Normand St-Pierre
The Ohio State University

How do Forage Quality Measures Translate to Value to the Dairy Producer?

Big Discovery!

- Forages are... Feeds

What are feeds used for?

- Animals do not require feeds!
- Feeds are *packages* of nutrients.
- The value of a feed is the sum of the values of the nutrients that it contains.

What are the nutrients of economic value?

It depends...

- On the buyer...

Who is the buyer?

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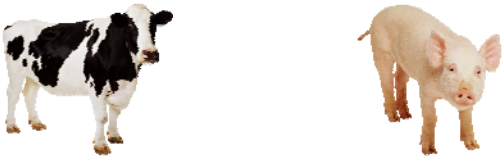
What are the nutrients of economic value?

It depends...

- On the buyer...
- On the class of animals

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What are the nutrients of economic value?

It depends...

- On the buyer...
- On the class of animals
- On the objective
  - Tactical vs. Strategic

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Tactical vs. Strategic

- Tactical:
  - Feed(s) that complements other feedstuffs already selected for the ration

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Tactical vs. Strategic

- Tactical:
  - Feeds that complements other feedstuffs already selected for the ration.
- Strategic:
  - Feeds are being looked as components of the whole diet.

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Tactical vs. Strategic

Tactical

Strategic

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Our Approach...

- Moderately sophisticated buyer
- Lactating dairy cows
- Strategic

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Our Approach...

- Moderately sophisticated buyer
- Lactating dairy cows
- Strategic

- Also assumes that feeds are free of unacceptable properties/compounds
  - Molds
  - Weeds

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What nutrients?

- Set 1:
  - NE_L
  - RDP
  - dRUP
  - eNDF
  - neNDF

→

- Set 2:
  - NE_L
  - MP
  - eNDF
  - neNDF

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What is NE_L ?

What is TDN?

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What is TDN?

Sum of:
- dProtein
- dNDF
- dFat (x 2.25)
- dNFC

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What is TDN?

Sum of:
- dProtein — High, well estimated by ADICP
- dNDF
- dFat (x 2.25)
- dNFC

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What is TDN?

Sum of:
- dProtein — High, well estimated by ADICP
- dNDF
- dFat (x 2.25) — High, 100% for fatty acids
- dNFC

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What is TDN?

Sum of:
- dProtein — High, well estimated by ADICP
- dNDF
- dFat (x 2.25) — High, 100% for fatty acids
- dNFC — High, 98% at maintenance

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What is TDN?

Sum of:
- dProtein — High, well estimated by ADICP
- dNDF — VARIABLE / Surface ratio of lignin to NDF
- dFat (x 2.25) — High, 100% for fatty acids
- dNFC — High, 98% at maintenance

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What is TDN?

Sum of:
- dProtein — High, well estimated by ADICP
- dNDF ← Why not use ivNDFd?
- dFat (x 2.25) — High, 100% for fatty acids
- dNFC — High, 98% at maintenance

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Total Tract In Vivo NDF Digestibility by Dairy Cows

16 experiments
65 diets
356 observations
Avg = 48.5%

57% of means

Grass-based

Trt Differences: IVNDF of ingredient vs TMR In vivo

Avg=1.5

Avg=5.8
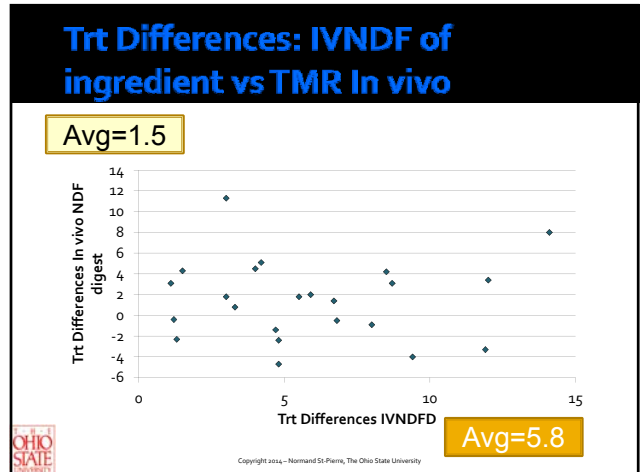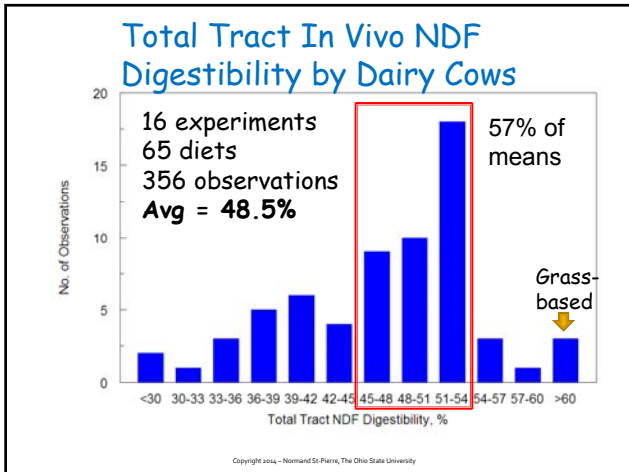
ivNDFd

- Overestimates differences.
- Magnitude of the difference in ivNDFd is NOT related to the magnitude of the difference in <u>true</u> (in vivo) NDF digestibility.
- BUT, the ranking within experiment was often OK
  - ivNDFd might have potential, but NOT as a direct replacement.

What is NE_L ?

What is TDN?

What is TDN?

Sum of:
- dProtein
- dNDF
- dFat (x 2.25)
- dNFC

What is NE$_L$

- A linear transformation of TDN
- But NOT with a zero intercept
  - 5% TDN = 0.00 Mcal/kg NE$_L$

- TDN <u>overestimates</u> the energy of forages relative to concentrates.

What is MP?

- Metabolizable protein

Protein Intake

Rumen:
Degradable Protein + Energy → Microbial Protein
Undegradable (feed) Protein

Intestine:
Microbial Protein
Undegradable Protein → Metabolizable Protein

Feces:
Undigestible Microbial Protein
Undigestible Undegradable Protein
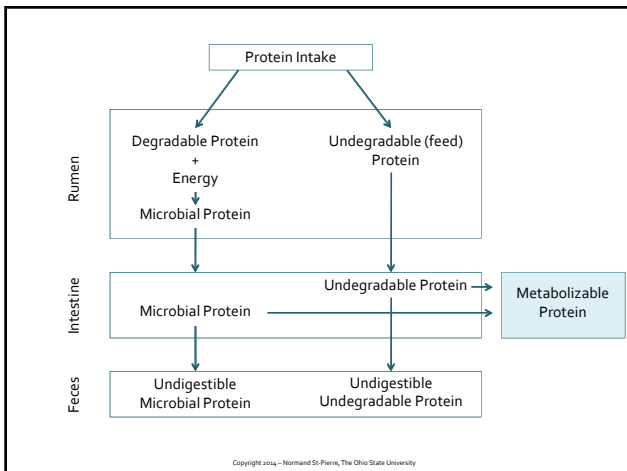
Aufmerksamkeit!

- Forages are all relatively low in undegradable protein.
- Degradable protein has no value unless there is sufficient ruminal energy to grow microbes.
- *CRUDE PROTEIN* (by itself) is not a ***Meaningful*** measure of economic value!

Market prices of nutrients

- Use all feeds sold in a given market
  - NOT just corn and soybean meal
- Use their nutritional composition
- Solve simultaneously (hedonic pricing)

- Sesame™ software
- Progressive Dairyman (monthly)
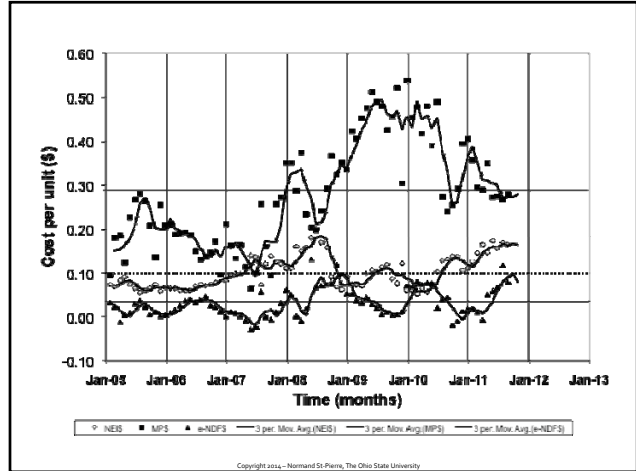
January 2010 to October 2013

Nutrients	Average	S.D.	Min	Max
NE$_L$ (¢/Mcal)	15.2	2.1	11.1	17.4
MP (¢/lb)	31.1	4.8	26.8	40.6
eNDF (¢/lb)	4.7	4.0	0.0	11.9
neNDF (¢/lb)	-8.5	2.8	-12.4	-5.1

Alfalfa - Entries

Nutrients	Units	Low	Reference	High
Dry matter	%	88	88	88
Crude protein	%	16	20	24
NDICP	%	2.5	2.5	2.5
ADICP	%	1.5	1.5	1.5
Ether Extracts	%	2.0	2.0	2.0
NDF	%	44	40	36
ADF	%	34	30	26
Lignin	%	8.8	7.0	5.4
Ash	%	10	10	10
RUP	% CP	0.20	0.175	0.15
RUPd	% RUP	70	70	70
NDFe	% NDF	92	92	92

Alfalfa – Calculated Values

Nutrients	Units	Low	Reference	High
TDN from NFC	%	29.9	29.9	29.9
TDN from NDF	%	15.8	15.4	14.8
TDN from CP	%	14.3	18.3	22.3
TDN from EE	%	2.3	2.3	2.3
TDN at 3X	%	50.7	54.0	57.1
NE_L at 3X	Mcal/cwt	51.5	57.6	63.5
MP at 3X	%	7.02	7.99	8.95

Grass - Calculated Values

Nutrients	Units	Low	Reference	High
TDN from NFC	%	18.1	22.1	26.0
TDN from NDF	%	30.8	28.3	25.9
TDN from CP	%	6.9	10.9	14.8
TDN from EE	%	3.4	3.4	3.4
TDN at 3X	%	47.9	52.9	57.9
NE_L at 3X	Mcal/cwt	44.6	53.0	61.5
MP at 3X	%	5.55	6.73	7.94
NE_L at 3X	Mcal/cwt	51.5	57.6	63.5
MP at 3X	%	7.02	7.99	8.95

Ref. Legume vs. High grass

	Reference Legume	High Grass	Grass/legume
NE_L (Mcal/cwt)	57.6	61.5	1.07
MP (% DM)	7.99	7.94	1.00
NDF	40.0	52.0	1.30
NDFd	50.5	59.4	1.18
dNDF	20.2	30.9	1.53
ndNDF	19.8	21.1	1.07

Legume vs. grass

	Reference Legume	Reference Grass	Grass/legume
NDF	40.0	60.0	1.5
NDFd	50.5	57.2	1.1
dNDF	20.2	34.3	1.7
ndNDF	19.8	25.7	1.3

Alfalfa and grass
Units per Ton

Nutrients	Units	Low	Alfalfa Ref	High	Low	Grass Ref	High
NE$_L$	Mcal	907	1014	1118	786	933	1083
MP	Lbs	124	141	158	98	119	140
eNDF	Lbs	712	648	583	1173	1035	897
neNDF	Lbs	62	56	51	24	21	18

$ Value – Reference Alfalfa

	Comp.	DM %	Mcal or Lbs/ton	Unit Prices ¢/unit	Value $/ton
NE$_L$ (Mcal)	57.6	88	1014.2	15.2	154.15
MP (%)	7.99	88	140.7	31.1	43.76
eNDF (%)	36.8	88	647.7	4.7	30.44
neNDF %)	3.2	88	56.3	-8.5	-4.79
TOTAL					**223.56**

$$1014.2 \times 15.2 \div 100 = 154.15$$

Not quite done...

- Two TMRs with same nutrient concentrations
  - TMR A – High quality alfalfa
  - TMR B – Low quality alfalfa

- Cow fed TMR A produce a bit more milk because the forage is "less filling".

Delta milk = 0.24 x (44 - NDF)
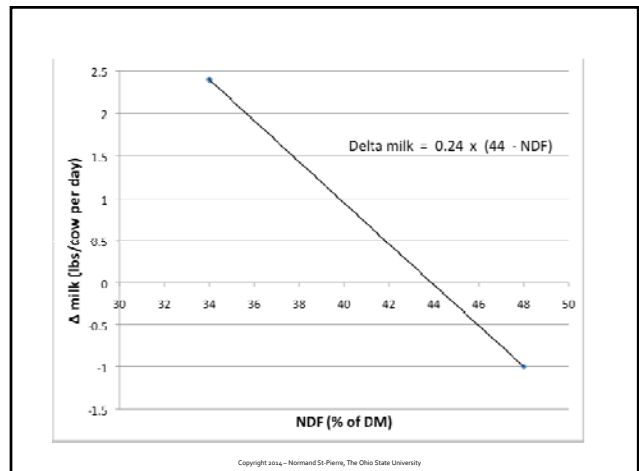
Quality adjustments
$/ton of hay per 1% deviation from reference[1]

Forage	+/- $1/cwt	$10/cwt	Milk Price $15/cwt	$20/cwt
Alfalfa	0.24	2.40	3.60	4.80
Grass	0.26	2.64	3.96	5.28

[1] References are:
Alfalfa: 44% NDF
Grass: 53% NDF

Examples

- Alfalfa at 39% NDF, milk at $20/cwt
- 44 - 39 = 5 units of deviation
- 5 units x $4.80/unit = + $24/ton

- Alfalfa at 35% NDF, milk at $18/cwt
- 44 - 35 = 9 units of deviation
- $18/cwt x $0.24/unit = $4.32/unit dev.
- 9 units x $4.32/unit = + $38.88/ton

Correction factor

- Depends on % NDF
  - Less than 44% (alfalfa) ➔ ⬆ value of forage
  - More than 44% (alfalfa) ➔ ⬇ value of forage

- Depends on milk price
  - Milk price high ➔ Large adjustment
  - Milk price low ➔ Small adjustment

Value of hay: 2010 - 2013

Feeds	Average	S.D.	Min.	Max.
Alfalfa - Reference	241	37	193	302
- Low	204	36	162	265
- High	277	38	223	338
Grass - Reference	191	46	145	271
- Low	129	47	77	210
- High	253	47	197	332

~ $ 50

Value of hay: 2010 - 2013

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Value of hay: 2010 - 2013

Feeds	Average	S.D.	Min.	Max.
Alfalfa - Reference	241	37	193	302
~ $9 / 1% NDF	204	36	162	265
- High	277	38	223	338
Grass - Reference	191	46	145	271
~ $8 / 1% NDF	129	47	77	210
- High	253	47	197	332

Value of hay: 2010 - 2013
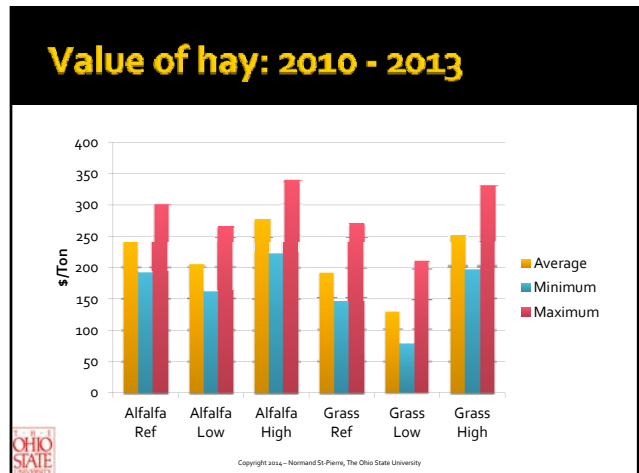
Contribution of Components to Value

| | Alfalfa | | Grass | |
	$/ton	% of total	$/ton	% of total
NE$_L$	155	64	142	74
MP	44	18	37	19
eNDF	30	13	49	25
neNDF	-5	-2	-2	-1
Milk	17	7	-33	-17
TOTAL	241	100	192	100

NDF Net:	18%	7%

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Marginal change in value

Entries	Alfalfa SD units	Grass SD units	Change in value ($/ton) Alfalfa	Grass
Dry matter	1.4	1.1	3.83	2.41
Crude protein	2.6	3.1	5.52	5.81
NDICP	0.9	1.3	1.15	1.48
ADICP	0.4	0.5	-2.11	-2.57
Ether extracts	0.5	0.7	2.36	3.31
NDF	6.3	6.2	-31.09	-31.59
Lignin	0.9	1.1	-4.00	-5.91
Ash	1.2	1.5	-4.41	-5.50
RUP	3.0	3.0	2.30	1.28
RUPd	5.0	5.0	1.37	1.00
NDFe	1.0	1.0	0.93	1.40

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NDFe	1.0	1.0	0.93	1.40

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What About Corn Silage?

- Free "markets" should determine the price
- However:
  - Markets are thin (not a lot of silage sold)
  - Inefficient (not a lot of information)
  - Not really "free"
    - A buyer only has a few potential sellers
    - A seller only has a few potential buyers

Corn Grower's Point of View

Corn Grower

- I have access to some acreage
- I grow X acres of corn
- I can harvest corn for silage or for grain
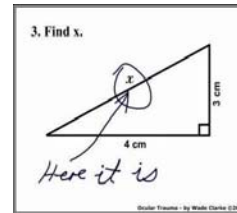- At what silage price am I indifferent?

Corn Grower

- 1 bu of corn = 56 x 88% DM = 49.3 lbs DM/bu
- If at maturity 50% of the plant DM is in the grain:
  - 49.3 ÷ 0.5 = 98.6 lb DM silage in a bu of corn
- 1 ton of corn silage = 2000 x 35% DM
  = 700 lbs DM/ton
- 1 ton of corn silage = 700 ÷ 98.6
  = 7 bushels of corn

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                    = 7 bushels of corn

Corn Silage ($/ton) = Corn grain ($/bu) × 7

Complicated Mathematics…

Honor Student at
University of Michigan

Corn Grower   Assumptions

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Multiplicative Factor

DM from kernels (%)	Factor
40	5.7
45	6.4
50	7.1
55	7.8
60	8.5

Corn Grower — Assumptions

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  - = 7 bushels of corn

DM Correction Factor

Dry Matter (%)	Z
25	0.714
30	0.857
35	1.00
40	1.14
45	1.29

Price at x% DM = Price at 35% DM x Z

Corn Grower

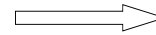Corn Silage ($/ton) = Corn grain ($/bu) × 7

Where?

When?

Corn Grower

Corn Silage ($/ton) = Corn grain ($/bu) × 7

- Standing in the field

Corn Grower

Corn Silage ($/ton) = Corn grain ($/bu) × 7

- Standing in the field
- Need to convert price "standing in the field" to price "when hitting the mixer wagon.

Price Adjustments

Item	Price/ton
Corn price ($/bu) * 7	$4/bu x 7 = $28.00
+ Harvesting costs ($/ton)	$5.00
+ Transportation costs ($/ton)	$3.00
+ Packing costs ($/ton)	$2.00
+ Inoculant & Cover ($/ton)	$2.00
= Subtotal	$40.00
+ Fermentation losses (10%)	$4.00
= Net cost to dairy producer	$44.00

Price Adjustments

Item	Price/ton
Corn price What the Corn Grower Receives	= $28.00
+ Harvesting costs ($/ton)	$5.00
+ Transportation costs ($/ton)	$3.00
+ Packing costs ($/ton)	$2.00
+ Inoculant & Cover ($/ton)	$2.00
= Subtotal	$40.00
+ Fermentation losses (10%)	$4.00
= Net cost What the dairy producer truly pays	$44.00

Corn Grower

Corn Silage ($/ton) = Corn grain ($/bu) x 7

Where?

When?

When?

- Price of corn when the decision is made to harvest the crop as silage
  - Can be in the spring if there is a binding contract between the grower and the dairyman.
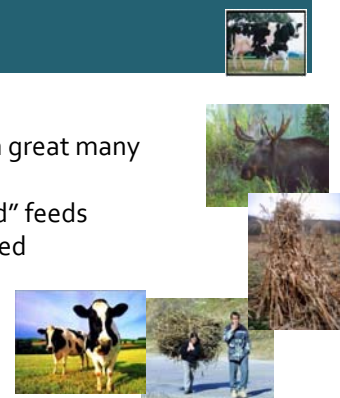 - In Aug.-Sept. if non-binding contract (I grow it for myself).

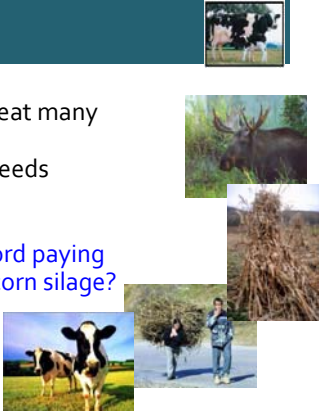## Dairyman's Point of View

Dairyman

- I have cows
- I have access to a great many feeds
- Cows don't "need" feeds
          Cows need
  NUTRIENTS

Dairyman

- I have cows
- I have access to a great many feeds
- Cows don't "need" feeds
        Cows need NUTRIENTS
- How much can I afford paying for the nutrients in corn silage?

Pricing Nutrients

Sesame 3.0

www.sesamesoft.com

Comparing the 2 methods

	Low	High	Median
Corn Price ($/bu)	$ 3.40	$ 6.00	$ 4.00
Value of Corn Silage ($/ton)			
Method 1	$ 37.18	$59.50	$44.00
Method 2	$ 47.40	$ 75.58	$ 58.08
Ratio of Method 2 to 1	1.27	1.27	1.32

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Floor price for Grower

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Floor price for Grower

Ceiling price for Dairyman

$$Floor\ (\$/ton):\ \ Corn\ (\$/bu) \times 7\ +\ 15$$

$$Ceiling\ (\$/ton):\ \ Floor \times 1.3$$

Summary

- Economic values of forages are driven by their nutritional contents.
- Economically important nutrients are:
  - NE_L, RDP, RUP, eNDF, neNDF
  - NE, MP, eNDF, neNDF
- Values of nutrients vary a LOT across time and location.

Summary

- Forage values must be corrected for quality effect on milk production
  - Correction is dependent on NDF and milk price

Summary

- Average value of alfalfa is fractionated as:
  - 64% energy
  - 18% protein
  - 18% fiber
- Average value of grass is fractionated as:
  - 74% energy
  - 19% protein
  - 7% fiber

NOT using TDN
NOT estimated by regression

Summary

- Economically important chemical assays:
  - Dry matter
  - Crude protein
  - Neutral detergent fiber
  - Lignin
  - Ash

## Summary: Corn Silage

- Corn grain price can be used to establish a floor price for the corn grower.
- The value of the nutrients can be used to establish a ceiling price for the dairyman.
  - About 1.3 × (floor price + harvesting & storage costs)
- Ultimately, the price is determined by how bad the grower wants to sell vs. how bad the dairyman wants to buy.

Thank you

"Proper" Correction for silage DM

GUMBY'S FLOSSING MISHAP
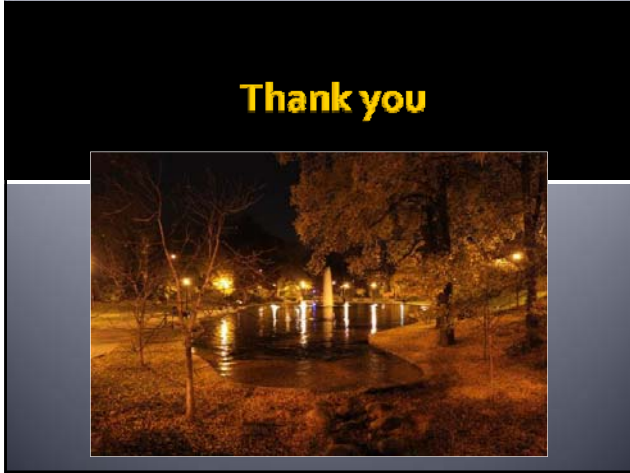
The hardness of the butter is proportional to the softness of the bread.

To steal ideas from one person is plagiarism; to steal from many is research.

The problem with the gene pool is that there is no lifeguard.

If you think nobody cares about you, try missing a couple of payments.

Bills travel through the mail at twice the speed of checks.

42.7 percent of all statistics are made up on the spot.