# Nutrient Economics: storage, handling and loss prevention

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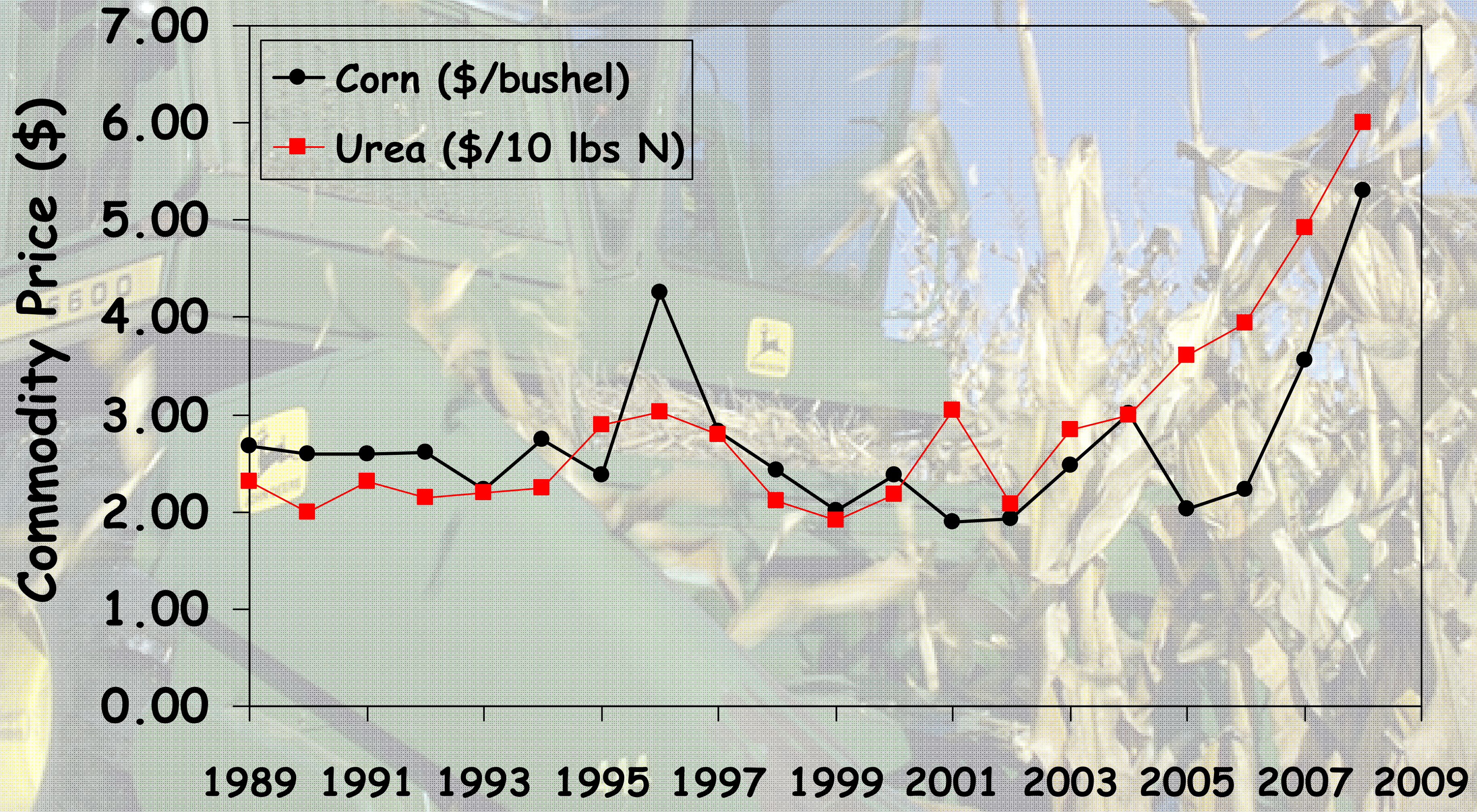
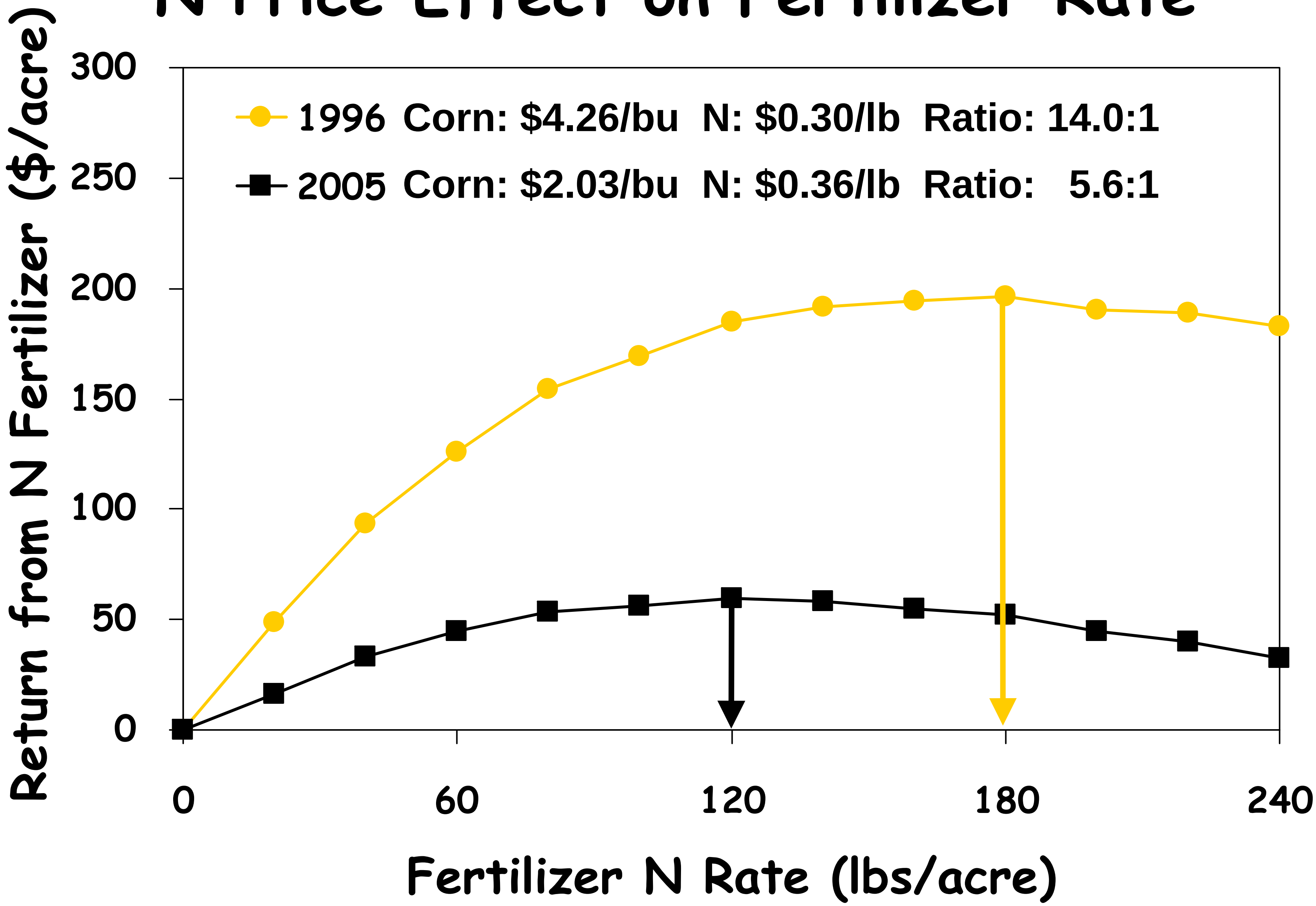
# N Price Effect on Fertilizer Rate




Source: NASS

Based on April prices for MO corn and National fertilizer prices

# N Price Effect on Fertilizer Rate



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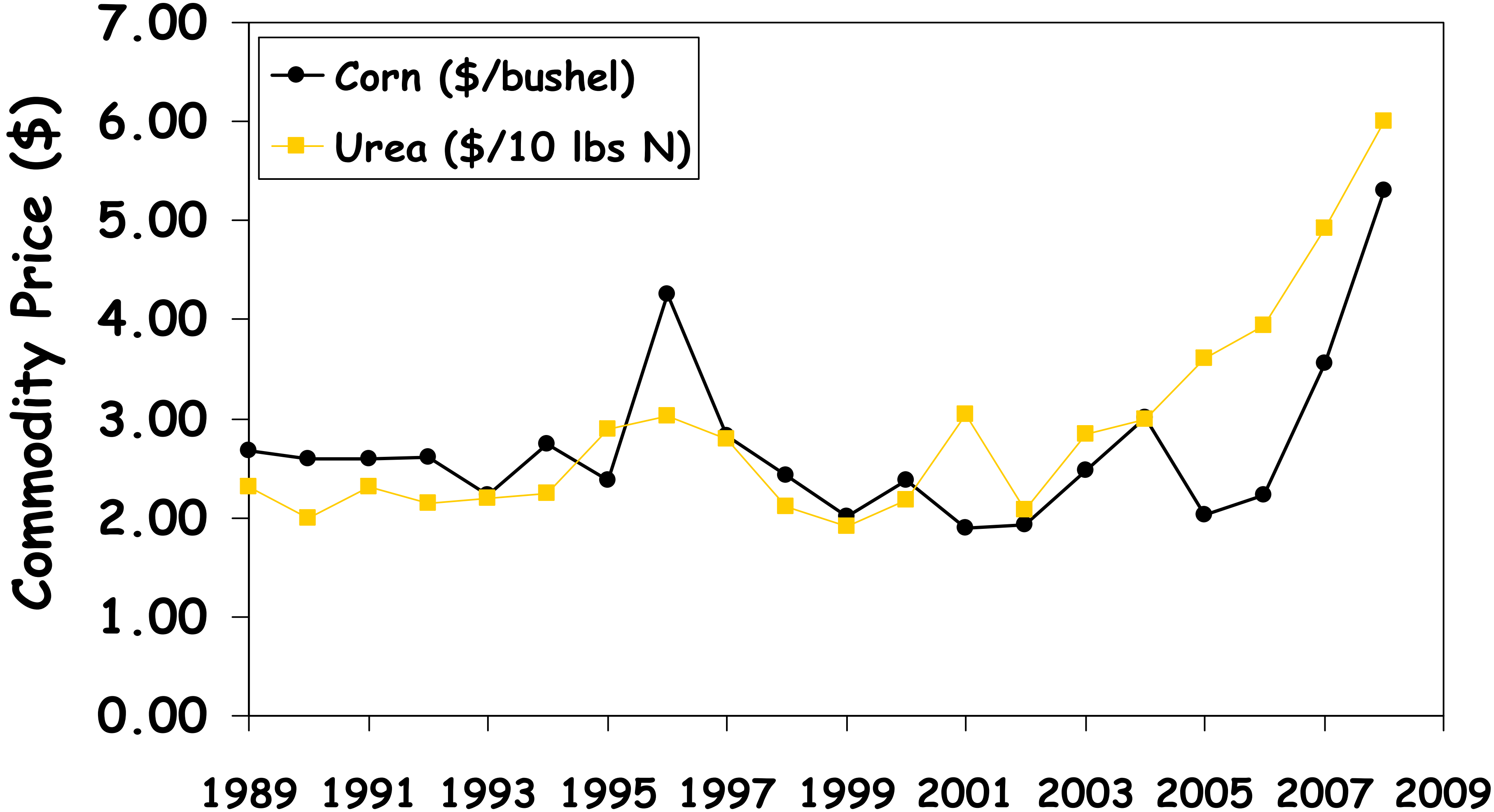


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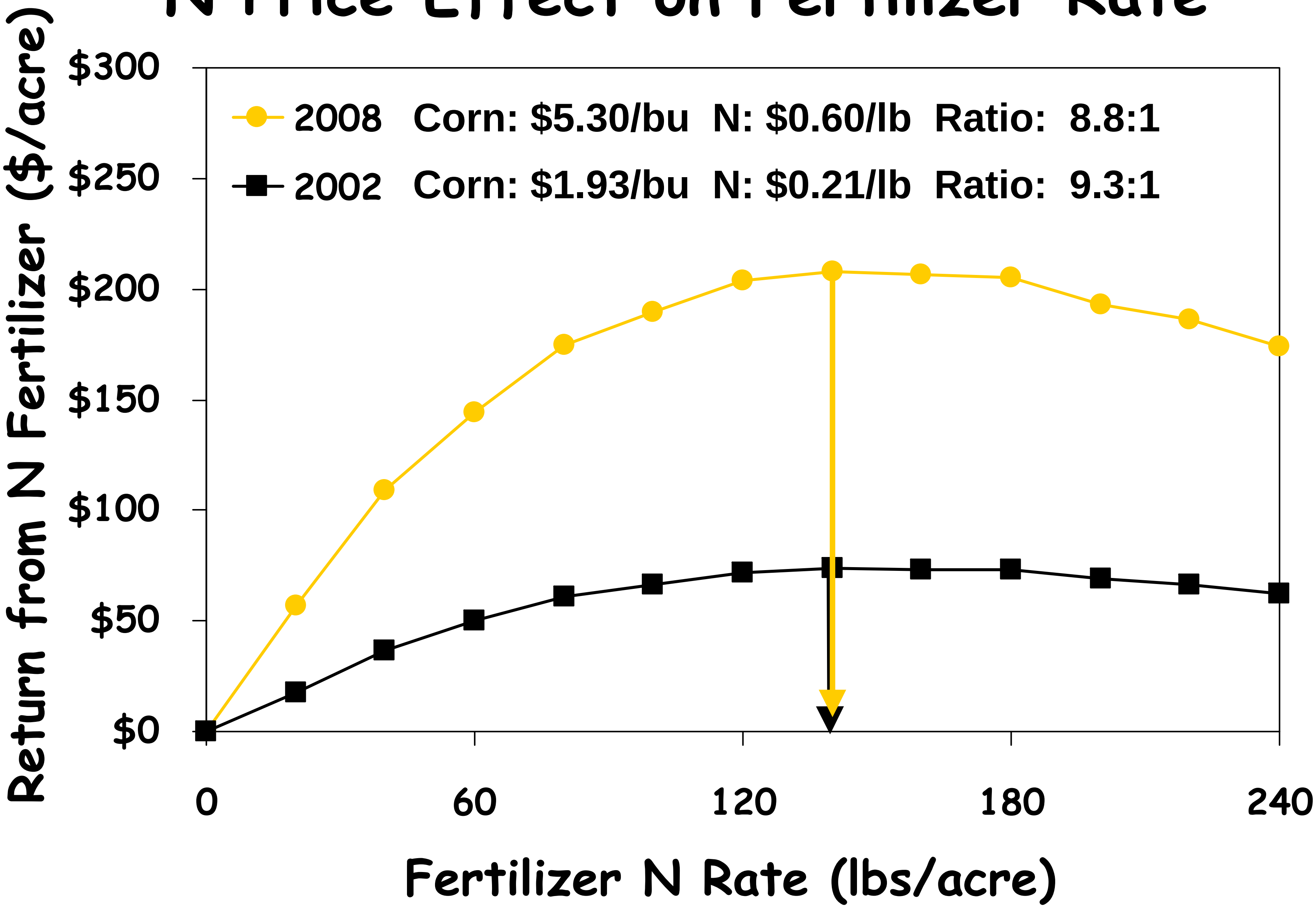
Based on April prices for MO corn and National fertilizer prices

# N Price Effect on Fertilizer Rate



# N Price Effect on Fertilizer Rate

The price of making a N fertilizer mistake:

| | 40 lbs/ac low | 40 lbs/ac high |
|---|---|---|
| | *- - - $/acre - - -* | |
| 2002 (low prices) | $7.00 | $0.70 |
| 2008 (high prices) | $18.40 | $2.80 |

# N Price Effect on Fertilizer Rate

- Optimum rates have not changed much.
- Value of good management has increased.


Questions?

# Options for Increasing Manure Value

- Inject manure (slurry and lagoon)
- Lagoon cover
- Agitate/dredge lagoon
- Convert from lagoon to slurry system

# Understanding the Nutrient Cycle on Pig Farms

## As we feed pigs we bring fertilizer on the farm.

Example:
Grow-finish pigs

# As a pig grows from 45 to 280 lbs.

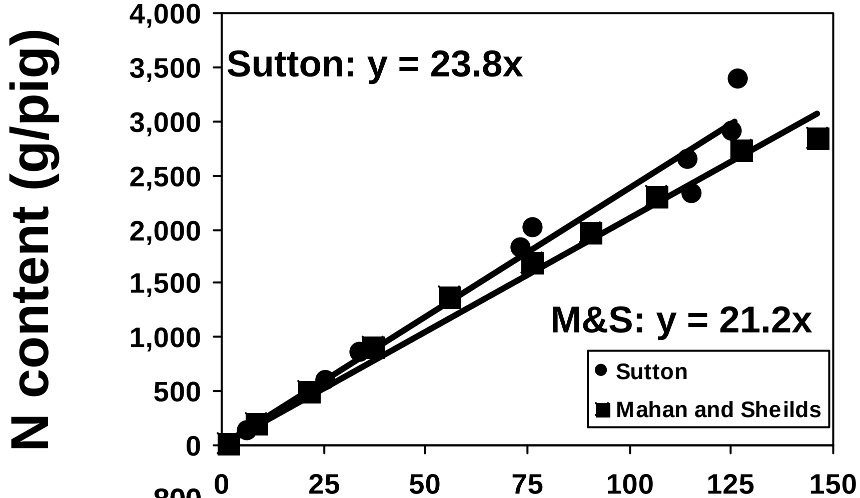
- Feed: 678 lbs/pig
- Days on feed: 133
- Nutrients fed/pig:
  - 14.8 lbs N
  - 2.5 lbs P
  - 3.7 lbs K

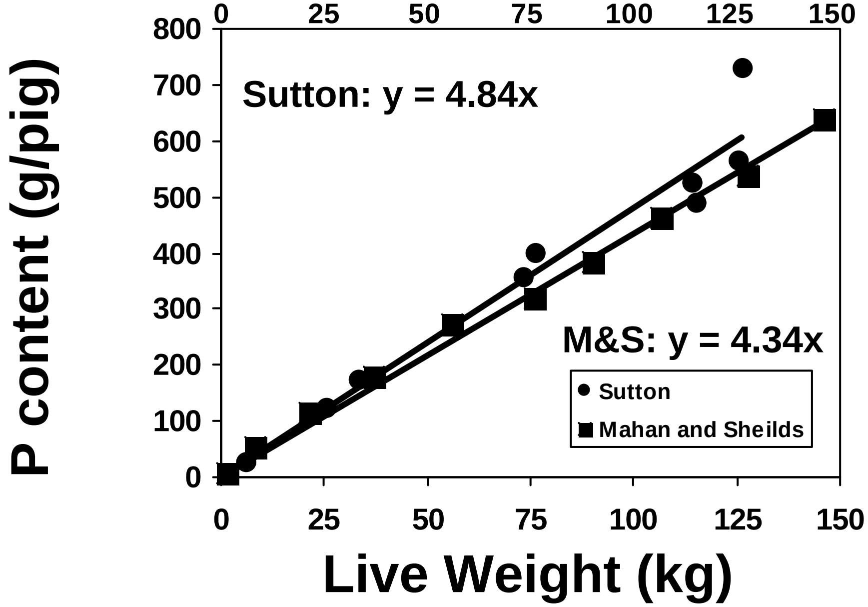
**<u>Summer 2008 MU Diet with phytase and lysine</u>**

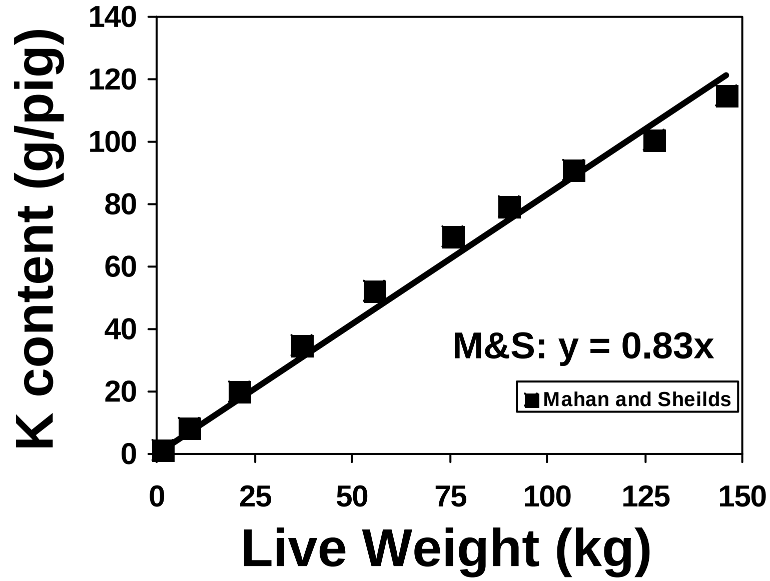
| Animal weight lbs | Crude Protein % | Phosphorus % | Potassium % | F/G ratio | Average Daily Gain lbs |
|---|---|---|---|---|---|
| 45-80 | 16.5 | 0.46 | 0.65 | 2.0 | 1.50 |
| 80-130 | 15.1 | 0.43 | 0.60 | 2.4 | 1.75 |
| 130-190 | 13.7 | 0.36 | 0.55 | 3.0 | 1.95 |
| 190-230 | 12.9 | 0.32 | 0.50 | 3.2 | 1.90 |
| 230-280 | 12.2 | 0.32 | 0.50 | 3.6 | 1.75 |

Calculations: Weight increase X F/G ratio X Nutrient concentration = lbs nutrient fed
Weight increase / Average daily gain = Days on feed

# Nutrients retained by Pigs on Feed




**<u>Nutrient retention rate</u>**

**N: 22.0 g/kg = 0.022 lbs/lb live w**

**P: 4.5 g/kg = 0.0045 lbs/lb live w**

**K: 0.8 g/kg = 0.0008 lbs/lb live w**

# As a pig grows from 45 to 280 lbs.

| Pig Fed → | Pig retention | Excreted → |
|---|---|---|
| 14.8 lbs N | 5.1 lbs nitrogen | 9.7 lbs N |
| 2.5 lbs P | 1.1 lbs phosphorus | 1.4 lbs P |
| 3.7 lbs K | 0.2 lbs potassium | 3.5 lbs K |

Pigs are inefficient
with nutrients

Excrete ~65% consumed N
Excrete ~57% consumed P
Excrete ~95% consumed K

Calculation: Weight increase X fraction of nutrients retained = lbs nutrient retained

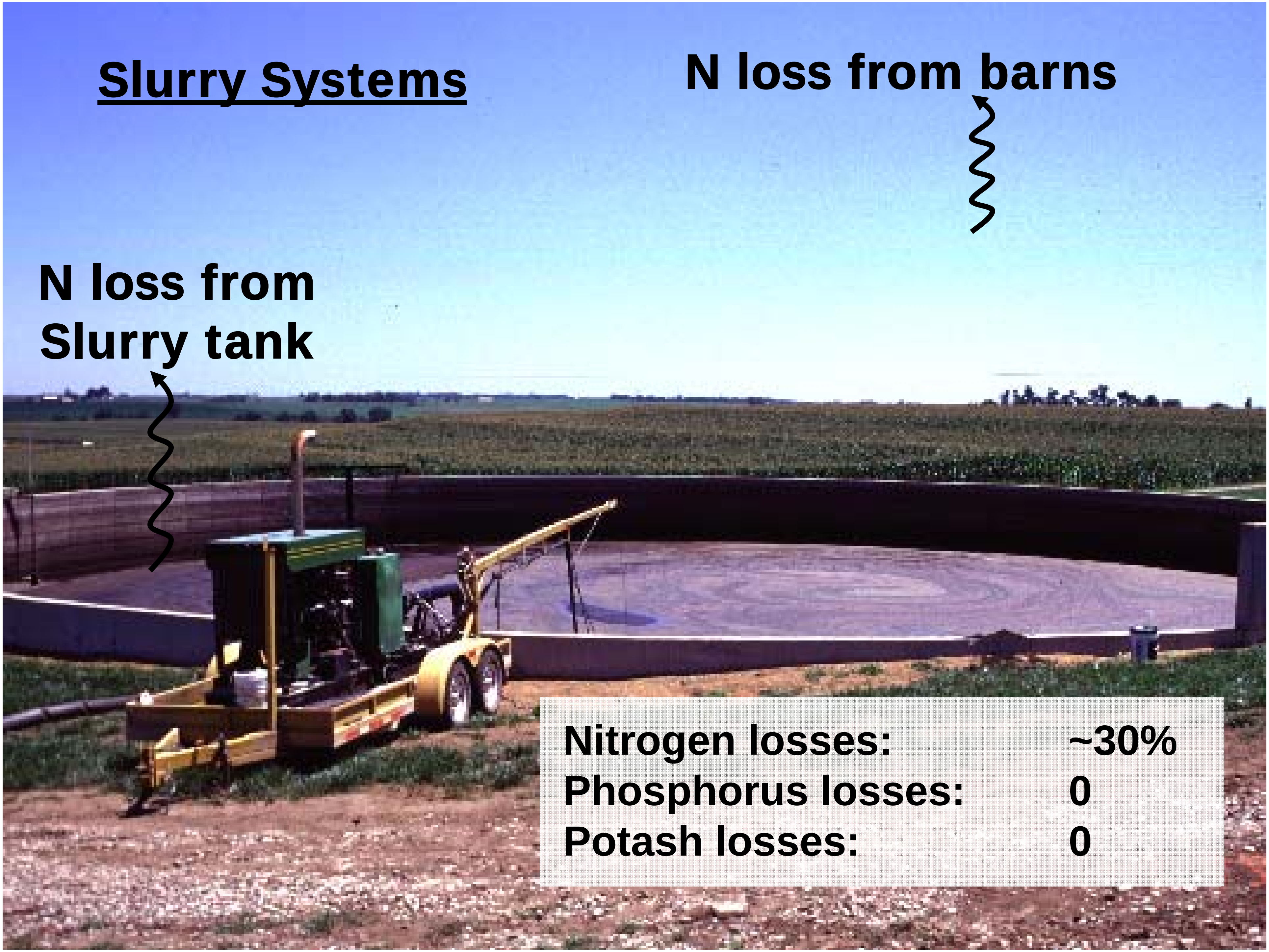
# What are those nutrients worth?

| | N | $P_2O_5$ | $K_2O$ | Total |
|---|---|---|---|---|
| | - - - - | *$ per Pig* | - - - - | |
| Fed | 10.39 | 6.18 | 2.49 | 19.06 |
| Excreted | 6.77 | 3.54 | 2.39 | 12.67 |

**But there are losses that reduce value of excreted nutrients…**

Based on $0.70/lb N, $01.10/lb $P_2O_5$, $0.55/lb $K_2O$

## Slurry Systems




| | |
|---|---|
| Nitrogen losses: | ~30% |
| Phosphorus losses: | 0 |
| Potash losses: | 0 |

**N loss from land application**

**N loss from land application**

# Surface Application

**Ammonia losses:**
**Range - 20 to 80%**
**MDNR – 50% of ammonia N**

# Little N loss from land application

# Injection Application

**Losses:**
**MDNR – 5% of ammonia N**

## Plant Availability of Nutrients

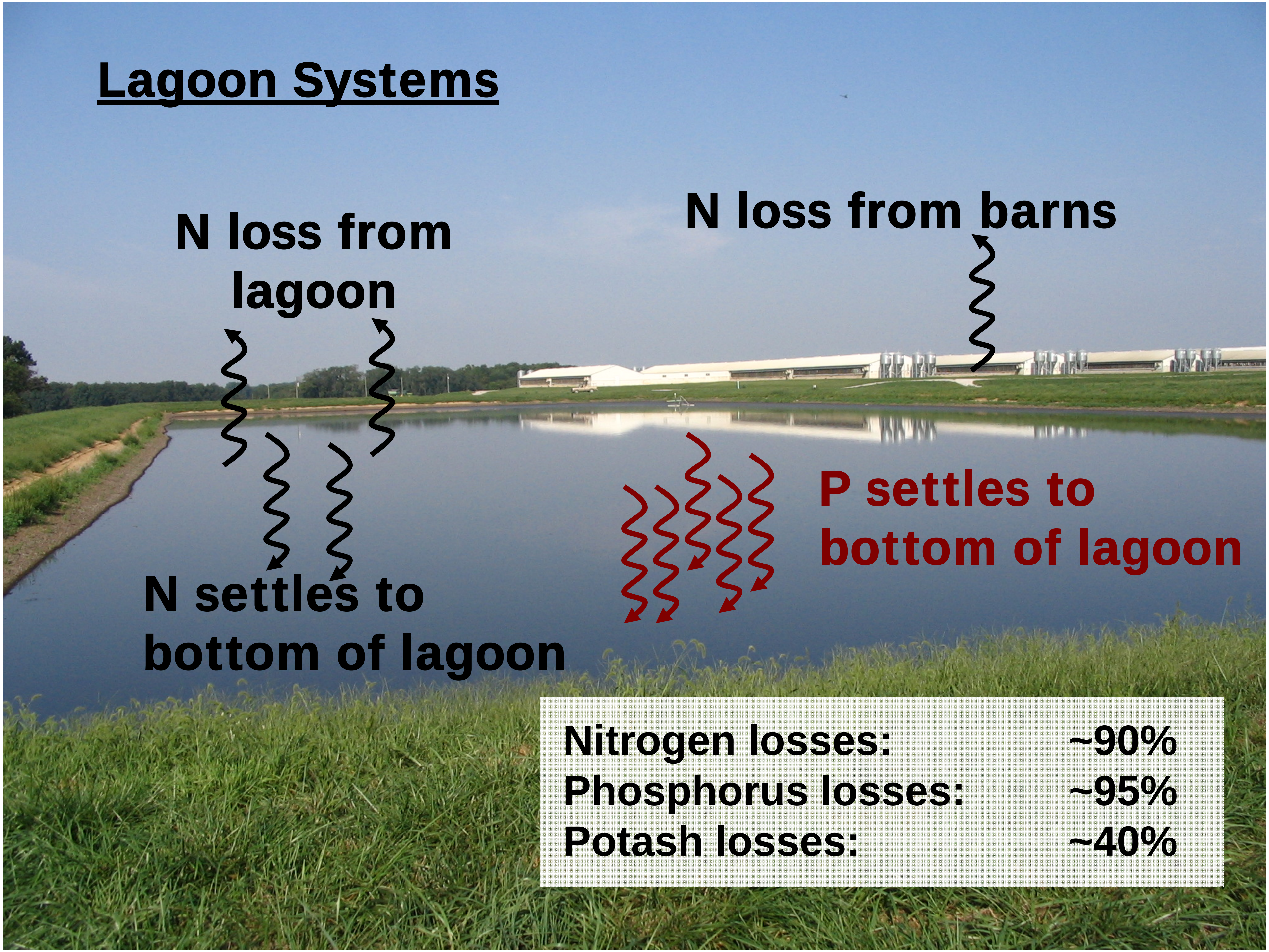
- 62% of organic N
- 100% of everything else

# What are those nutrients worth?

## Slurry System

| | N | $P_2O_5$ | $K_2O$ | Total |
|---|---|---|---|---|
| | - - - - | *$ per Pig* | - - - - | |
| Excreted | 6.77 | 3.54 | 2.39 | 12.67 |
| Pumped | 4.74 | 3.54 | 2.39 | 10.68 |
| Plant available | | | | |
| surface | 2.66 | 3.54 | 2.39 | 8.58 |
| injected | 3.72 | 3.54 | 2.39 | 9.65 |

Based on \$0.70/lb N, \$1.10/lb $P_2O_5$, \$0.55/lb $K_2O$


Lagoon Systems
N loss from lagoon
N loss from barns
P settles to bottom of lagoon
N settles to bottom of lagoon
Nitrogen losses: ~90%
Phosphorus losses: ~95%
Potash losses: ~40%

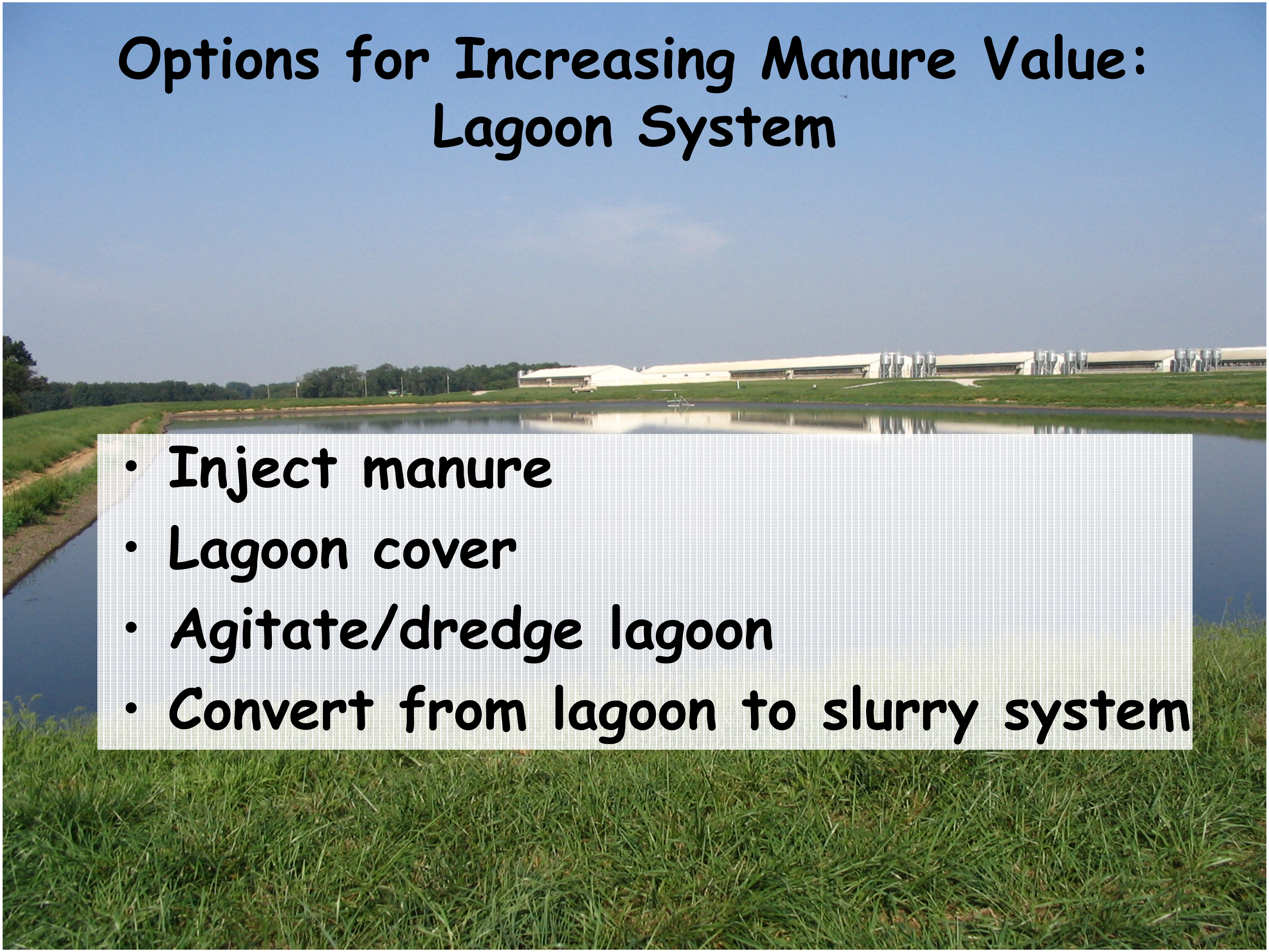
# What are those nutrients worth?

## Lagoon System

| | N | $P_2O_5$ | $K_2O$ | Total |
|---|---|---|---|---|
| | - - - - | *$ per Pig* | - - - - | |
| Excreted | 6.77 | 3.54 | 2.39 | 12.67 |
| Pumped | 0.68 | 0.18 | 1.42 | 2.27 |
| Plant available | | | | |
| surface | 0.35 | 0.18 | 1.42 | 1.94 |
| injected | 0.62 | 0.18 | 1.42 | 2.21 |

Based on \$0.70/lb N, \$1.10/lb $P_2O_5$, \$0.55/lb $K_2O$

# Options for Increasing Manure Value: Lagoon System



- Inject manure
- Lagoon cover
- Agitate/dredge lagoon
- Convert from lagoon to slurry system

# Agitate/Dredge Lagoon

- Maximum potential value (injected)

| | N | $P_2O_5$ | $K_2O$ | Total |
|---|---|---|---|---|
| | - - - - | *$ per Pig* | - - - - | |
| **Unagitated** | **0.62** | **0.18** | **1.42** | **2.21** |
| **Agitated** | **2.66** | **3.54** | **2.36** | **8.55** |

- Potential issues
  - Difficult to fully agitate lagoons.
  - Incomplete agitation leads to variability in nutrient concentration.
  - Difficult to predict nutrient concentration.
  - Manure has low N:P ratio.

# Convert to Slurry System – pull-plug gravity system

- Maximum potential value (injected)

| | N | $P_2O_5$ | $K_2O$ | Total |
|---|---|---|---|---|
| | - - - - *$ per Pig* - - - - | | | |
| **Lagoon** | **0.62** | **0.18** | **1.42** | **2.21** |
| **Slurry** | **3.72** | **3.54** | **2.36** | **9.62** |

- Approaches
  - Eliminate lagoon and build slurry tank.
  - Build transfer tank maintaining lagoon as backup storage.
- Potential issues
  - Cost of tank and new land application equipment.

# Convert to Slurry System – sloped gutter flush systems

- Challenge
  - Must maintain a source of flush water.
    - Cannot convert flush systems to gravity flow.
    - Converting to scraper system complex and high odor.
- Approach
  - Solid separation (not particularly effective at concentrating nutrients).
  - Build two tanks
    - Initial tank to settle solids (land apply from this tank).
    - Flushing water tank for decanted water from first tank.
- Potential issues
  - Lots of cost for little benefit.

# Increasing Manure Value in Lagoons

| | Potential value | Odds to get fertilizer value | Capital cost |
|---|---|---|---|
| | *$/pig space/yr*[1] | | |
| Injection | 0.60 | High | $20,000 |
| Agitation | 13.95 | Low-medium | $12,000 |
| Conversion | | | |
| Gravity | 16.29 | High | $100/pig space[2] |
| Flush | ? | Medium-high | ? high |

[1] Based on 2.2 turns/year

[2] Estimated cost of cement tank only.


Questions?

# We Keep Getting More Efficient at Raising Pigs.

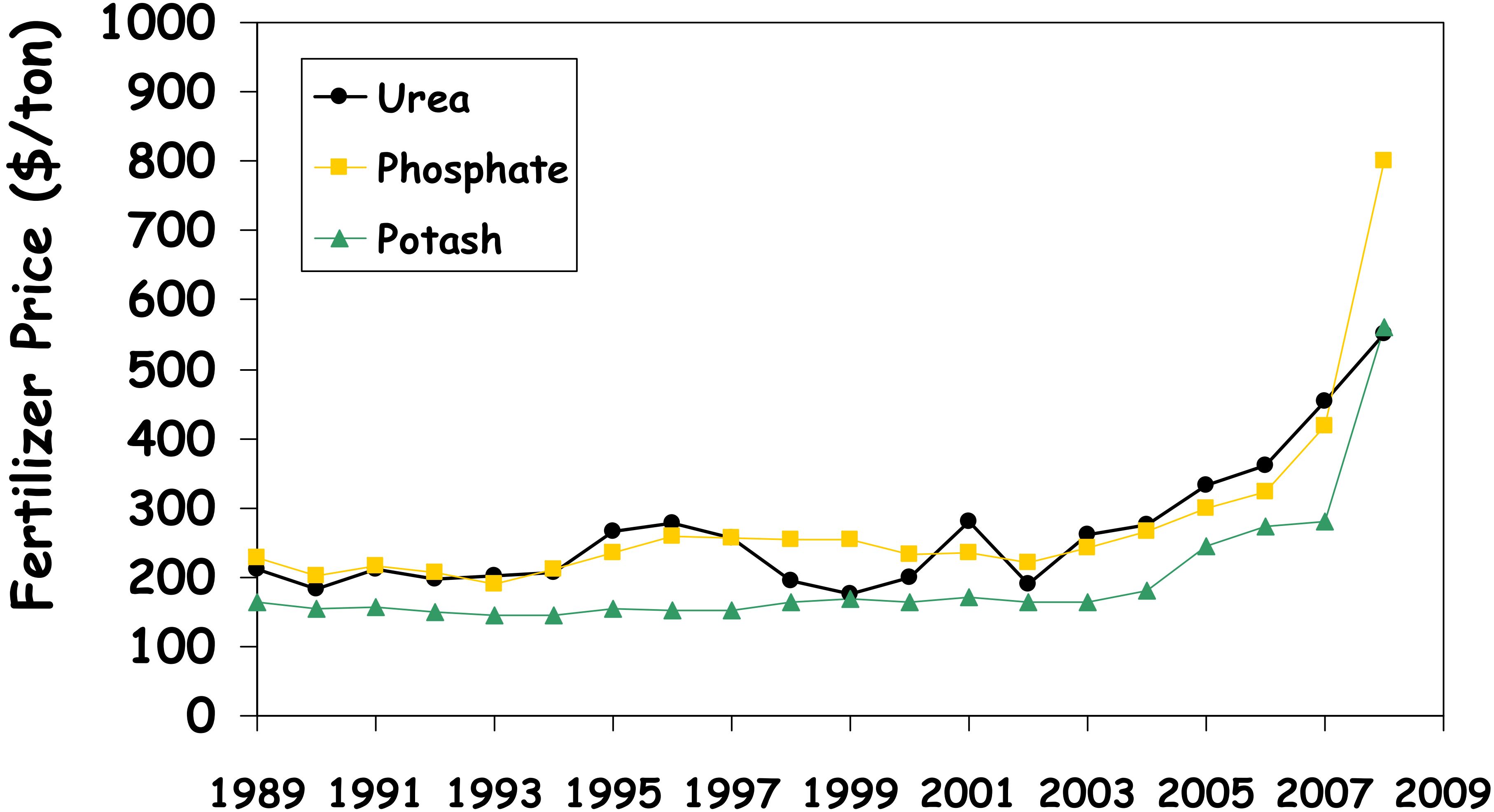
# We Keep Getting More Efficient at Raising Pigs.

| Diet | F/G | ADG (lb/d) | CP (%) | P (%) | K (%) |
|---|---|---|---|---|---|
| Early 2000 MU diet | 3.24 | 1.8 | 15.5 | 0.61 | 0.55 |
| 2007 KSU, phytase added | 2.85 | 1.7 | 15.0 | 0.44 | 0.55 |
| 2008 MU, phytase added | 2.89 | 1.7 | 13.7 | 0.36 | 0.55 |
| Reduction (%) | 10 | | 11 | 39 | |

# Consequently Pigs are Excreting Fewer Nutrients.

| | Excreted Nutrients | | |
|---|---|---|---|
| Diet | N (lb/pig) | $P_2O_5$ (lb/pig) | $K_2O$ (lb/pig) |
| Early 2000 MU diet | 13.8 | 8.1 | 4.8 |
| 2007 KSU, phytase added | 11.0 | 4.3 | 4.3 |
| 2008 MU, phytase added | 9.7 | 3.2 | 4.3 |
| Reduction (%) | 30 | 60 | 10 |

# But Fertilizer Prices are Skyrocketing.




Source: NASS
Based on April National fertilizer price

# Impact on Manure Value – Injected Slurry.

| Diet | Value of Manure[1] ($/pig) | Area fertilized[2] N-based (Acres/pig) | Area fertilized[2] P-based (Acres/pig) |
|---|---|---|---|
| Early 2000 MU diet | 4.34 | 0.09 | 0.08 |
| 2007 KSU, phytase added | 5.86 | 0.07 | 0.04 |
| 2008 MU, phytase added | 7.92 | 0.06 | 0.03 |
| Change (%) | +82 | -29 | -60 |

[1]Fertilizer value based on NASS data in April

2000 N=$0.22/lb; P2O5=$0.25/lb; K2O=$0.13/lb

2007 N=$0.49/lb; P2O5=$0.45/lb; K2O=$0.23/lb

2008 N=$0.60/lb; P2O5=$0.87/lb; K2O=$0.45/lb

[2]Based on Corn (150 bu/A) – Bean (40 bu/A) rotation.

# We keep getting more efficient at raising pigs

- Loss of income for contract operations using manure as a fertilizer on their farm.

- Impact on independent operations?
  - Good news for land limited operations.
  - Other operations need to evaluate relative impact of fertilizer and feed costs.

# Questions

# Integrating fertilizer value into feed management decisions.

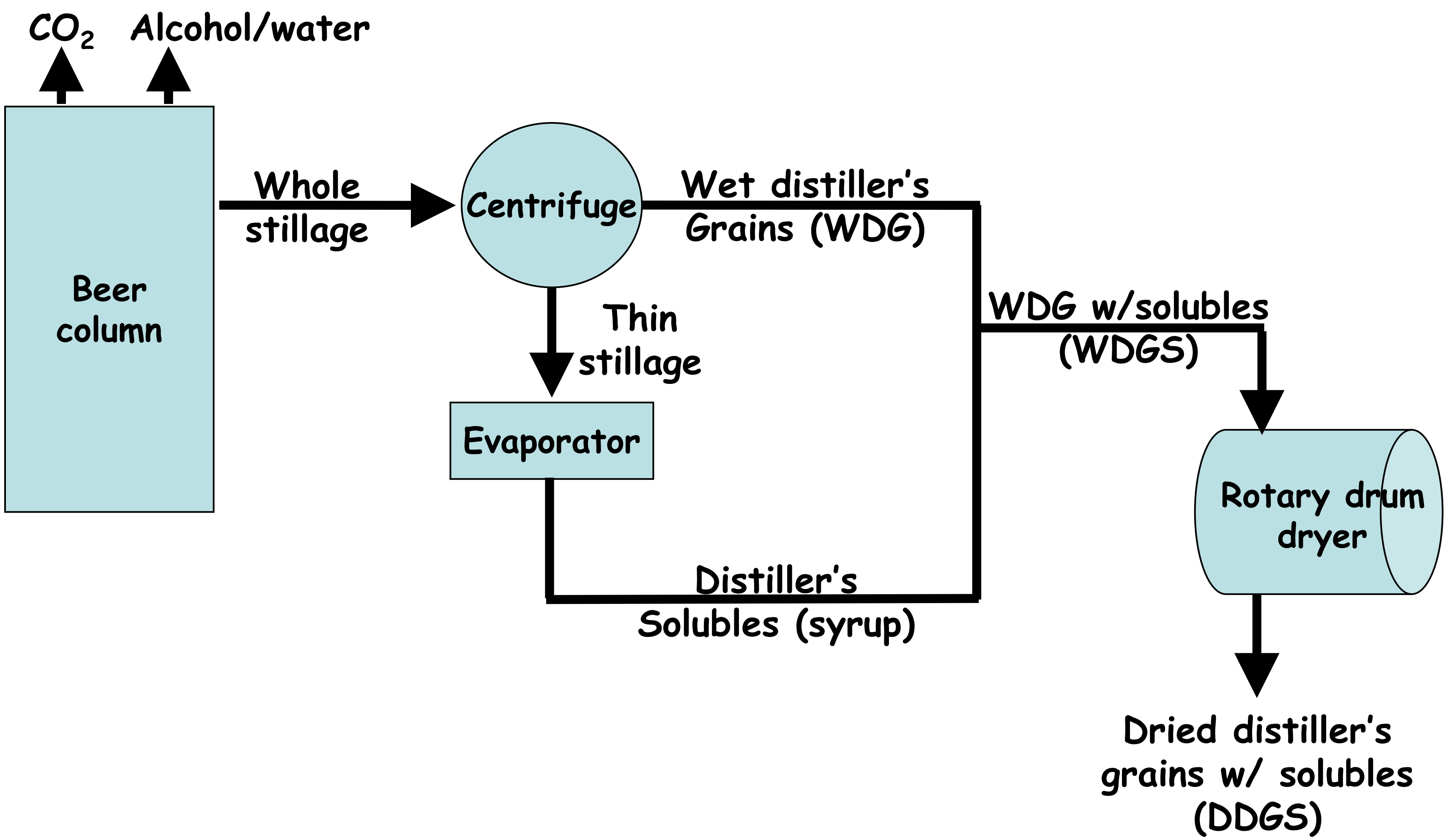
## Forces affecting diet decisions.

- High grain prices
- Economics of byproduct feeds.
- Low hog and chicken prices.

**Should fertilizer value of manure affect feed decisions?**

# Impact of Dried Distillers Grains on Manure Management

# Ethanol Byproducts – Dry grind plants



# MASS BALANCE

3 lbs Corn → ~ 1 lb Distiller's Grains (DDGS) → ~ 1 lb Ethanol

| | | | |
|---|---|---|---|
| Theoretical | $C_6H_{12}O_6 \longrightarrow$ | $2\ C_2H_5OH$ | $+\ 2\ CO_2$ |
| Molecular wt. (g/mol) | 180 | 92 | 88 |

# Impact of Dried Distillers Grains on Manure Management.

| | Corn Grain | DDGS |
|---|---|---|
| | - - - - - % - - - - - - | |
| Crude Protein | 9.0 | 31.3 |
| Phosphorus | 0.29 | 0.86 |
| Potassium | 0.36 | 1.21 |
| Sulfur | 0.13 | 0.58 |

All values on a 100% DM basis.

Based on Belyea et al., 2004
Clevenger et al., 2001

# Impact of Dried Distillers Grains on Manure Management.

| Ration | Crude Protein | | Phosphorus | | Potassium | |
|---|---|---|---|---|---|---|
| | STD | DDGS | STD | DDGS | STD | DDGS |
| | - - % - - | | - - % - - | | - - % - - | |
| Pig grower[1] | 18.2 | 19.4 | 0.8 | 0.8 | 0.8 | 0.8 |
| Dairy lactating[2] | 17.0 | 17.0 | 0.36 | 0.37 | 1.4 | 1.3 |
| Beef finish[3] | 13.0 | 16.1 | 0.32 | 0.44 | 0.60 | 0.67 |

[1] Grower pig ration with 10% inclusion rate.
[2] Lactating cow ration with 20% inclusion rate (Anderson et al., 2006).
[4] Beef finish ration with 30% inclusion rate (Al-Suwaiegh et al., 2002)

# Impact of Dried Distillers Grains on Manure Management.

Impact of Dried Distillers Grains on Manure Management

| | Pig Grower | | Dairy lactating | | Beef finish | |
|---|---|---|---|---|---|---|
| Diet component | STD | DDGS | STD | DDGS | STD | DDGS |
| | - - % - - | | - - % - - | | - - % - - | |
| Corn grain | 69.7 | 61.8↓ | 35.6 | 26.7↓ | 84 | 54↓ |
| Corn silage | - | - | 25.0 | 25.0 | - | - |
| Soybean meal | 23.7 | 24.7 | 12.5 | 1.6 ↓ | - | - |
| Alfalfa | - | - | 25.0 | 25.0 | 7.5 | 7.5 |
| DDGS | 0 | 10.0↑ | 0 | 20.0↑ | 0 | 30↑ |
| Dical | 2.35 | 2.09↓ | 0.22 | 0 ↓ | - | - |

# Impact of Dried Distillers Grains on Manure Management.

- Beef
  - Will increase manure nutrients and manure value.
- Dairy
  - Higher inclusion rates will increase nutrients and manure value.
- Pigs
  - Will have limited impact on manure nutrients.

# Integrating fertilizer value into feed management decisions.

## An example: Supplemental feed for beef cattle.

- Should I buy corn or high quality hay to supplement short pasture?

| Parameter | Corn | Hay |
|---|---|---|
| Cost ($/ton) | 190 | 135 |
| Dry Matter (%) | 84.5 | 90 |
| Total Digestible Nutrients (%TDN) | 90 | 60 |
| Tons feed/ton TDN | 1.3 | 1.9 |

# Integrating fertilizer value into feed management decisions.

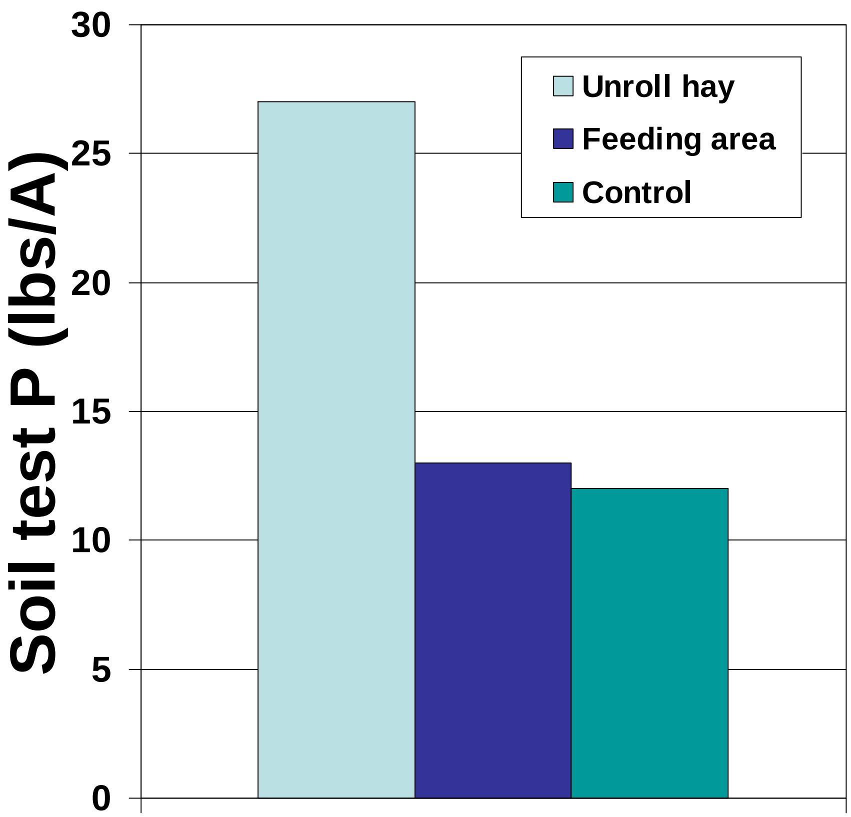
## An example: Supplemental feed for beef cattle.

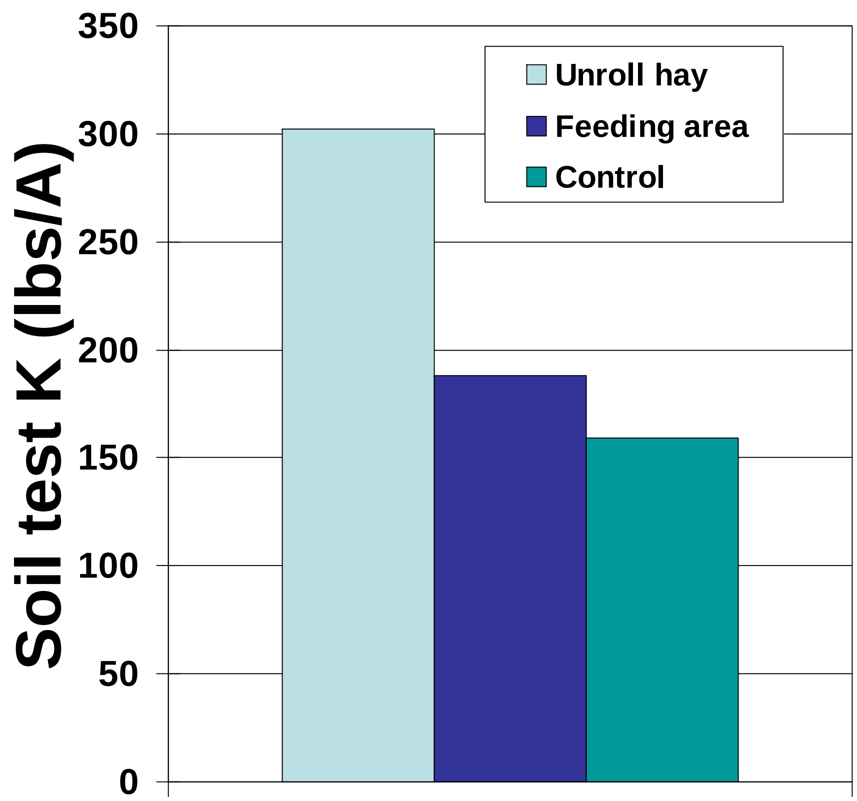
- Should I buy corn or high quality hay to supplement short pasture?

| Parameter | Corn | Hay |
|---|---|---|
| Cost per ton TDN ($/ton TDN) | 250 | 250 |
| Fertilizer value per ton TDN ($/ton TDN) | 26 | 90 |
| Net cost per ton TDN ($/ton TDN) | 224 | 160 |


Feed as Fertilizer

# Management needed to distribute nutrients!




- 4-year study
- Chris Zumbrunnen, NE MO

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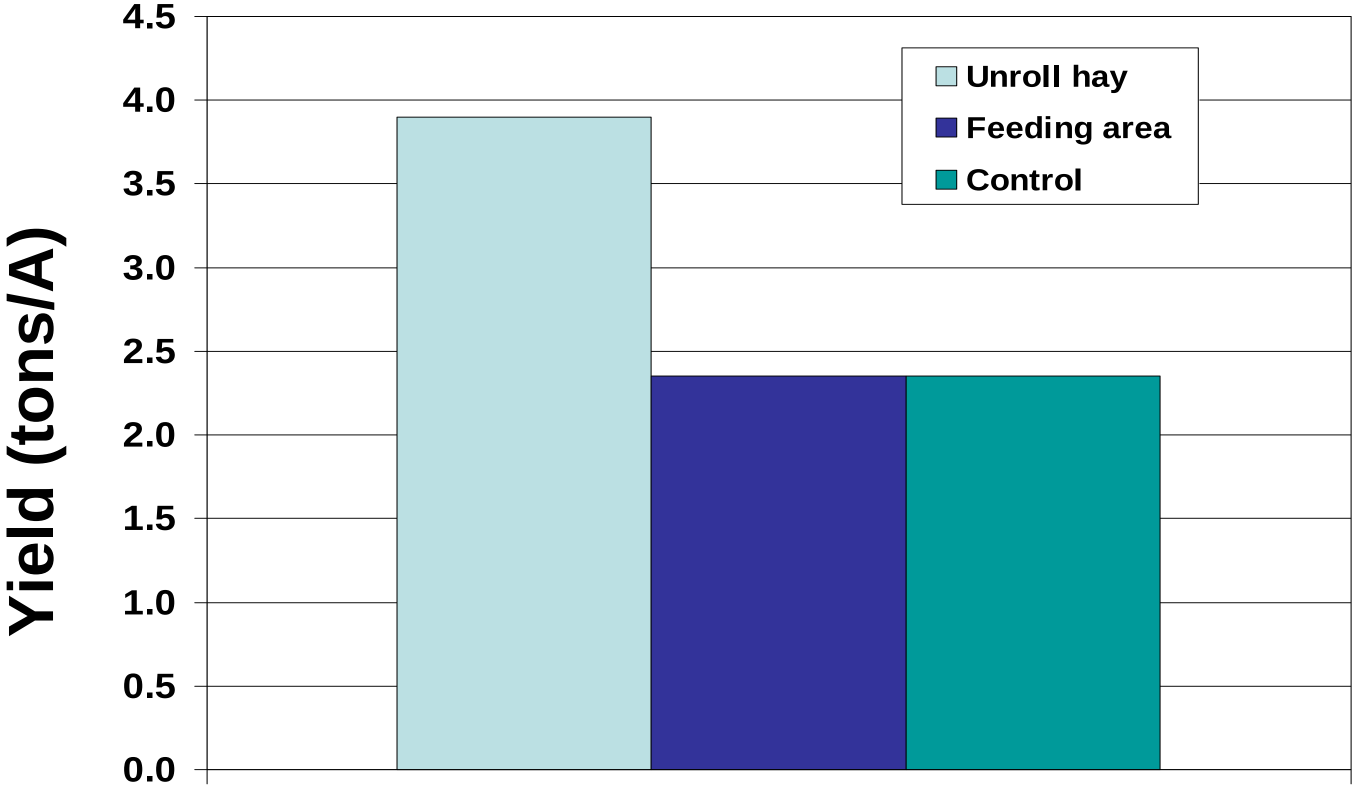


- 4-year study
- Chris Zumbrunnen, NE MO

# Recipe for success

- Regularly move feeders and feeding areas around the pasture.
- Increase the stocking density of animals but move animals more frequently.
- Do not use the same pasture for supplemental feeding every year.
- Maintain a setback area of at least 100 feet between supplemental feeding areas and streams.

# Impact of Dried Distillers Grains on Manure Management

| | Corn Grain | DDGS |
|---|---|---|
| | - - - - - - % - - - - - - | |
| Crude Protein | 8.8 | 28.5 |
| Phosphorus | 0.29 | 0.86 |
| Potassium | 0.36 | 1.21 |
| Sulfur | 0.13 | 0.58 |
| Metabolizable energy (BTU/lb) | 7200 | 7000 |

All values on a 100% DM basis.

Based on Belyea et al., 2004
Clevenger et al., 2001

| | Corn Grain | DDGS |
|---|---|---|
| | *- - - lbs per ton* | *- - -* |
| Nitrogen | 28 | 92 |
| Phosphate | 13 | 39 |
| Potash | 9 | 30 |
| Approx. nutrient value ($/ton) | $32 | $100 |

# Integrating fertilizer value into feed management decisions.

Forces affecting diet decisions.

- High grain prices
- Economics of byproduct feeds.
- Low hog and chicken prices.

**Should fertilizer value of manure affect feed decisions?**

# Questions?