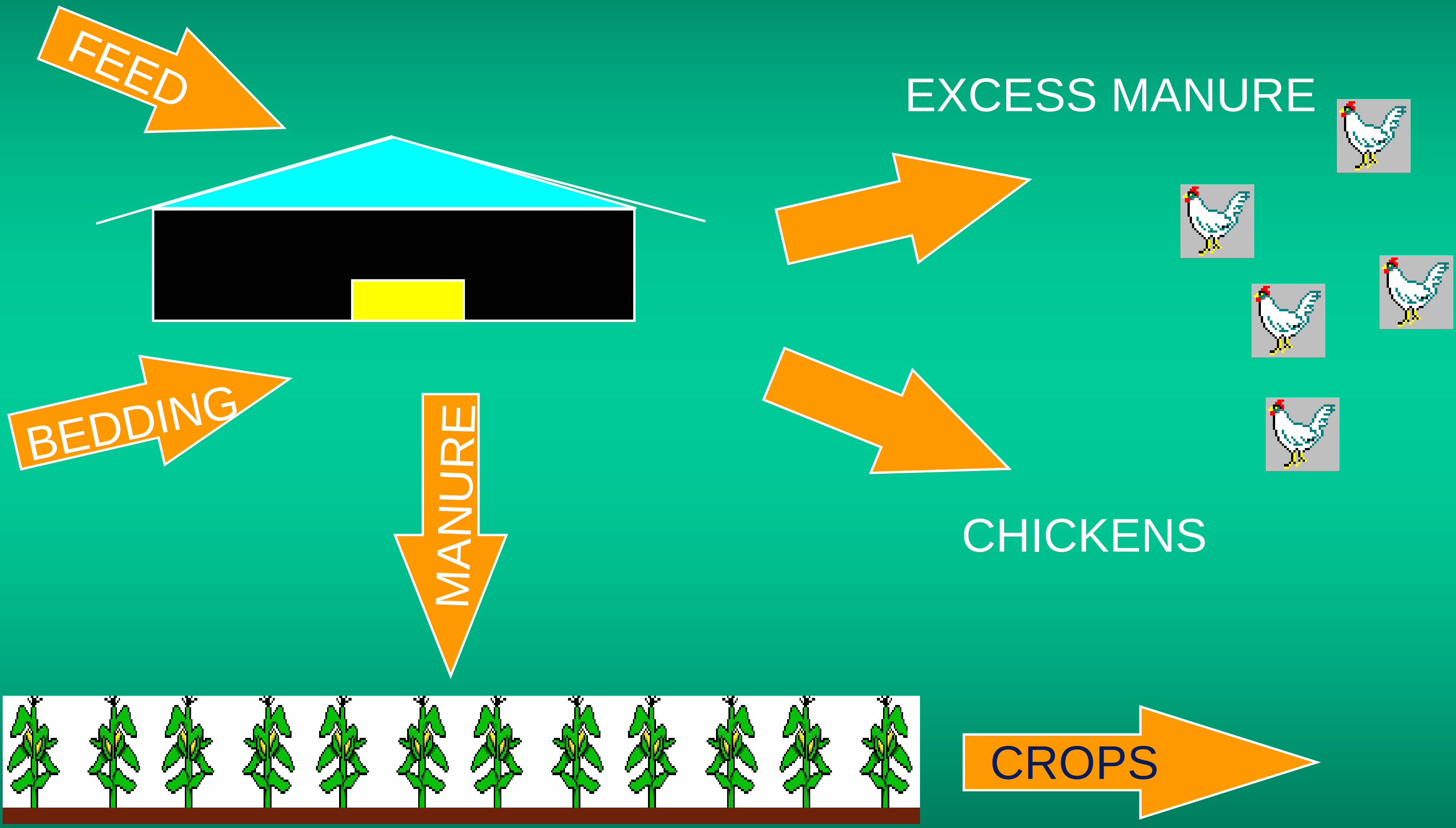
	Year				
Phosphorus Source	1970	1975	1980	1985	1990
Additions:	------------- P, million lbs -------------				
P in manure	112	121	116	115	109
P in fertilizer	102	114	137	136	98
Removals/Losses:					
Crop removal	104	113	146	145	134
P in runoff	2.9	3.1	3.2	3.1	2.8
Change in Storage:	107	119	104	103	70

Bundy, 1994

Dairy Farm



Intensive Poultry Farm



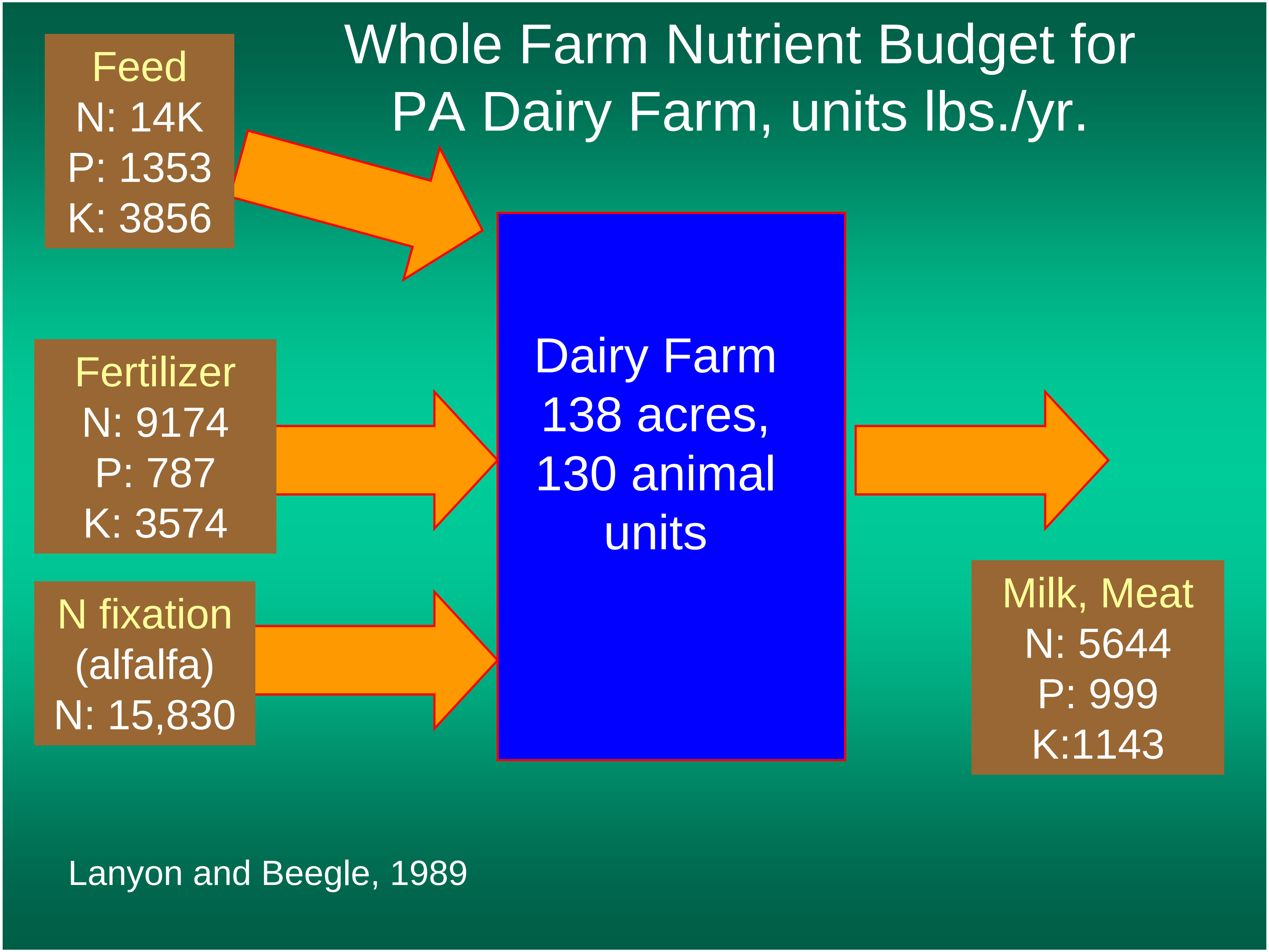
The Nutrient Budget on Farm

Inputs - Outputs = Surplus

Inputs		Outputs		Surplus
Feed	-	Milk	=	Manure, Soil Storage
+		+		
Fertilizer		Meat		
+		+		
Livestock replacements		Grain/ Forage		

Constructing a Nutrient Balance

- Define system and subsystems (whole farm Vs. farm fields)
- Document inputs and outputs
- Evaluate potential changes in storage within system components
- Identify surplus/deficit areas that are potential loss sites to the environment or potential accumulation/depletion sites


Whole Farm Nutrient Budget for PA Dairy Farm, units lbs./yr.
Feed
N: 14K
P: 1353
K: 3856
Fertilizer
N: 9174
P: 787
K: 3574
N fixation
(alfalfa)
N: 15,830
Dairy Farm
138 acres,
130 animal
units
Milk, Meat
N: 5644
P: 999
K:1143
Lanyon and Beegle, 1989

Nutrient Balance & Nutrient Recovery Efficiency

Change in Storage + Losses	Output/Input
N: +33,356	N: 14%
P: +1,140	P: 47%
K: +6,287	K: 15%

Typical recovery efficiencies for NY and Dutch dairies are 20-35% for N, 35% for P and 25-35% for K

Phosphorus Balance and Uptake Efficiency for Livestock Farms: U.S. Vs. Netherlands

	Input	Output	Surplus	Plant Uptake	Animal Uptake	Total Uptake
	Kg P_2O_5/ Ha/ Yr.			%		
U.S.	39	13	26	56	15	33
Neth.	143	55	88	69	24	38

Source: Sharpley and Rekolainen, 1997

Nutrient Balance Approach in Netherlands

- “NM Yardstick”: A voluntary program for livestock farmers
- Calculate input-output budgets for N and P and determine surpluses
- Nutrient losses direct measure of principal problem--excess nutrients on farm
- Results-oriented approach is cost efficient; Farmers have freedom to determine most economical method to reduce nutrient surpluses

Nutrient Reduction for Two "Yardstick" Farms in Duck-Apple-Ashwaubenon Watershed, WI (1996-97)

Nutrient	Application Rate (lb/acre)	Change in Soil Conc. (ppm)
Nitrogen	-43	N/A
Phosphorus	-5.3	-0.29
Potassium	-9.3	-1.0

* Reduction of fertilizer use has resulted in average savings of $376 for two farms.

Mark Muller, Inst. For Ag. and Trade Policy

Annual P Fed to Lactating Cows and Excreted in Feces

Dietary P level g/kg	Supplemental P Kg. cow/yr.	Fecal P Kg. cow/yr.
3.5	0	18.9
3.8	2.5	21.4
4.8	10.6	29.6
5.5	16.4	35.3

Powell et al., 2000

Land Requirement for Recycling Manure P

Dietary P level g/kg	Land area needed to recycle manure P (ha)	Change in land area from supplementary diet P (%)
3.5	0.63	0
3.8	0.71	13
4.8	0.99	57
5.5	1.18	87

Powell et al., 2000

Assumptions for land area requirements: Annual cropping system with 47% alfalfa, 37% corn grain, 9% soybean, 7% corn silage having harvested dry matter of 11.2, 7.4, 2.9, and 17.2 Mg/ha and P removal of 30 kg/ha

Ways to Improve Nutrient Cycling Efficiency

- **Reduce quantities of nutrients excreted by improving animal nutrition**
  - Reduce or eliminate mineral P supplements if not needed
  - Formulate rations that maximize animal uptake of nutrients and minimize excretion

Ways to Improve Nutrient Cycling Efficiency

- **Enhance retention of excreted nutrients in collected manure (reduce volatile and liquid losses from handling and storage)**
  - Chemical or physical treatment to reduce NH_3 volatilization
  - Recover leachates from milking house, barns, etc.
  - Separate liquid and solid fractions of manure

Ways to Improve Nutrient Cycling Efficiency

- **Improve nutrient uptake in forages and crops from land-applied manure**
  - Analyze manure to measure amounts of nutrients present
  - Calibrate manure spreader so you know how much manure is applied to fields
  - Control N loss from volatilization by incorporation of manure in soil
  - Minimize nutrient leaching and runoff losses by timing applications close to crop planting