NUTRIENTS AND THE ENVIRONMENT

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National Evironmental Regulations on the Horizon

The Environmental Protection Agency is seeing a brighter light at the end of the tunnel for the Clean Water Act. In early August, EPA released its proposed permitting guidelines for concentrated animal feeding operations. The idea is to protect waterways from livestock manure runoff, especially from large production operations.

Following a 60-day public comment period from the date it was published in the Federal Register, the agency expects to compose the final rules by year's end. These requirements are included in the National Pollution Discharge and Elimination System program.

According to EPA's release, the agency estimates that 15,000 to 20,000 CAFO's will have to develop comprehensive nutrient management plans that comply with Clean Water Act requirements. Another 400,000 or more animal feeding operations will be encouraged to voluntarily file a plan. These rules will cover a gamut of large livestock production facilities, including pork, beef, dairy and poultry.

To get an idea of what's included in the guidelines, EPA's draft document will provide you with information on:

- Which facilities will need to apply for permits.
- Co-permitting of corporate entities.
- Land application of manure.
- Public notice guidelines.
- Monitoring and reporting requirements.

For more information or to get a copy of the draft, contact EPA's Water Resource Center at (202) 260-7786 or check out its website at http://www.epa.gov/owm.

(Pork, October 1999)

NEWSLINE

Cutting Phosphorus on the Minds of Researchers

(Render, October 1999)

Nutrition

▼Reducing Nitrogen Excretions

Manure/Odor Management

▼Odor Levels Reduced With Feed Changes

POS Sales—FEED MANAGEMENT

Summit on Nutrient Management and the Environment

Is livestock waste regulation necessary?

Feed Facts HOG

MOOR

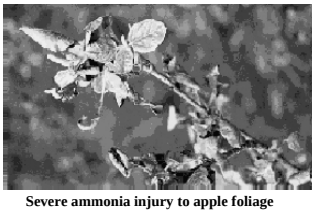
Strategies to Reduce Nutrient Excretion of Swine

At a Glance

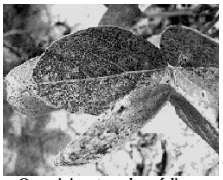
You're just 2 steps away from better air quality & improved performance.

Get rid of malodorous gases. Pig performance pays for it.

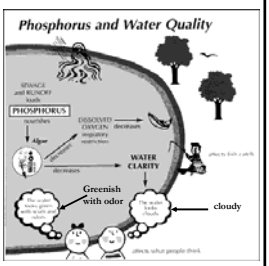
1998 EPA Section 303(d) List
Top 15 Causes of Water Quality Impairment



Severe ammonia injury to apple foliage

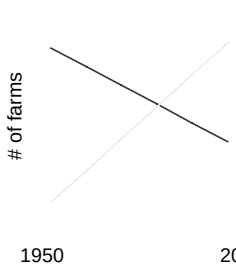


Ozone injury to soybean foliage



www.omafra.gov.on.ca

Introduction



- With more animals being reared in a small area the volume of manure produced has also dramatically increased
- Increases in manure volume have caused concerns about the possible environmental impact of these farms

Relevance to Animal Science

- High number of animal feeding operations (AFO)-280,000
- Increased court cases (complaint by neighbor, etc)
- Manure - nutrient source for crops
  - alternative uses such as energy production

If not properly managed:
- manure poses a threat to soil, water and air quality, and to human and animal health

- impending environmental regulations by EPA[1]/CERCLA[2]
- EPA, CERCLA, and EPCRA[3] – report emission of H_2S and HN_3 that exceed 100 lbs in any 24-hr period

[1]Environmental protection agency
[2]Comprehensive environmental response, compensation, and liability act
[3]Emergency planning and community right-to-know act

http://www.ars.usda.gov/docs.htm?docid=1083&page=8

Measures taken to reduce nutrient excretion

Pre-excretion approach (diet modification)

Nutrient input mass reduction (feeding strategy)
- Reduction in dietary CP
- Reduction in dietary inorganic P (phosphate)
- Ingredient selection/processing (e.g. DDGS)

Nutrient form modification
- pH manipulation of diet
- Ammonia binding – urease inhibitor

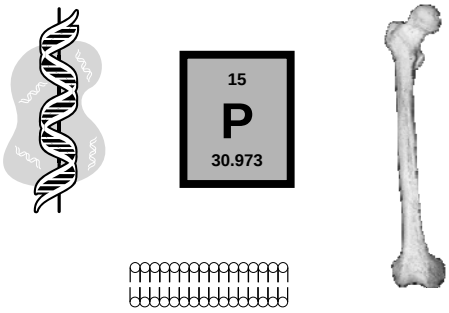
Measures taken to reduce nutrient excretion

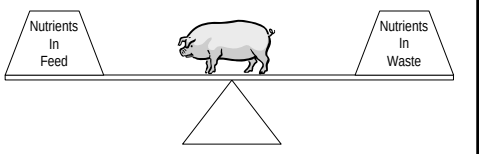
Post-excretion approach

- Decreased pen surface pH – acidification (Shi et al., 2001)
- Use of urease inhibitors and/or essential oils (Parker et al., 2004)
- Absorbing NH_3 with zeolites (Eng et al., 2004)

(chemical amendment)

Nutritional Importance of P



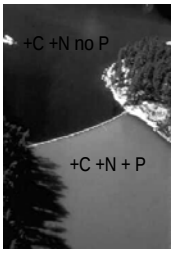


P and the Environment

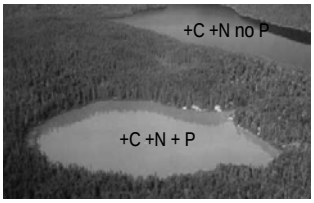
What are the risks?

How should they be managed?

Phosphorus generally limits biological activity in most freshwater ecosystems



Picture taken in 1973



Picture taken in 2001

University of Manitoba Experimental Lakes Area

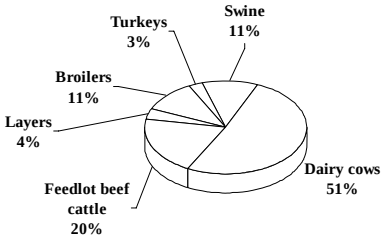
Impact of Diet and Age on Element Excretion from Dogs
C.W. Wood, K.A. Cummins, C.C. Williams, and B. H. Wood

Comm. Soil Sci. Plant. Anal. 35:1263-1270

- ~53 million dogs in the U.S.
- Estimated DM excretion =
  - 3 million kg of fecal DM/d
    $(53x10^6)*20kgBW*.015*.2 = 3,180,000$ kg DM/d
  - 3,180,000*2.2*365/2000 ~ 1.3 million tons fecal DM/yr.
- P excretion ~ 40g/kg fecal DM
  - 3,000,000*40/1000= 120,000 kg P/d
  - 120,000*2.2*365/2000 = 48,280 tons P/yr.

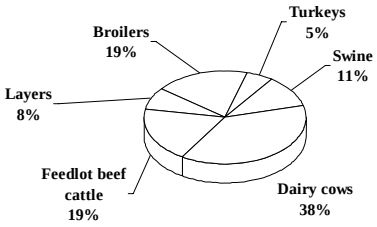
Swine ~ 59,000 tons P/yr ⟶ 43,000 tons.yr.

U.S. Manure Dry Matter Production



Powers & Van Horn, 2001

U.S. Manure Phosphorus Production

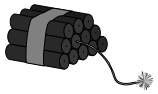


Poultry = 18% manure DM; 24% manure N

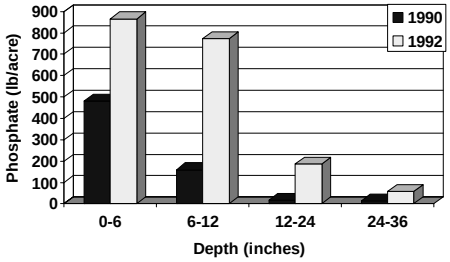
Powers & Van Horn, 2001

Introduction

- Large emphasis on regulating manure application
  - primarily through regulating nitrogen application
- When regulating N only, other nutrients may build up in the soil



Build-up of P_2O_5 When Swine Manure is Applied to the Land to Meet the N Needs



Adapted from Mueller et al., 1994

Nutrient content of manure (lb/1000 gal)

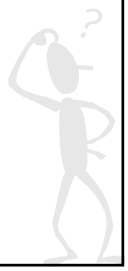
	Total N	NH_4-N	P_2O_5	K_2O
Lagoon Effluent	5	4	3	4

Nutrient requirements of corn (lb/acre)

	N	P_2O_5	K_2O
Corn Needs	100	40	40

How do we prevent nutrient build-up in the soil?

- Legislation
- Better manure management practices
- Better feeding strategies



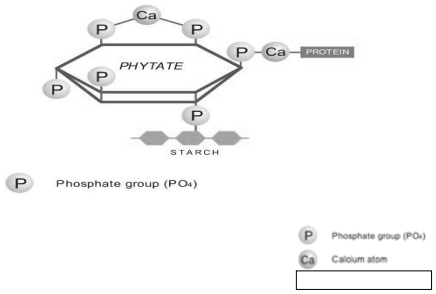
Feeding Strategies

- Eliminate over formulation
- Phase feeding
- Split sex feeding
- Low phytic acid grains
- Phytase

Ca^{++}

Ca^{++}

Zn^{++}



P Requirements

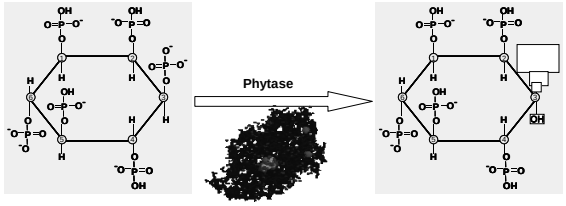
	Body Weight (kg)			
	10-20	20-50	50-80	80-120
Total P	.60	.50	.45	.40
Available P	.32	.23	.19	.15

Phytase

- Benefits…
- Limitations…

Phytases…

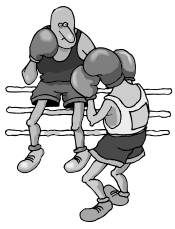
- Phytases are phosphatases that catalyze the hydrolysis of phosphate from phytate



Commercially Available Phytases

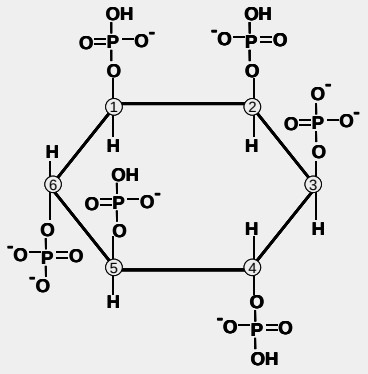
natuphos®

RONOZYME™ P
A new phytase for animal feeds



Allzyme Phytase

- 3-phytase
- Aspergillus niger
- Solid substrate fermentation
- pH optima: 2.5 and 5.5
- Available in dry form
- 1,000 U/g



Natuphos Phytase

- 3-phytase
- Aspergillus ficuum gene
- Submerged liquid fermentation
- pH optima: 2.5 and 5.5
- Available in liquid and dry form
- Variety of levels, up to 10,000 U/g

Ronozyme Phytase

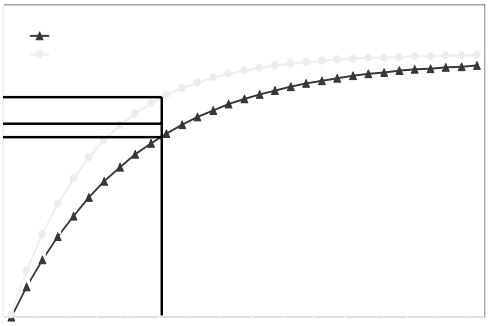
- 6-phytase
- Peniophora lycii gene
- Submerged liquid fermentation
- pH optima: 4.5
- Available in liquid and dry form
- Ronozyme CT- increased heat stability
- 2,500 U/g

Things to consider when comparing phytases…

- Efficacy
- Cost
- Heat stability
- Stability in feed
- Application method

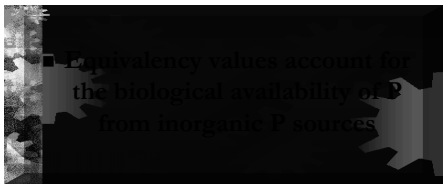
The effect of phytase on P digestibility

- Things to consider…
- How to compare studies…
- Equivalency vs. Released values…



Comparison of phytase response curves for the increase in P digested (g/kg of diet).

The Amount of P Released vs. P Equivalency Values



P Release Values

- Swine (500 U/kg):
- = 0.85 g P (Jongbloed et al., 1996)
- = 0.75 g P (Kornegay et al., 1998)
- = 0.71 g P (Dungelhoef and Rodehutschord, 1995)

Equivalency Values

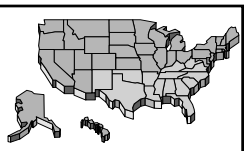
- Swine (500 U/kg):
- = 1.11 g P from inorganic P
- (Jongbloed et al., 1996)
- = 0.98 g P from inorganic P
- (Kornegay et al., 1998)
- = 0.93 g P from inorganic P
- (Dungelhoef and Rodehutschord, 1995

What does all of this mean?

- Market Hog - assumptions
- Consume 707 lb feed (2.65 F:G from 50 to 250 lb)
- .5% total P in diet
- Excretes 1.94 lb of P

- If Phytase is Added to the Diet and P is reduced .1%
- decrease P excretion 30%
  - .58 lb less P excreted per hog

The Big Picture



- 57,143,000 hogs produced annually in the U. S.

- Phytase supplementation
- Decrease P excretion by 16,629 tons

Summary

- P is an essential nutrient in swine diets
- P requirements need to be continually revisited
- High levels of P in swine manure have the potential to cause environmental pollution if mismanaged
- P levels in the manure can be reduced by alterations in feeding management and nutrition

Nitrogen

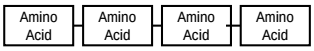
- N cycling has doubled - anthropogenic actions (Smil 1990)
  - Production and use of N fertilizers
  - Planting of N-fixing crops
  - Burning of fossil fuels
- Agricultural contribution to increased N emission – 50 to 90% (Howarth et al., 2002)

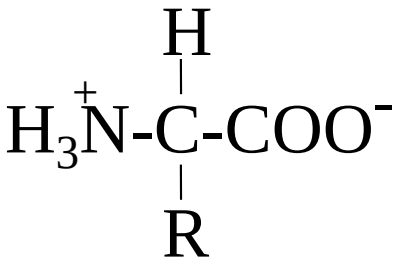
Nitrogen

- Where does N come from in the diet?

Nitrogen

- CP = N x 6.25
- On average there are 16g of N for every 100g of CP





Functions of Amino Acids

- Functional components of:
  - Muscle
  - Bone
  - Connective tissue
- Milk production
- Cellular and tissue repair
- Regulation of body water
- Transport of oxygen and carbon dioxide
- Mineral transport
- Enzymes
- Energy

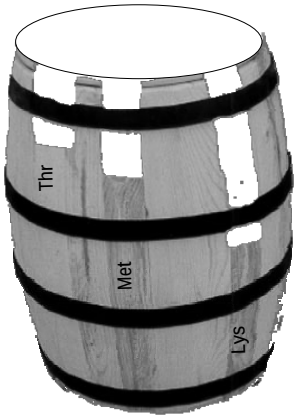
Essential vs. Nonessential

- Essential AA must be supplied by the diet
- Nonessential AA can be synthesized by the animal

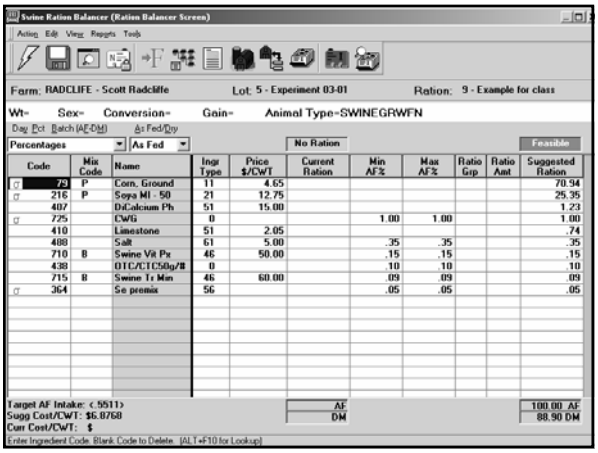
Swine

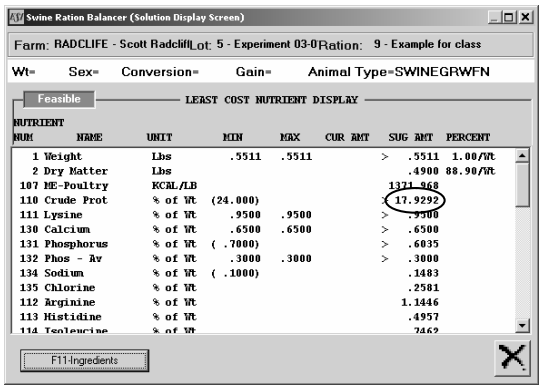
- Essential
  - Arginine**
  - Histidine
  - Isoleucine
  - Lysine
  - Methionine
  - Phenylalanine
  - Threonine
  - Tryptophan
  - Valine
  - Leucine
- Nonessential
  - Alanine
  - Asparagine
  - Aspartic acid
  - Cysteine**
  - Glutamic acid
  - Glutamine??
  - Glycine
  - Proline??
  - Serine
  - Tyrosine**

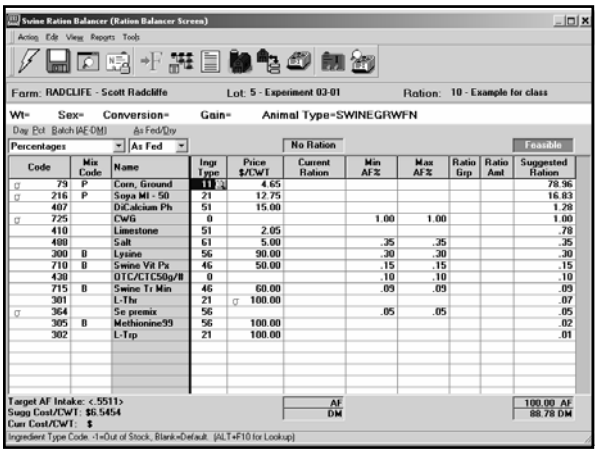
Limiting amino acid concept…

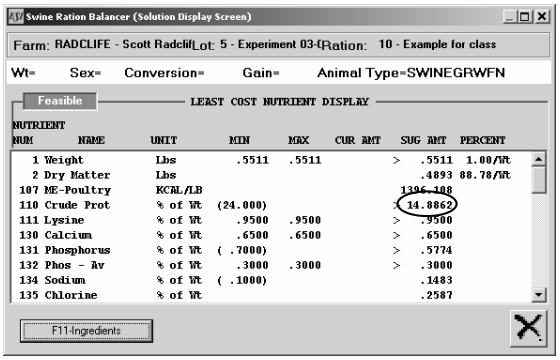


Diet formulation….



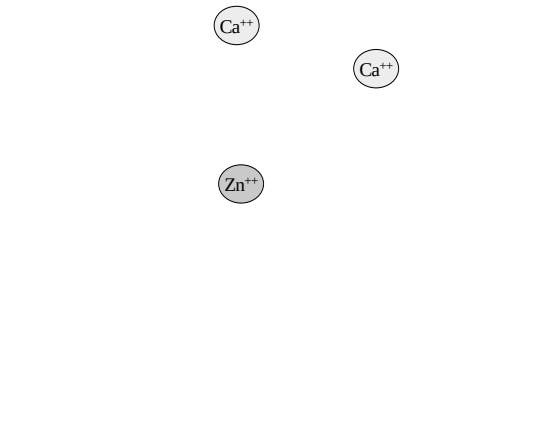


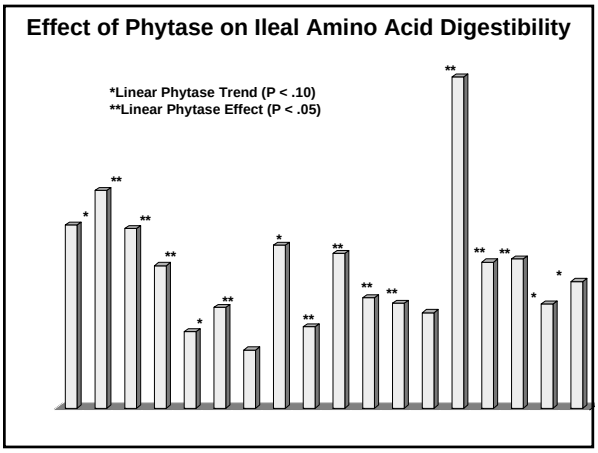




Synthetic amino acids....

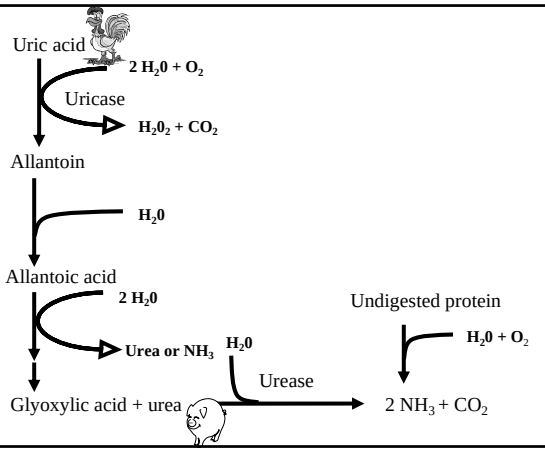
- Incorporating synthetic Lys, Met, Thr, and Trp into a G/F swine diet results in a 3.04 %-unit decrease in CP content of the diet (17.93-14.89 = 3.04)
- This is equivalent to a 17% reduction in CP/N content of the diet
  (3.04/17.93*100 = 16.95%)

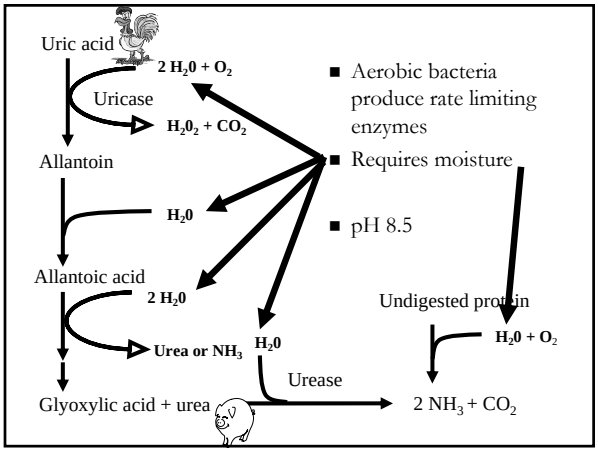




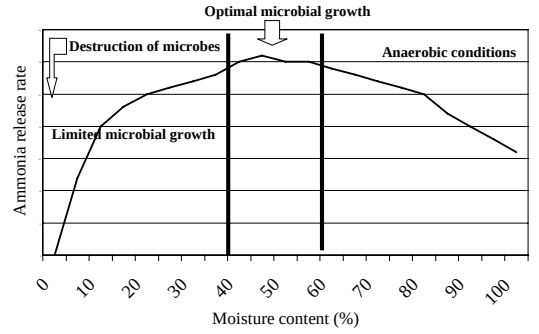
Ammonia formation

- **Ammonia - degradation of uric acid/urea and undigested protein**
- **Degradation is influenced by:**
  - **Aerobic bacteria**
  - **moisture (40-60%)**
  - **pH (5.5 and higher)**
  - **temp (20-30°C)**

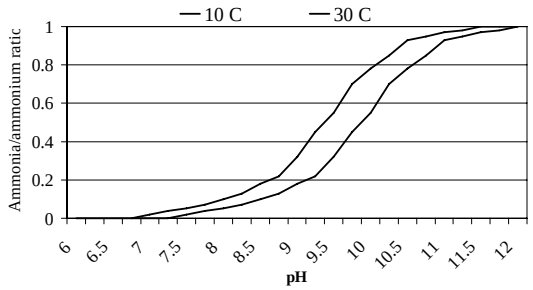




Ammonia Release & Moisture Content



Dependence of Ammonia on pH & Temperature



Summary

- **Environmental pollution can be reduced through:**
- **Diet modification (source reduction & form modification)**
- **Use of exogenous enzymes (phytase)**
- **Chemical amendments (aluminum chloride)**
- **Good manure management**
- **Too much of a good thing?**