Dietary nutrient management:

What goes in, must come out.

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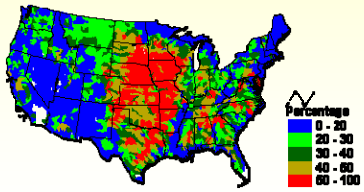
Sources of nutrients

Animal Agriculture Contributions to Total Phosphorus Export



- **Specialization**
- **Nutrient Importation**
- **Nutrient Concentration**
- **Ground and Surface Water**

Smith & Alexander, 2000

Who's fault is this?

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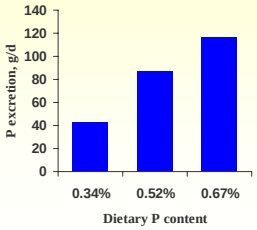
http://www.extension.org/pages/Precision_Phosphorus_Feeding_for_Dairy_Cattle

Dietary Nutrient Mgmt

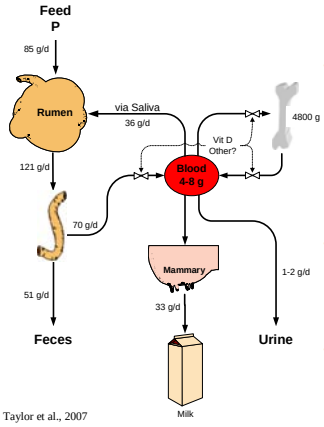
- **Nutrition is the SOURCE of the problem**
- **Solution? DON'T FEED MORE THAN NEEDED ☺**
  - **Reduce feed waste**
  - **Properly balance rations**
  - **Properly mix rations**
  - **Less overfeeding for "insurance"**
  - **Improve knowledge of P availability and requirements**

P Intake and Excretion



- **Relationship between P intake and excretion?**
  - **13 early-lactation cows**
  - **Fed diets containing one of 3 levels of dietary P**
  - **Days 7-75 of lactation**
  - **Total collection study (milk, urine, feces)**
- **Direct, linear relationship between P intake and excretion**

Knowlton et al., 2002



Taylor et al., 2007

- Absorption is regulated to meet needs
  - 3 forms of P in feed: phytate, organic, inorganic
  - only inorganic form of P is absorbed
  - Bone buffers deficiencies
- Digestion can limit availability
  - Phytate vs other organic vs inorganic
- Excess is excreted in feces

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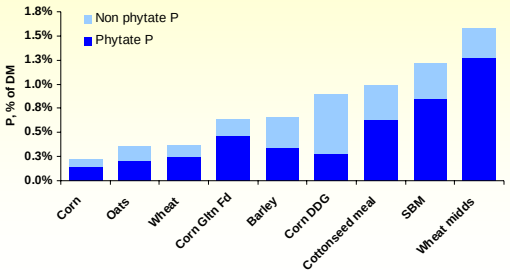
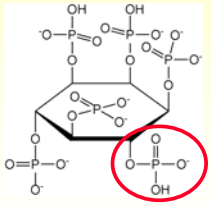
Phytate Content of Grains



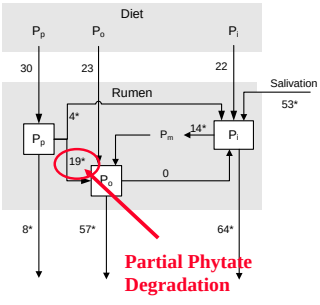
Phytic Acid



- Carbon ring structure with 6 P atoms
- Indigestible by production species
- Digestible by microbes in the rumen

en.wikipedia.org/wiki/File:Phytate.png

Model of Hill et al. 2008



- Phytate ~80% digestible
  - Not reduced to an inorganic form
  - Does digestibility decline as more is fed?
  - All ingredients the same?
- Very limited data!!
  - Only a couple of diets

Pp=phytate P, Po=non-phytate organic P, Pi=inorganic P

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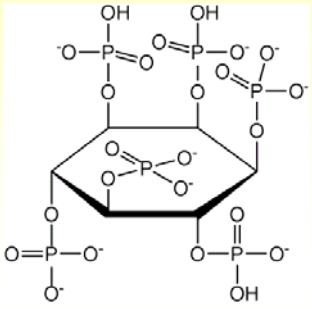
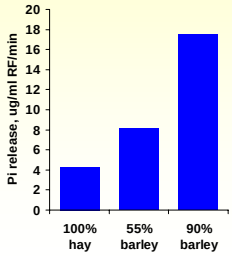
Phytate Degradation



en.wikipedia.org/wiki/File:Phytate.png

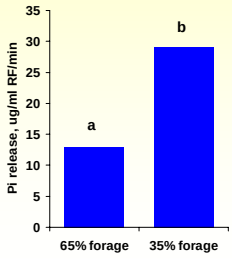
Ruminal Phytase

Beef Study



Yanke et al., 1998

Dairy Study

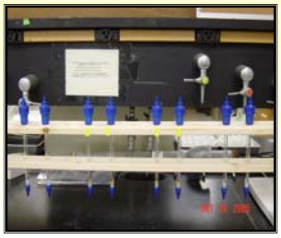


Knowlton et al., 2004

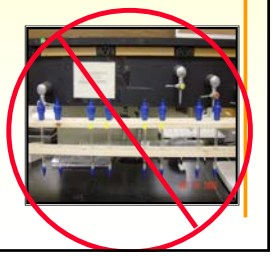
Analytical Challenges

Classical phytate analysis

- **Liquid chromatography (anion exchange)**
  - **Then, nitric & perchloric acid digestion**
  - **Colorimetry**
- **Classic method for feed**
- **Digesta, feces?**
  - **Lower IPs co-elute with PA**

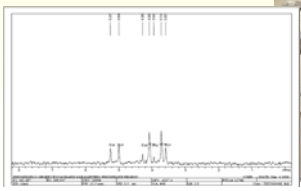


Classic phytate analysis



Nuclear Magnetic Resonance Spectroscopy

- Comprehensive information, inorganic & organic P compounds
- Time-consuming, expensive, insensitive



HPLC/HPIC

- High performance liquid / ion chromatography
- Economical (compared to NMR)
- Limited to samples w/ pure matrix

http://en.wikipedia.org/wiki/High_performance_liquid_chromatography

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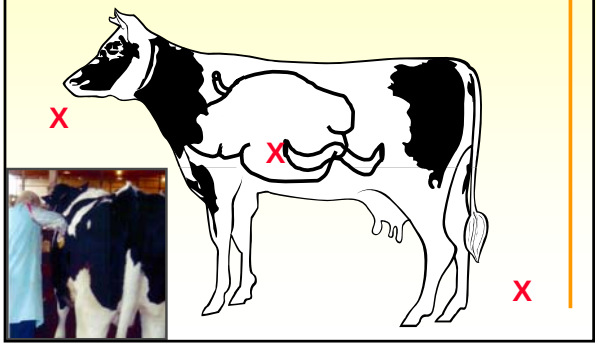
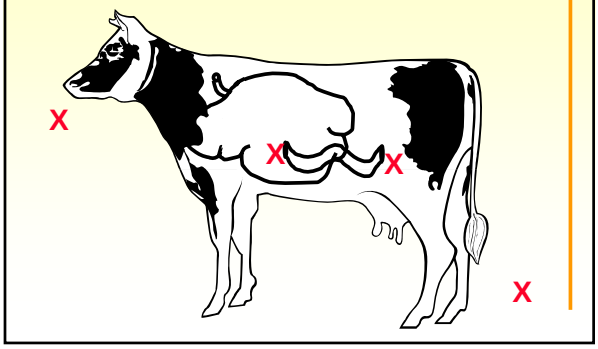
Analytical Progress

- NMR
  - Improved separation of peaks to more clearly define phytate
- HPIC
  - Developing improved acid & base extractions to clean up samples
  - Using NMR to verify methods
  - Can reliably measure IP_6, IP_{5-1}, and Pi
    - Feed
    - Digesta
    - Feces

Experimental Progress

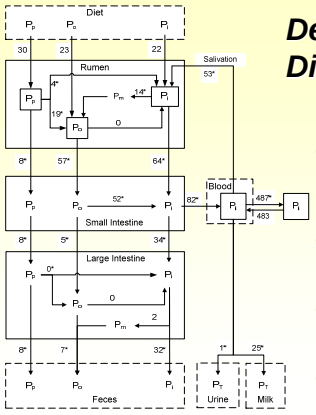


Experimental Progress



Next Steps

- Analyze samples from animal experiments
- Use the relationships we find (diet comp & digestion) to improve the model
- Collect feeds from across the US
- Analyze them



Derive P Digestibilities

- Use data to estimate digestibities by ingredient
- Refine requirements
- Deploy for ration balancing
- ↑ confidence in the system

We need feed samples!!

Forages	Concentrates	By-products	
Alfalfa hay	Corn grain	Corn gluten feed	Cotton seed meal
Grass hay	Soybean meal (48%)	Corn gluten meal	Wheat midds
Corn silage	High moisture corn	DDGS	Almond hulls
Small grain silage		Hominy	Citrus pulp
		Brewers grain	Feather meal
		Whole cotton seed	Fish meal
		Soy hulls	

Purpose: Fractionation of P in feedstuffs to more accurately define P digestibility.

We need multiple samples of each!!

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Next Speaker

- **Dr. Charlie Stallings**

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