


### ***Dietary nutrient management:***

***What goes in, must come out.***

**Katharine F. Knowlton and Mark Hanigan**  
*Department of Dairy Science, Virginia Tech*



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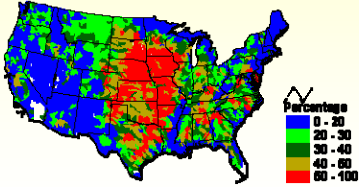
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### ***Sources of nutrients***

**Animal Agriculture Contributions to Total Phosphorus Export**



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

*Smith & Alexander, 2000*

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### ***Who's fault is this?***



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## 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

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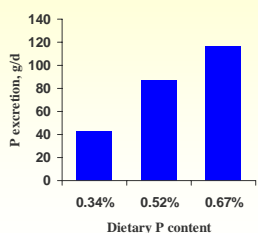
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## P Intake and Excretion

- 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*

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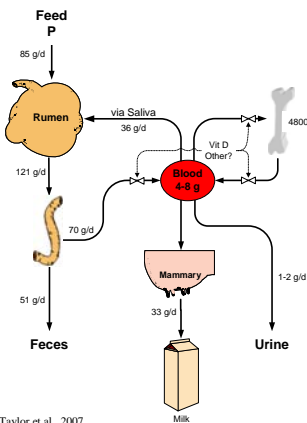
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- Absorption is regulated to meet needs
- 3 forms of P in feed: phytate, organic, inorganic
- only inorganic form of P is absorbed
- Bone buffers deficiencies
- Digestion can limit availability
  - Phytate vs other organic vs inorganic
- Excess is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

Taylor et al., 2007

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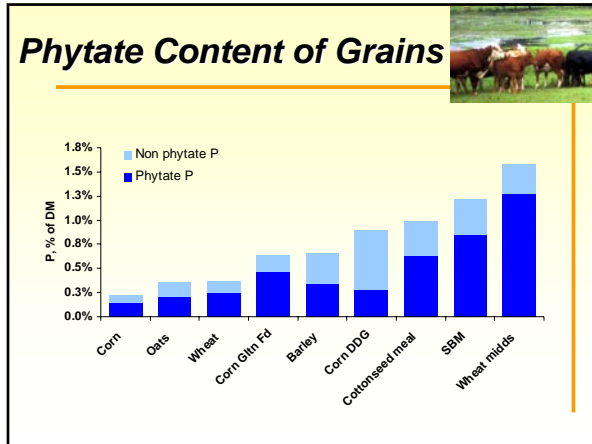
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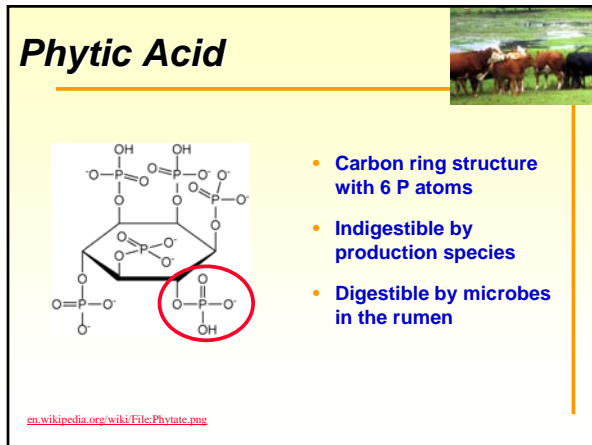
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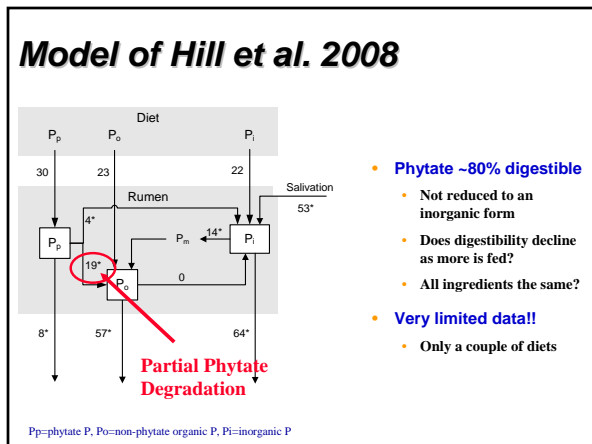
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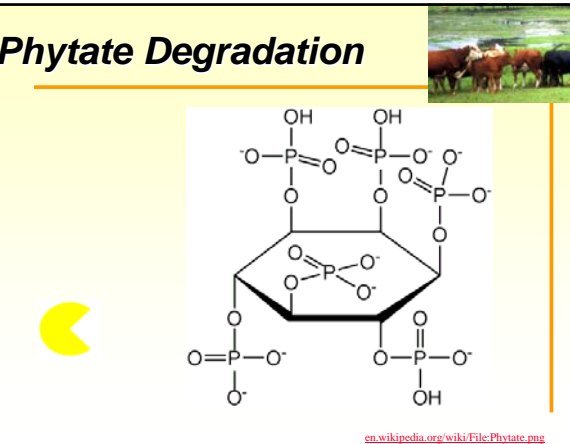
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### Phytate Degradation



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

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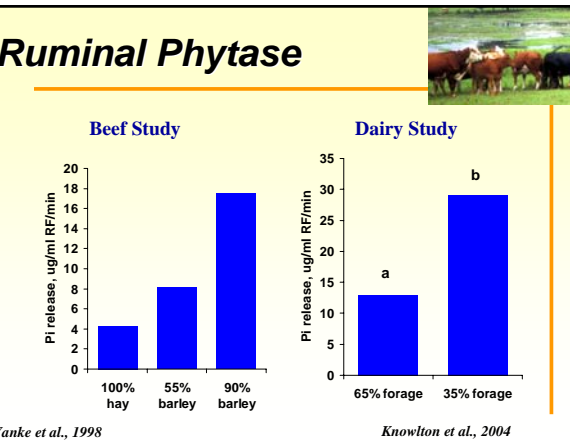
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### Ruminal Phytase



**Beef Study**

Forage Type	Pi release, ug/ml RF/min
100% hay	~4
55% barley	~8
90% barley	~17

**Dairy Study**

Forage Type	Pi release, ug/ml RF/min
65% forage	~13 (a)
35% forage	~29 (b)

Yanke et al., 1998      Knowlton et al., 2004

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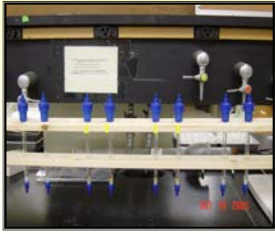
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### Analytical Challenges

*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



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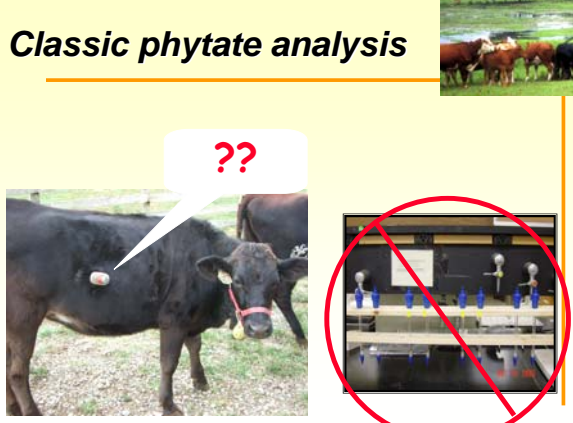
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### Classic phytate analysis



The slide features a yellow background. At the top left, the text "Classic phytate analysis" is written in bold black font. To the right is a small inset image of a herd of cows in a field. Below the text, there is a larger image of a black cow with a red tag on its ear. A red speech bubble with two question marks "??" is positioned above the cow's head. To the right of the cow is a photograph of a laboratory setup with several blue bottles on a counter, which is circled in red with a large red 'X' over it, indicating that this method is outdated or incorrect.

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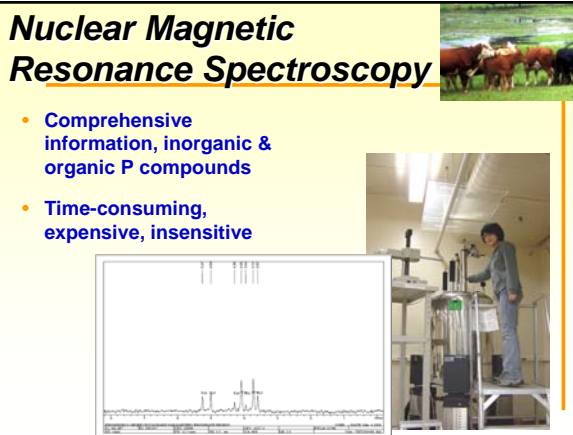
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### Nuclear Magnetic Resonance Spectroscopy

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



The slide has a yellow background. The title "Nuclear Magnetic Resonance Spectroscopy" is at the top left. To the right is a small inset image of a herd of cows. Below the title, there are two bullet points. The first bullet point is "Comprehensive information, inorganic & organic P compounds". The second bullet point is "Time-consuming, expensive, insensitive". Below the text, there is a graph showing several peaks on a white background, representing an NMR spectrum. To the right of the graph is a photograph of a person in a lab coat operating a large piece of scientific equipment, which is an NMR spectrometer.

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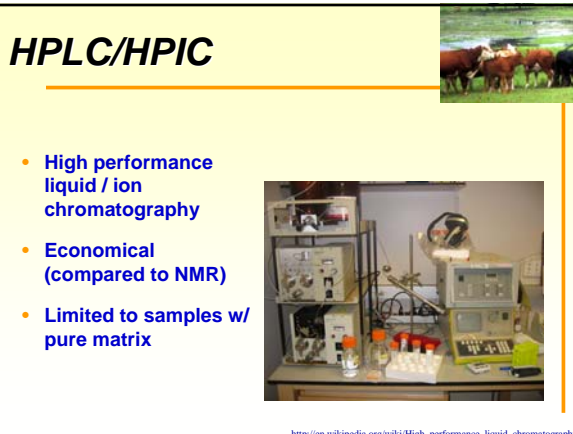
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### HPLC/HPIC

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



The slide has a yellow background. The title "HPLC/HPIC" is at the top left. To the right is a small inset image of a herd of cows. Below the title, there are three bullet points. The first bullet point is "High performance liquid / ion chromatography". The second bullet point is "Economical (compared to NMR)". The third bullet point is "Limited to samples w/ pure matrix". Below the text, there is a photograph of a laboratory setup with various pieces of equipment, including a large machine and several bottles, representing HPLC/HPIC equipment.

[http://en.wikipedia.org/wiki/High\\_performance\\_liquid\\_chromatography](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  $IP_0$ ,  $IP_{2,1}$ , and  $P_i$ 
    - Feed
    - Digesta
    - Feces

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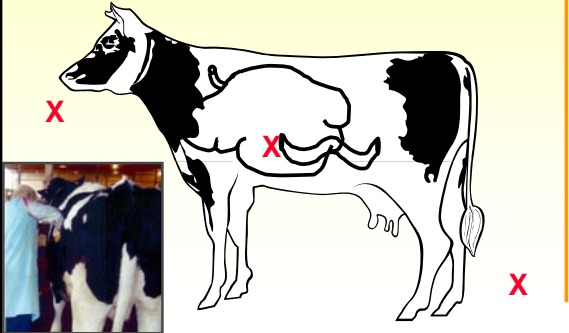

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### Experimental Progress



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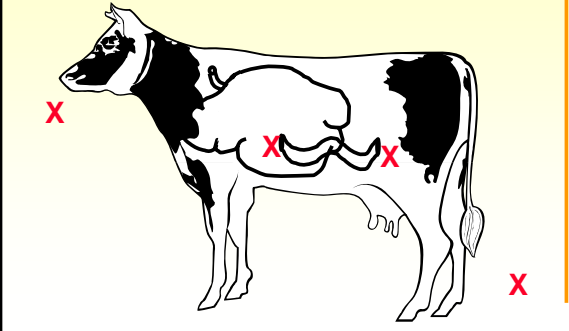

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### Experimental Progress



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## 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

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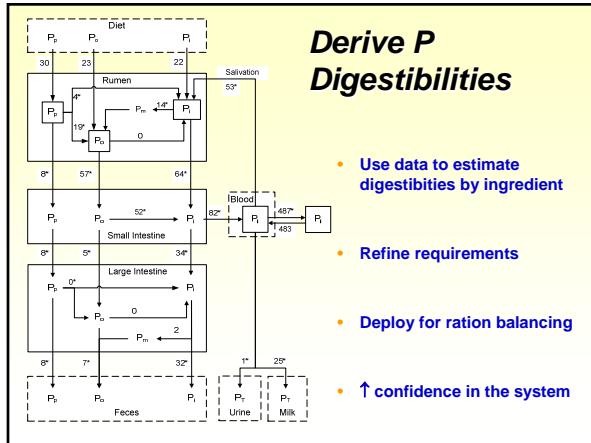
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## Derive P Digestibilities



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

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## 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!!

Contact: Jamie Jarrett 661.331.8062 or [jamiej31@vt.edu](mailto:jamiej31@vt.edu)

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## Acknowledgements



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- Drs. Chao Shang and Rory Maguire, Analytical Techniques
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## Next Speaker



- **Dr. Charlie Stallings**

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