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Troubleshooting Forage Feeding Problems . . .

Bill Mahanna, Ph.D., P.A.S., Dipl. ACAN
Pioneer Hi-Bred International, Inc.

Troubleshooting Forage Feeding Problems.....

Bill Mahanna, Ph.D., P.A.S., Dipl. ACAN
General Manager - Nutritional Sciences
Pioneer Hi-Bred International, Inc.
7100 NW 62nd Avenue
Johnston, IA 50131
Voice: 800-247-6803 ext 6673
Fax: 515-334-6665
Cell: 515-229-3409
Internet: mahannaw@phibred.com

Major Challenges Facing Forage Producers....

- **Selection of the Best Genetics**
- **Conservation of Dry Matter**
  - to preserve valuable sugars/starch
- **Maintenance of Intake Potential**
  - palatability
  - consistency
- **Evaluation of Nutritional Value and Proper Ration Complementation**
  - understanding kinetics of forage digestion, not just chemical entities (NDF, starch)

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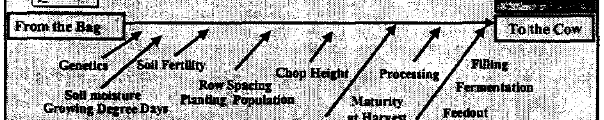
St. Paul, MN May 22-24, 2001
Bill Mahanna, Ph.D., PAS, Dipl. ACAN
Pioneer Hi-Bred International, Inc.

Lets start with the King of Forages...Corn Silage



All these quality/yield drivers in the Corn Silage "***Seed to Feed***" continuum...

A way of thinking about the corn plant that may help explain some of the laboratory and feeding problems associated with corn silage.....

- **Grain is much more energy-dense than stover making the Grain to Stover (G:S) ratio the biggest driver of corn silage energy.**
- **While stover (cell wall) digestibility can "handcuff" a nutritionist, the fact is that there is little genetic difference between hybrids for dNDF. The huge range in dNDF is more of a result of the influence of environmental factors such as growing conditions and harvest timing.**

Research Proves Nutritional Variation Does Exist

But just how big is that nutritional variation?

Michigan 2-year Study (1988/89)
(Wisconsin Forage Council Meeting Proceedings, 1/28-9/92, pg 111-115)

CP	1-2% units (7.9-9.2%)
Stover Digestibilities	5% units (41-46%(110-120CRM)/46-51%(100-110CRM)
W.P. Digestibilities	4% units (77-81%)

This means that yield and grain content are still big drivers of total value ......

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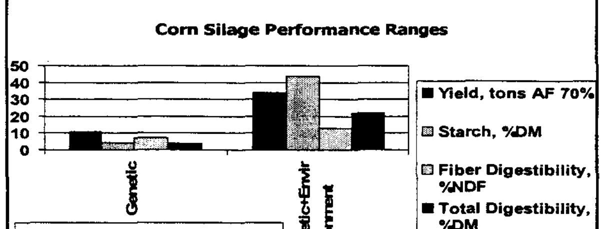
Genetic and Environment *Contribute to Corn Silage Performance*



Don't confuse (G) Differences with (G+E) Ranges that can be caused by variation in weather, soil types, harvest, ensiling or laboratory techniques.

215 side-by-side samples from five distinct silage genotypes, pre-ensiled from 1999 plots in the Northeast U.S. as data set for Dr. Greg Roth (Penn State) sabbatical at Miner Institute

Not Everybody Has the Same Needs.....

Try not to fall into the trap of:
"one silage hybrid is good for all silage growers"

To best serve silage customers needs, we must understand:

- **their unique agronomic challenges,**
- **their ration constituents (sources and cost of both starch and fiber ingredients),**
- **expected ration inclusion rates**
- **harvest window (use of custom cutter)**
- **the nutritional demands of the group of animals that will be fed the silage**

And then recommend hybrids accordingly.....

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Silage Hybrid Selection Priorities

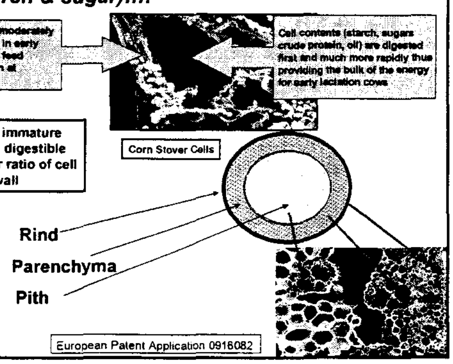
- Agronomics
  - Disease Resistance
  - Early Growth
- Yield - 2/3 of selection value
  - 7-10-ton variation, measurable
  - 2 ton yield drag means ~10% more acres to fill same pit
- Digestibility- 1/3 of selection value
  - 2/3 of Digestibility - FAST (RAE) pool (Starch and Sugar)
  - 1/3 of Digestibility - Fiber Digestibility - low variability, difficult to measure accurately

Hierarchy of Nutrient Availability: The Role of Fiber vs Cell Contents (starch & sugar)....

Cell Walls are only moderately digested especially in early lactation cows with feed passing from rumen at 5-6%/hour.

Cell contents (starch, sugars crude protein, oil) are digested first and much more rapidly thus providing the bulk of the energy for early lactation cows

The main reason immature forages are more digestible is due to a higher ratio of cell contents to cell wall



European Patent Application 0916082

Findings of the Wisconsin Corn Silage Consortium

Summary

- **Narrow range in quality**
- **Quality values are repeatable**
- **Little relationship between agronomics and quality**
  - stalk and root lodging not related to quality
- **Stover composition strongly influenced by both maturity and grain fill**
  - For each 10% increase in grain yield expect a 1% decrease in NDF and .5% increase in total whole plant digestibility.
  - As grain fill reduced, stover cell wall (NDF) digestibility reduced but overall stover IVTD (cell wall and cell contents) increased due to non-translocated NSC's.
- **Genetic potential for quality improvement**

U of WI Recommendations for Corn Silage Selection Targets

- **#1 Grain Yield**
- **#2 Whole Plant DM Yield**
- **#3 Standability**
  - » for grain yield options
- **#4 Relative Maturity**
- **#5 Quality**

Source: JG Coors - 9/19/95 Review of the 4-year UW-Corn Silage Consortium (1991-94), Madison, WI. Reference: http://corn.agronomy.wisc.edu/
Note: comments made even before the onset of silage processing

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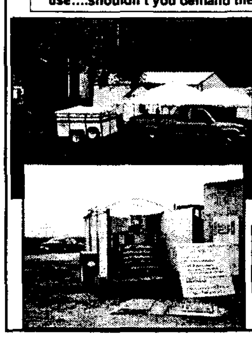
How Much Silage Plot Data is Enough?

You expect a certain level of confidence (reliability) in the data on the bulls you use....shouldn't you demand the same for the silage hybrids you plant?



	Units Increase LSD <0.05	Side-by-Side Locations Needed
Wet Tons/acre	2	18
ADF	2	32
NDF	2	37
in-vitro digestibility	2	22
Grain yield (bu)	5	30-40

Partner with a company dedicated enough to the silage market to provide a minimum of 20 paired comparison locations over multiple to help you make valid silage hybrid decisions!

Silage Performance - Single Plots

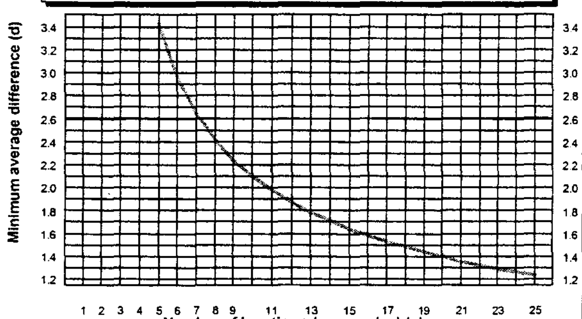
Cooperator: McMillen; Edward
Pioneer Sales Rep: Bower; Alan M.
State, County: PA-Perry

Planted:05/12/1999 **Harvested: 09/10/1999**

Brand	Product	YLD	DM	Starch	Dig. Fiber	WP Dig.	NE-L	Milk/A
Pioneer	33Y18	30.0	32	23	47	70	0.69	18988
Mycogen	7250	20.6	33	28	45	72	0.75	15053
Pioneer	33J56	24.7	32	25	47	71	0.76	18101
NK	MAX496	21.8	32	27	47	72	0.74	15572

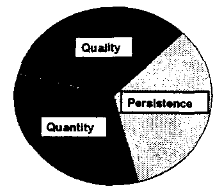
One plot: need 8-ton yield and 14-point digestibility differences to say there is a genetic difference!

Minimum average difference (d) in traits which can be detected with a given number of locations or samples (n)



Source: D.A. Sapienza, Ph.D. August 2000

Now on to the Queen of Forages....



Alfalfa Management
"Trade Offs"

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Alfalfa Harvest Management...

Cut on Quality

Not only on Calendar

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Alfalfa Harvest Management...

Over time, RFV falls into the optimal range.

It does not rise into it.

RFV = % DDM x % DMI / 1.29

100 RFV = Full Bloom Alfalfa

%DDM = 88.9 - (0.779 x %ADF)

%DMI = 120/%NDF

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Field-Based Methods To Predict Alfalfa Maturity...

- Plant Growth Stages
- PEAQ
- GDD
- Scissor's Cut

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Predicting Alfalfa Maturity........

- **Utilizing Results**
  - **Set Harvest Goals**
    - 150 RFV for milk cows
    - 120-130 RFV for other cattle
  - **Adjust for Field Loss**
    - expect 10% loss
    - cut at 165-170 RFV
    - harvested forage will be 150 RFV
  - **Adjust for Harvest Time**
    - 1 day = 3-4 RFV units
  - **Adjust for Field Conditions**
    - soil type
    - slope of soil

Not uncommom to loose 20 RFV during entire cutting and curing process.

Remember that field-based quality methods are on fresh alfalfa...fiber levels will be higher in fermented silage... sugars will be lowered and fiber concentrated by 5-35% depending upon the quality of the fermentation.

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Alfalfa Quality Summary...

- Weather, cutting schedule and post harvest handling are more critical to alfalfa quality than variety selection.
- Variety differences exist in alfalfa for forage quality, but all varieties can produce optimal quality. Differences are consistent across cuttings and locations.
- Varieties decline in quality at approximately the same rate.
- The differences among existing varieties are generally small (8-12 RFV points). This represents a 1-4 day time spread.
- Varietal differences (early cut vs late cut) to optimum RFV(i.e. 140-160) may be used on the farm to extend the harvest window.
- Focus on yield and disease/pest package....be aware of limitations of data used to make decisions

Six Goals for Quality, Stable Silage

1 - **Achieve a low pH**
2 - **Ensure proper spectrum of fermentation acids**
3 - **Conserve water soluble carbohydrates**
4 - **Minimize protein degradation**
5 - **Control front-end fermentation temperatures**
6 - **Minimize aerobic activity upon feed-out**

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Typical Silage Service Calls.....

- Hot Silage
- Moldy silage
- Excessive surface spoilage
- Seepage (excess effluent)
- Unloading difficulties
- Poor bunklife
- Poor intakes/production

Side dishes and desert won't cure the problem if the main course is bad!

Depending Upon Silage Quality...You Can Feed 40-60% Forage on a DM basis. In times of high energy costs or low milk prices, this may be the best way to "cheapen rations"

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What is usually the problem.... 95% of the time

- Improper harvest moisture
  - Don't rely on kernel milkline for determining CS moistures
  - Err on the dry side with alfalfa and wet side with CS
- Improper compaction
  - Determine lbs/cu ft and develop benchmarks
- Improper face management
  - Monitor temperatures & compaction and reward excellence
- Improper feed mixing and delivery
  - Sorting and acidosis
  - Screen rations at delivery and several hours later
- Poor quality due to maturity at harvest
  - Don't rely on calendar, understand plant physiology
- Extremely high quality and not adjusting for energy in ration
  - Monitor starch, degree of kernel damage and dNDF

What is not the problem 95% of the time: Small deviations in recommended VFA profiles!!

Changes in Corn Forage Quality and DM Losses

	Corn Forage[1] Fresh	Corn Forage[1] Ensiled
DM, %	34.8 (5.7)	33.1 (6.8)
CP, % DM	7.9 (1.1)	8.1 (1.1)
SP, % CP	27.2 (6.4)	47.1 (11.8)
ADF, % DM	22.9 (4.2)	24.9 (4.3)
NDF, % DM	42.5 (6.5)	46.0 (6.3)
NSC, % DM	41.6 (6.9)	37.4 (6.5)
NE_L, Mcal/lb	0.76 (0.03)	0.73 (0.03)
DM loss, % per month	---	2.2 (2.3)[2]
Forage Value per ton, $[3]	30.20	29.44

Silage comes out wetter than going in

Fiber is concentrated

WSC/starch is lost

DM (shrink) losses need to be valued at the replacement cost of NSC/starch, not the field value of the crop.

1/ NeDHIA, 1995 2/ Holter, 1983 3/ Menzi and Aldrich, 1984

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Silage "Food Line"......

Fresh Forage → **Silage Microflora** → **Rumen Microflora**

↑ DIP
↓ UIP (Lys,Try)
↓ Sol CHO
↑ Starch Avail
↑ FA (↓ NFC)

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Summary of Silage Laws......

- The better the fermentation the more difficult is aerobic stability (bunklife)
- Wetter silages need a lower pH for stability than wilted silages
- The faster the fermentation the less proteolysis
- Stressed crops/high manure application/poor management predisposed silage problems
- ↑ buffering capacity/ ↓ WSC crops (alfalfa) ferment more difficulty than ↓ BC/ ↑ WSC crop (corn)
- Grass/legumes generally more aerobically stable than corn or cereal silages

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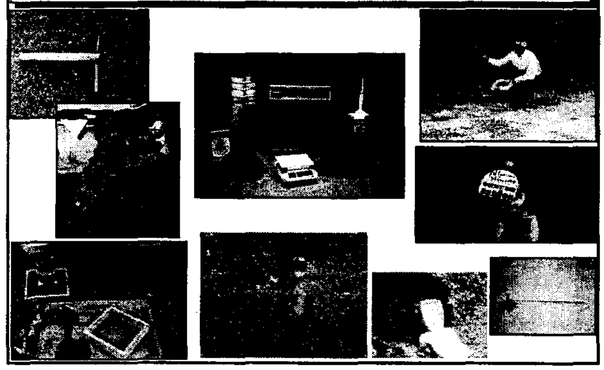
Test Equipment For On-Site Analysis of Ensiled Forages and Grains



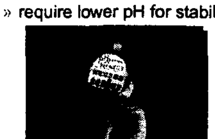
Laboratory Tests for Problem Silages.....

- Nutritional Analysis - wet chemistry preferred for "atypical" samples ($50) OK to freeze samples.
  - » Moisture
  - » Crude Protein
  - » ADIN – bound protein
  - » Starch
  - » ADF, NDF
  - » NE-L, TDN, RFV
- Digestion Kinetics (~$21) Dairy One Forage Lab (formerly the NYDHIA lab), Ithaca, NY (607-257-1272) or Dairyland Labs, Arcadia, WI (608-323-2123)
  - » 30 hr IVTD, 30 hr dNDF, OSU NE-L
- Volatile Fatty Acids, Ethanol, Ammonia Nitrogen, pH ($15) Cumberland Valley Lab, Hagerstown, MD (800-282-7522), Dairy One, Ithaca or Dairyland Labs, WI
  - » Lactic, acetic, propionic, iso-butyric, butyric acids, total VFA, Lactic:Total
  - » samples should be frozen to reduce volatilization.
- Water Soluble Carbohydrates, Pepsin Digestible Protein (bound protein in HMC). OK to freeze. Midwest Laboratories Omaha, NE (402-334-7770)
- Microbial Analysis. JKM Mycologist (James Maryanski) Mount Prospect, IL (847-390-0810)
  - » Yeast counts and ID
  - » Mold counts and ID
  - » Bacteria (Bacillus)
  - » Do not freeze samples, chilled only.
- Mycotoxin Screen ($60,GC/HPLC). NDSU Vet Diagnostic Lab (701-231-8307)
  - » Elisa (like Neogen, Bio-Pharm) only for grain
  - » GC & HPLC for forages
  - » Samples may be frozen
- **Sampling Procedures:**
  - – Observe distribution, compaction and structural problems
  - – Sub-sample from 6 locations: surface & 1-2' deep...good vs problem areas. "Scoop" sample, do not "grab".
  - – If microbial analysis use insulated cooler, blue ice and express mail service early in the week

Stable Silage Goals: Low pH

- pH = 4.0 - 4.5 for legume silages
- pH = 3.8 - 4.2 for corn, cereals and grass silages
- pH range lower for wetter silages
  - » require longer fermentation
  - » require more sugars
  - » require lower pH for stability

But remember...terminal pH tells you little about how much time it took (efficiency) to arrive at that pH.



Crop Buffering Capacity

• Corn Forage	200 MEQ
• Orchardgrass	300 MEQ
• Perennial Ryegrass	350 MEQ
• Alfalfa	480 MEQ
• Red Clover	560 MEQ

*MEQ = milliequivalents of NaOH required to increase the pH of 1 gm. DM forage from 4-6

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Stable Silage Goals: Proper Fermentation Acids

Substrate		End Products
$C_6H_{12}O_6$ (glu&fru)	→	$2\ C_3H_6O_3$ (lactic acid)
$C_5H_{10}O_5$ (xyl,arabin)	→	$C_3H_6O_3 + C_2H_4O_2$ (lactic acid) (acetic acid)
$C_6H_{12}O_6$ (glu,fru)	→	$C_3H_6O_3 + C_2H_5OH + CO_2$ (lactic acid) (ethanol)
$3\ C_6H_{12}O_6$ (glu,fru)	→	$C_3H_6O_3 + C_2H_4O_2 + 2\ C_6H_{14}O_6 + CO_2$ (lactic acid) (acetic acid) (mannitol)

Blue = homofermentative parthways. Red = heterofermentative pathways. Lactic acid is 10x stronger acid than acetic acid. Ethanol doesn't drop pH. CO_2 causes DM loss.

Potential Negatives: the better the fermentation, the more potential for aerobic stability (bunklife) problems due to more retained sugars.

Volatile Fatty Acid	Ideal Fermentation (DM basis)	Average Fermentation (DM basis)
Lactic Acid	>3.0% alfalfa >4.0% corn silage	2-3%
Acetic Acid	<2.0%	2-3%
Butyric Acid	0.0%	<0.1%

These are not absolutes!

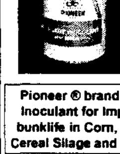
Acetate can be high in high yeast silage because convert lactate to acetate + ethanol. Acetate does not have the mold inhibition of lactate. Smell like nail polish remover can be methyl, ethyl or propyl acetate and ethanol from yeast activity.

Ideally like a 3-6:1 ratio between lactic and acetic acid. If too high lactic and too little acetic acid, aerobic stability may be a problem. Total VFA can approach as high as 12% in very wet, grass silages.

Next Generation Aerobic Stability Products....

Potential Negatives: the better the fermentation, the more potential for aerobic stability (bunklife) problems due to more retained sugars.

2 Lactic Acid → Acetic Acid



Volatile Fatty Acid	Ideal Fermentation (DM basis)	Average Fermentation (DM basis)
Lactic Acid	>3.0% alfalfa >4.0% corn silage	2-3%
Acetic Acid	<2.0%	2-3%
Butyric Acid	0.0%	<0.1%
Propionic Acid	<1.0%	<1.0%
Valeric Acid	0.0%	<0.1%

Pioneer ® brand 11A44 Inoculant for improved bunklife in Corn, Grass Cereal Silage and HM corn

Degrading the preformed lactic acid is why it takes 3-4 weeks for maximum aerobic stability benefits to be achieved with L. buchneri.

Ideally like a 3-6:1 ratio between lactic and acetic acid. If too high lactic and too little acetic acid, aerobic stability may be a problem. Total VFA can approach as high as 12% in very wet, grass silages.

VFA's as a Diagnostic Tool:

Our stated goal with inoculation has been about a 3:1 lactic to acetic ratio -- perhaps a better goal (close to the same) is having 75% of all VFA's as lactic acid.

Send samples in 1 quart zip locked bags, squeeze out excess air. Use Post Office Priority Mail. Send on Monday or Tuesday. Ask for pH, DM, VFA's and ethanol in addition to standard analysis. **If possible, take a sample from a good spot as a benchmarking comparison.**

Table 1. Corn silage fermentation measures; sample means and standard deviations.

Corn Silage	pH Units	Lactic Acid %DM	Acetic Acid %DM	Lactic-to-Acetic Acid Ratio
Pioneer-treated (n=14)	3.8 ± 0.3	7.3 ± 2.4	2.7 ± 1.3	2.7
Non-Pioneer (n=31)	3.9 ± 0.5	6.7 ± 2.6	3.0 ± 1.6	2.2

Table 2. Haylage fermentation measures: sample means and standard deviations.

Haylage	pH Units	Lactic Acid %DM	Acetic Acid %DM	Lactic-to-Acetic Acid Ratio
Pioneer-treated (n=16)	4.3 ± 0.3	6.4 ± 2.6	2.4 ± 1.2	2.7
Non-Pioneer (n=25)	4.6 ± 0.5	5.8 ± 3.0	2.3 ± 1.4	2.5

Source: Kurt Ruppel - Eastern Dairy Specialist

Source of VFA Analysis:
Dairyland Labs – Arcadia, WI
Cumberland Valley Labs – Hagerstown, MD
Dairy One Forage Lab – Ithaca, NY

Proper sampling is critical. Best method is to have the farm work silage unloader over the entire exposed face as they would when feeding the silage normally. Take samples of the total mixed silage from a TMR mixer. In tower silos, have the unloader run over as much of the face as possible and take samples at the beginning, middle and end of unloading, if mixing is not possible. The next best method on bunkers is to divide the exposed face into thirds, and take samples from near the top, middle and near the bottom from each section. Mix all nine samples together and sub-sample. Use comparative sampling to make distinctions between good and bad spots in the bunker. DO NOT TAKE SAMPLES FROM JUST OPENED SILOS, OR FROM THE TOP OR END OF UN-OPENED SILOS!!

Corn Silage Fermentation Analysis: *18 month summary*

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DM Range / #	Ammonia	pH	Lactic	Acetic	Propionic	Butyric	Lactic/VFA
<25 / 156	0.77	3.99	5.05	4.89	0.40	0.12	47
26-28 / 205	0.72	3.86	5.42	4.21	0.44	0.07	52
28-30 / 351	0.73	3.86	5.17	3.79	0.40	0.03	54
30-32 / 355	0.63	3.89	5.15	3.19	0.30	0.03	58
32-34 / 313	0.63	3.90	4.73	2.59	0.20	0.02	62
34-36 / 231	0.80	3.86	4.77	2.36	0.17	0.04	64
36-38 / 154	0.71	4.00	4.21	2.02	0.14	0.03	65
38-40 / 112	0.66	4.09	3.56	1.69	0.08	0.02	66
>40 / 198	0.65	4.17	3.20	1.30	0.05	0.03	69

Note that a large percentage of samples in this database are from "problem" silages. Table should be used to note trends, not necessarily for benchmarking.

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Alfalfa Fermentation Analysis: *18 month summary*

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DM Range / #	Ammonia	pH	Lactic	Acetic	Propionic	Butyric	Lactic/VFA
<24 / 48	5.25	5.39	3.04	4.18	0.64	2.10	30
24-28 / 116	4.57	5.17	4.46	4.26	0.61	1.64	40
28-32 / 212	3.33	4.91	4.87	3.80	0.33	0.90	49
32-36 / 191	2.41	4.84	5.26	2.96	0.15	0.34	60
36-40 / 228	1.90	4.70	4.95	2.15	0.09	0.20	67
40-44 / 172	1.63	4.76	4.83	1.62	0.06	0.09	73
44-48 / 99	1.68	4.77	4.42	1.45	0.04	0.05	74
48-52 / 75	1.35	4.90	3.39	1.04	0.03	0.05	75
>52 / 86	1.11	5.50	2.06	0.68	0.04	0.02	73

Note that a large percentage of samples in this database are from "problem" silages. Table should be used to note trends, not necessarily for benchmarking.

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Grass Silage Fermentation Analysis: *18 month summary*

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DM Range / #	Ammonia	pH	Lactic	Acetic	Propionic	Butyric	Lactic/VFA
<24 / 45	4.05	5.03	3.34	4.02	0.72	1.60	34
24-28 / 66	2.44	4.73	4.49	3.15	0.37	0.80	50
28-32 / 100	1.51	4.51	4.57	2.49	0.25	0.40	59
32-36 / 73	1.34	4.57	4.72	2.05	0.13	0.34	64
36-40 / 44	1.37	4.59	4.59	1.59	0.14	0.16	70
40-44 / 34	0.93	4.60	4.09	1.10	0.03	0.05	77
>44 / 33	1.03	4.85	2.90	1.10	0.03	0.02	70

Note that a large percentage of samples in this database are from "problem" silages. Table should be used to note trends, not necessarily for benchmarking.

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HMC Fermentation Analysis: *18 month summary*

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DM Range / #	Ammonia	pH	Lactic	Acetic	Propionic	Butyric	Lactic/VFA
<64 / 11	0.53	3.66	2.35	0.97	0.05	0.02	69
64-68 / 28	0.53	4.04	1.24	0.48	0.02	0.02	70
68-72 / 66	0.48	4.38	0.96	0.33	0.04	0.02	70
72-76 / 83	0.30	4.26	0.84	0.24	0.01	0.00	77
76-80 / 23	0.20	5.07	0.43	0.22	0.01	0.00	65

Note that a large percentage of samples in this database are from "problem" silages. Table should be used to note trends, not necessarily for benchmarking.

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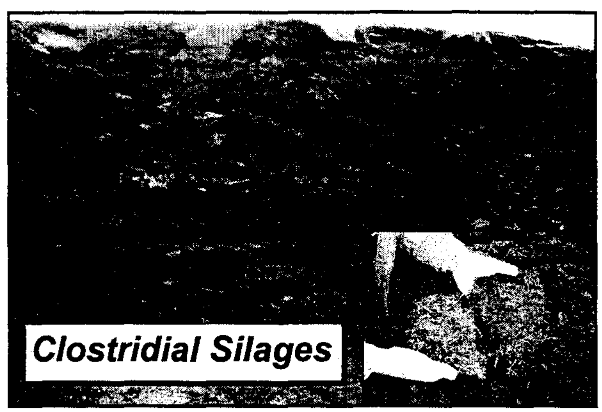

Environmental Conditions That Contribute To Clostridial Activity

- Low dry matter silages
- Low water soluble carbohydrate content
- High silage temperatures
- High buffering capacity of the crop
- Elevated ash content (>5% in CS, >8-10% in alf/grass silage)
- Often high pH pockets result within bagged silage
  - result of aerobic Bacillus and yeast activity
  - Clostridial environment created

Jonsson, 1991

Butyric Acid Dose Calculator

Butyric acid concentrations and pounds of silage DM intake to reach butyric acid doses of:

- 50 gms – reduced DM intake and risk of ketosis to early lactation cows
- 150 gms – high risk of ketosis in early lactation cows
- 250 gms – high risk of ketosis in all lactating cows

Source: Dairyland Laboratories, Inc. 12/2000 and Gary Oetzel, DVM – Univ of Wisconsin

% DM	Mg/lb	50 gms	150 gms	250 gms
0.25	1.1	44.1	132.2	220.3
0.50	2.3	22.0	66.1	110.1
0.75	3.4	14.7	44.1	73.4
1.00	4.5	11.0	33.0	55.1
1.25	5.7	8.8	26.4	44.1
1.50	6.8	7.3	22.0	36.7
1.75	7.9	6.3	18.9	31.5
2.00	9.1	5.5	16.5	27.5
2.25	10.2	4.9	14.7	24.5
2.50	11.4	4.4	13.2	22.0
2.75	12.5	4.0	12.0	20.0
3.00	13.6	3.7	11.0	18.4
3.25	14.8	3.4	10.2	16.9
3.50	15.9	3.1	9.4	15.7
3.75	17.0	2.9	8.8	14.7
4.00	18.2	2.8	8.3	13.8
4.50	20.4	2.4	7.3	12.2
5.00	22.7	2.2	6.6	11.0
5.50	25.0	2.0	6.0	10.0
6.00	27.2	1.8	5.5	9.2
6.50	29.5	1.7	5.1	8.5
7.00	31.8	1.6	4.7	7.9
8.00	36.3	1.4	4.1	6.9
9.00	40.9	1.2	3.7	6.1

Hemorrhagic Bowel Syndrome

Mark Kirkpatrick DVM

Formerly Iowa State University Field Services
AABP District 6 Director
As of Late August, 2000 with Pharmacia in Idaho

208-922-1942 kirkpatrick@am.pnu.com

Occurrence of Clostridial Fermentation and Finding α - Perfringens Toxin In 1999 Pioneer Technical Service Samples.......

- 9 alfalfa samples
  - 3 Clostridial
  - 3 α - Perfringens
  - 2 positive perfringens negative for Clostridium
- 22 corn silage samples
  - 7 Clostridial
  - 3 α - Perfringens
  - 3 positive perfringens negative for Clostridium

Alpha toxin screening at U. AZ by Dr. Glenn Songer

Hemorrhagic Bowel Syndrome (HBS)

- An emerging syndrome?
- Sporadic in morbidity
- A typical 80 cow dairy may only see 1-2 cases/year
- Some farms will experience an "outbreak form"
- Mortality may approach 85-100% of cases due to peracute nature

Clinical Signs of "HBS"

- Short Incubation Period - producer will see nothing wrong and subsequently find a "Down Cow"
- Severe Sweats indicative of Pain
- Bruxism (teeth grinding)
- Sternal recumbancy
- Extreme depression
- Sunken Eyes

Clinical Signs of "HBS"

- Slight Bloating may be evident
- Pale Mucous Membranes
- **Fluid Slosh in lower right abdomen**
- Distended Gut Loops per Rectal Palpation
- <u>SUDDEN DEATH</u>

What "HBS" is <u>Not</u>

- **Salmonella** - the most common rule-out. Cattle can look bad in a hurry with this type of infection. Blood can be present in the stools (cows dead with HBS before you notice bloody stools).
- **Sudden death** - Peritonitis, Pericarditis, Torsion of the abomasum, Intestinal mesenteric torsion.

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Risk Factors

- ***C. perfringens* type A** has to be present in the ration to cause disease
- Readily fermentable carbohydrate is needed to **support growth** (e.g. lamb, Type D, over-eating disease).
- Partial **slowdown or stoppage** of ingesta flow (acidosis induced?) allowing proliferation of ***C. perfringens.*** *Generation time = 8.8 min.*
- Over-representation of Brown Swiss?

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Field Observations

- Model of Infection

Feed Contamination: Is there a source of *C. perfringens* type A?

Lamb Enterotoxemia: Carbohydrate engorgement or presence in small intestine in high amounts.

Gut Physiology? Rumen Emptying rates, local hypomotility?

Diagnosis

- Appearance of Characteristic Lesions and Clinical Signs
- Isolation of *Clostridium perfringens* type A (produces alpha toxin only, type C & D also produce alpha toxin) from the lesion site in high numbers. Colonization occurs fast!
- Gram stain of Impression Smear yields high numbers of Gram (+) rods
- Isolation from fecal samples is not considered diagnostic

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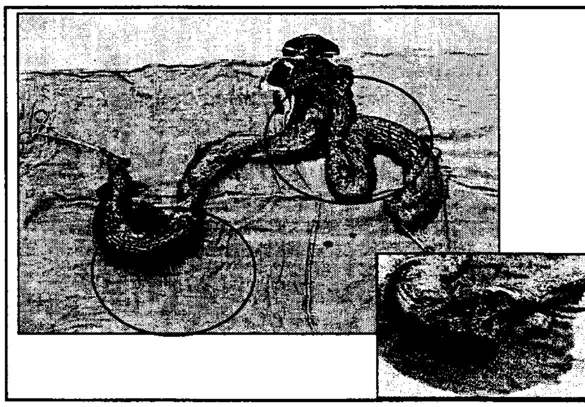
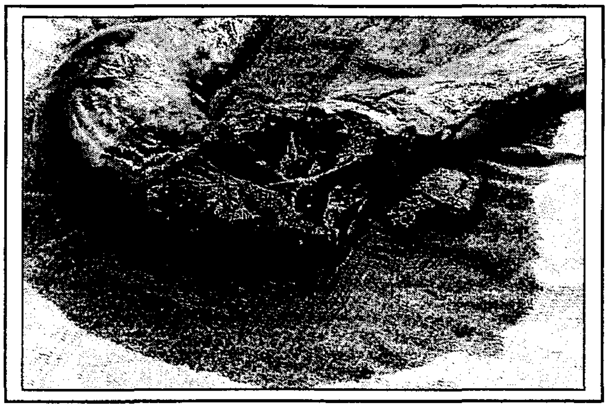
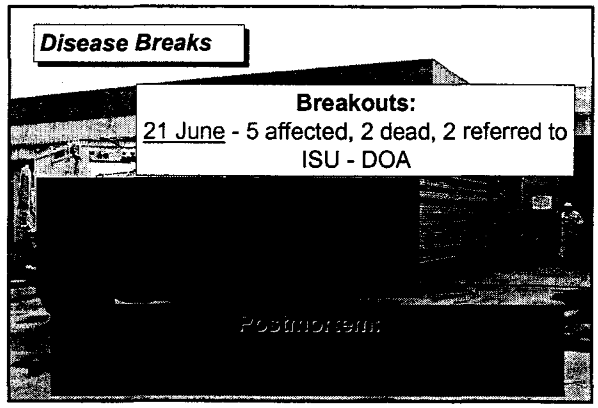
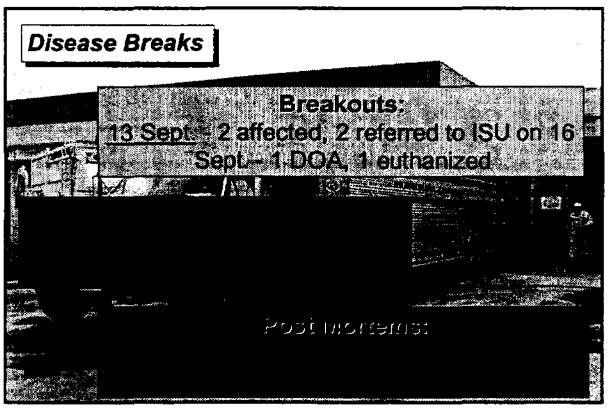
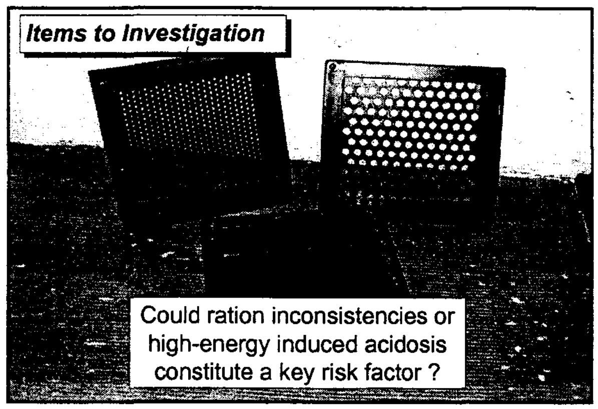
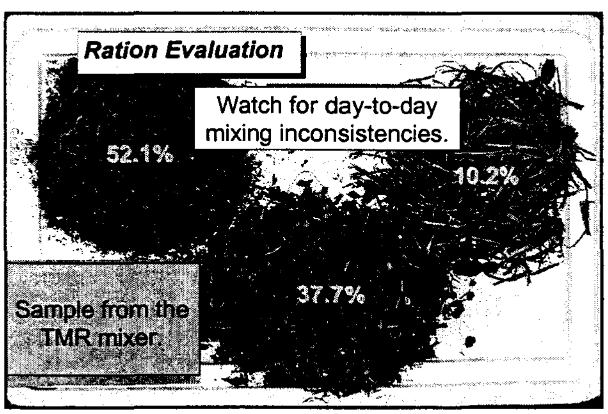


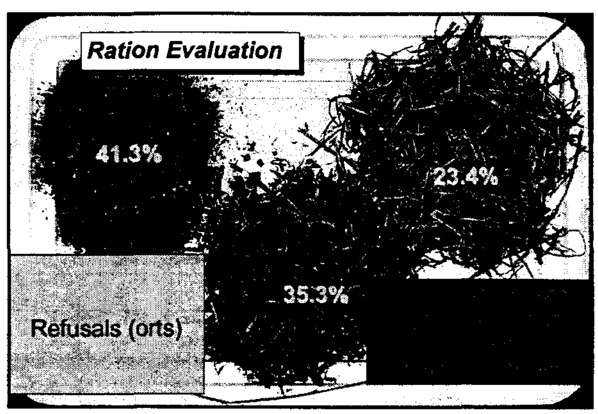



Disease Breaks
Breakouts:
21 June - 5 affected, 2 dead, 2 referred to ISU - DOA
[redacted]


Disease Breaks
Breakouts:
13 Sept - 2 affected, 2 referred to ISU on 16 Sept - 1 DOA, 1 euthanized
[redacted]


Items to Investigation
Could ration inconsistencies or high-energy induced acidosis constitute a key risk factor ?


Ration Evaluation
Watch for day-to-day mixing inconsistencies.
52.1%
10.2%
37.7%
Sample from the TMR mixer


Ration Evaluation
41.3%
23.4%
35.3%
Refusals (orts)
[redacted]

-----Original Message-----
From: Arden nelson [mailto:Synappsrd@AOL.COM]
Sent: Wednesday, October 25, 2000 3:34 PM
To: AABP-L@UMDD.UMD.EDU
Subject: Re: [AABP-L] Sudden deaths

Steve,

My personal theory for acute deaths, due I believe due to intestinal Clostridial bacterial infections is that a period of acidosis predisposes these animals to "overeating disease."

In three herds, adjusting the rations for more health, same milk, and implementing a well timed clostridial vaccination program "stopped" the deaths.

Example herd: 400 cows, drylot dairy in central Texas, lost 20+ fresh (7-14 DIM) cows in summer of 1998. We adjusted the close-up diet and started vaccinating twice prior to calving for 8-way Clostridial. Summer of 1999, he lost 2 cows in the intense heat to the apparent same syndrome: freshen fine, ketosis, down, dead.

Best regards and long time, no see. Arden
Arden J. Nelson, DVM
Diplomate, ABVP-Dairy
Syn-apps rd
5410 Augusta Trail
Fort Collins, CO 80528-9185
v-970-266-8459
f-970-266-8513

-----Original Message-----
From: Mark.A.Kirkpatrick@am.pnu.com
[mailto:Mark.A.Kirkpatrick@am.pnu.com]
Sent: Wednesday, October 25, 2000 9:29 PM

This jejunal hemorrhage syndrome is really interesting, and as one practitioner put it: "It will probably be like a DA where we find a number of different things that predispose cattle to this syndrome."

Arden brings up a good point with respect to ration safety, but the smoking gun of acidosis has been very tough to track and document. In our Iowa State investigation of a herd that was having repeated bouts of this syndrome we were unable to document any fat depressions to speak of on monthly DHIA tests, or through examination of the daily bulktank records. Admittedly the bulk tank has a masking effect on individual or small group fat test levels. But there was no discernable pattern other than a lightening strike effect as to which individuals were affected. Could it be that individual dry matter intakes and individual acidosis may be at play? In this herd we were able to document deaths under two conditions.

1) The presence of haylage in the ration. We found it fairly easy to recover Clostridium perfringens type A in large numbers and pure culture. When removed, the death rate abated. When added we had deaths again in 1.5 weeks from inclusion. Producing haylage in an Ag-Bag (relatively sterile structure) provided 8 months of relief.
2) We also experienced deaths during the feeding of corn silage that had been removed from the bunker silo less than one week after closure. The amount of soluble sugars and starches available to allow Clostridial fermentation must be high. Additionally several herds using the same type of unfermented product in NE Iowa experienced the same rash of breaks.

3) We examined the ration via recalculation to double check the nutritionists figures. ADF and NDF levels where within acceptable limits and NFC was at 35%. Wet chemistry analysis of the ration showed good compliance by the producer in producing a ration that was at the specs of the nutritionist. Physical form was evaluated with 10%, 37% and 52% on the top, middle and bottom pans. **There was sorting going on in the ration**, which would agree with Arden's comment concerning ration safety.
4) Record evaluation showed incidences at all stages of lactation and all levels of production greater than 50 lbs. No deaths were noted in heifers. Death rates to seem to closely follow management level milk. When the producer did things to make this herd produce, his incidence
rate also followed. Bottom line is "What produces Milk?" Carbohydrate in the form of starch, Dry Matter Intakes and in this case haylage. Removal of the haylage and reformulation of the ration dropped the herd 5 lbs. Reintroduction brought the production back.
5) The other potential risk factor is issues of gut motility itself. In this single herd, on one day, 2 cows were affected and both had intussceptions associated with the segmental hemorrhagic lesions.
Constable et al. suggests that Brown Swiss are more prone to intussceptions, but the presence of the lesions asks the question whether motility aberrations are at work. Culture within the hour following death demonstrated pure C perfringens type a in high numbers. Could it be that individual dry matter intakes, acidosis or starch escape from the rumen are assisting in setting up this condition? Another thought: Dr. Alan Harding from Arizona tested cattle for serum calcium levels **following a break of this syndrome and determined that several of the cattle were hypocalcemic. Could this be a factor as well?**
6) Vaccinations: Strictly speaking from the reference point of this single herd we had no remission of deaths with the use of 7-way Clostridial vaccines at an increased frequency. Likewise the use of an autogenous C perfringens type A offered no protection. Protection could be dependent on the presence of the appropriate toxoid. Type A's are a notoriously wide designation, so finding the correct type A may be hit or miss at best. Knowing when the toxin is elaborated in culture represents the next hurdle and compounds the difficulty in vaccine production.

There have been reports by practitioners that feel they are seeing a benefit to administering the Clostridium C&D toxoid on a herd basis. If we are dealing with more than type A this may have some merit. Also on the type A front recent work presented at the AAVLD by University of Pennsylvania researchers suggested that 22 C perfringens isolates out of 47 (from cattle submitted for evaluation of this syndrome) yielded a C perfringens type A that delivered Beta-2 toxin. Beta-2 has a track record in Europe causing hemorrhagic enteritis in other species as well as bovines.

Where to go on this problem? If it is a Clostridium perfringens enteritis then there have to be 3 events. The first is the presence of the organism. The second is the presence of fermentable starches needed to cause growth, sporulation and toxin elaboration. The third is a slowdown or stoppage of ingesta in the gut lumen. Once growth starts the generation time for Clostridium perfringens is 8.8 minutes (Dr. Glenn Songer).
1) Examine the ration for energy levels in terms of calculations and possibly nutrient analysis. Arden's comment concerning ration safety is right on track.
2) Examine the physical form of the diet. Is there significant amounts of sorting going on? Rod Martin's paper in the 4-States Dairy conference was an eye-opener looking at shaking the ration every 6 hours. The cows were certainly creating their own rations. We asked the producer to create a 10-day rolling bank of TMR samples that he had placed in the freezer for any future analysis. This was useful and cheap.
3) Consider testing 10 individuals in the affected pen for serum calcium levels. This is reasonably cheap to do and may provide some insights.
4) Look at the Fat/Protein levels for the overall herd, lactation 1's and the early lactation individuals. Are there any suggestions that the fat levels are dropping? Rumenocentesis would also be called for.
5) Have a look at the individual components that are going into the diet. Pay special attention to items that high in soluble or readily fermentable starches. Throttling back items such as high grain corn silage, high moisture corn or readily fermentable small grains could be advisable.
6) Consider retrieving a sample of gut from affected animals. Tie of the ends of the gut loop, get it cooled down fast and into a diagnostic lab for culture. Clostridium perfringens type A can be too easy to culture, but it would be interesting to get the isolate typed to see of the capabilities for Beta-2 toxin exist.
7) We cultured all fermented feedstuffs and were not able to recover C perfringens from corn silage or high moisture corn. We did have very repeatable luck at isolating it from the alfalfa haylage. If recovery is an easy event, maybe inordinate amounts of Clostridium perfringens may be available to the animal.
8) Good Luck! I'm sorry for the length of this message, but I hope it helps.
Mark Kirkpatrick Pharmacia Dairy Technical Services

3rd Goal for Stable Silage: Conservation of Water Soluble Carbohydrates (WSC)

Crop	Before Ensiling	Post Ensiling
Corn Silage	6-8%	0-2%
Legumes/Grasses	4-6%	0-1%
High Moisture Corn (upper limit with cob)	1-4%	0-1%

- Can limit fermentation
- Problem in mature, wet crops
- No problem at typical alfalfa maturities
- Rarely a problem in corn silage
- HMEC > WSC than HMC
- Organic acid salts in forages resist pH drop

Grasses have about 50%C-5 pentoses (xylose, arabinose) => 1 lactic + 1 acetic (not as good at dropping pH) and higher in C6's in the fall. Legumes high in C6 hexoses (glucose, fructose) in spring =>2 lactic (rapidly drop pH). More C5's in fall thus harder to drop pH in fall cut alfalfa due to more acetic acid production from homofermentative fermentation.

↑ buffering cap/ ↓ WSC crops (alfalfa) ferment > difficult than ↓ BC/ ↑ WSC crop (corn)

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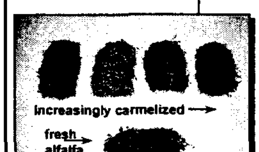
4th Goal for Stable Silage:Protein Conservation



- Heat damage (bound or unavailable protein)
  - ADIN % of total protein
    - >12% indicates excessive heat (>130°F.)
    - use for all forage silages
    - adjust CP in ration
  - Pepsin insoluble % of total protein
    - >20% indicates excessive heat
    - use with high moisture ear or shelled corn

Alfalfa silage studies show lysine, threonine, histidine, arginine, tryptophan are substantially degraded during fermentation. Isoleucine, leucine and valine tend to resist degradation.

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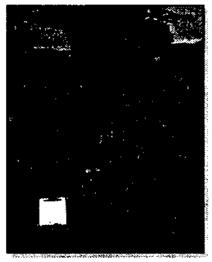
5th Goal for Stable Silage: Temperature

- No greater than 15-20°F above ambient temperature at ensiling
- Large storage structures retain heat longer than smaller storage structures

Grass/legumes generally more aerobically stable than corn or cereal silages due to presence protein degradation byproducts.



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6th Goal for Stable Silage: Microbial/Fungal Activity

Microbial Analysis: Colony-forming units/gram of silage (as fed)

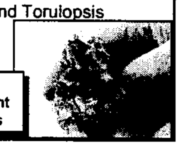
» Total aerobes: <100,000 (10^5) cfu/gram
Example: Bacillus species

» Molds: <100,000 (10^5) cfu/gram of silage (as fed)
Example: Mucor, Monilia, Aspergillus, Fusarium(field) and **Penicillium** (very lactate tolerant)

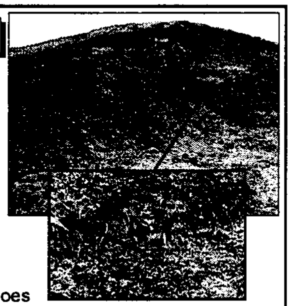
» Yeast: <100,000 (10^5) cfu/gram of silage (as fed)
Acid utilizers: Candida and Hansenula
Less concern: Saccharomyces and Torulopsis

Acetate can be high in high yeast silage because convert lactate to acetate + ethanol. Acetate does not have the mold inhibition of lactate.

Stressed crops/high manure application/poor management predisposes silage problems



Yeast and Mold in Silages



- Result of air penetration into silage mass supplying air to aerobic organisms
- Mold activity is precluded by yeast
  - mold needs pH > 4.5 to sporulate
  - yeast sporulation occurs at low pH
  - utilizes lactic acid as substrate causing pH to rise
- Yeast silage can be hot silage but does not necessarily decrease dry matter intakes

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McDonald, 1981
Woolford, 1984

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Molds Found in Silage

- Primary Molds
  - Mucor (white/gray fluffy) 45%
  - Penicillium (green/blue) 45%
  - Aspirgillus (yellow/green) 7%
  - Monilia (white/yellow) 3%
- Others isolated infrequently
  - Geotrichum
  - Absidia
  - Monascus
  - Chrysonilia

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Pioneer Tech Service
1996

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Mold/Mycotoxins: Most are Field Produced

- Fusarium (in the field) can produces vomitoxin (DON, grains 10ppm), zearalonone (50ppm) and Fumonisin (highly carcinogenic).
  - Unlikely to grow in well managed silos
  - Fusarium can grow/produce toxin at filling
  - most mycotoxin produced in field
- Molds found in silage
  - **Penicillium**
  - Aspergillus - aflatoxin (20ppm corn, .5ppm milk)
  - Monilia
  - Mucor

one kernel in 1 million = 1 ppm
one kernel in 1 billion = 1 ppb

In general, additive value of DON, zearalenone and T-2 not > 6-10 ppm. Fumonisin <100 ppm. FDA aflatoxin < 20ppb in total ration.

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Bt Corn and Mold Activity....

- Second-generation corn borer control should reduce Fusarium ear rot
  - Bt protein must be expressed in kernels late in the season
  - IA State data shows ear rot scores lower in some of the Bt hybrids
- No effect on Gibberella ear rot because it infects ears without insect damage
- Mixed results on reduced stalk rot with Bt corn
  - spores enter via roots as well as corn borer vector
- Initial Pioneer mycotoxin screens show same levels as non-Bt hybrids. ISU studies show significant reduction.

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Mycotoxins In Alfalfa And Grass Forages?

- Mycotoxins do exist in grass pastures
- Detection problems
  - plant material (chlorophyll) debris
  - HPLC vs ELISA diagnostic confusion
  - Dr. Alan Gottlieb Univ of Vt plant pathologist is the leader in this area of mycotoxin research
- Crop residue and soil incorporated into fresh forage by harvest equipment is likely the mode of mycotoxin entry
- Generally, not considered as big a concern as are mycotoxin contamination in corn grain and silage

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Mycotoxin Tests Available

- ELISA (enzyme-linked immune stimulant assay)
  - Fast, in house test
  - Economical ($10-15)
  - General screen designed for grains only
- Chromatography
  - Slower lab test
  - Less economical ($120-150 for entire screen)
  - Types
    - » HPLC (high pressure liquid chromatography)
    - » GC (gas chromatography)
    - » TLC (thin layer chromatography)

Amounts to collect
Large grains = 5 pounds
Cereal grains = 3 pounds
Concentrates = 1-2 pounds
Forages = 2 pounds

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Mycotoxin Analysis Comparisons

	ELISA		Gas Chromatography	
	Vomitoxin (ppm)	Zearalonone (ppm)	Vomitoxin (ppm)	Zearalonone (ppm)
Corn Silage	2.4	2.78	1.3	0
HM Corn	3.1	2.86	0.6	0
Alfalfa Silage	8.8	1.4	0	0

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Mold/Mycotoxin: Solutions

- **Short Term**
  - **Dilute feedstuff (<.5ppm)**
  - **Don't feed to transition cows**
  - **Avoid zearalonone in pregnant cows or heifer rations**
  - **Adsorbants**
    - » Bentonite
    - » Novosil
    - » Zarmin
  - **Modify nutrition**
    - » Inc. Energy 5-10%
    - » Inc. Protein 5-10%
    - » T.M.: (Se, Zn, Cu, Mn)
    - » Vitamins: (A, E, B-1)
  - **Dispose of feedstuff**
- **Long Term**
  - **Modify Crop Management**
    - » Manure mgmt.
    - » Moldboard plowing
    - » Plant/harvest early
    - » Crop rotation
  - **Manage silo filling**
  - **Disease resistant hybrids**
  - **Avoid silage blends with differing maturities**
  - **Eliminate feedstuff**
    - » avoid cobs by feeding HMSC
    - » avoid screenings
    - » clean equipment regularly

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For Corn Silage, Management of Key to Quality.

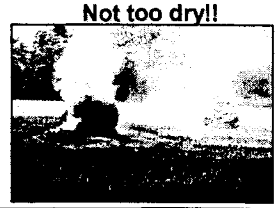
Investment in Premium Seed Genetics can be Completely Negated unless Attention is Paid to Harvest, Storage and Feeding Management!

Harvest At Correct Maturity & Moisture

In other words....

Not too Wet!!

Not too dry!!



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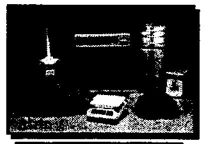
Harvest At Correct Maturity & Moisture

This is 60% of the battle

- **Proper wilt assures concentration of water soluble carbohydrates.**
- **Primary goal - eliminate oxygen by ensiling between 60-70% moisture.**
- **Avoid >70% with legumes, grasses, and cereals.**
  - **Err on the wet side with corn silage and on the dry side with legume silage**
- **Prevent runoff - 80X B.O.D. of raw sewage.**



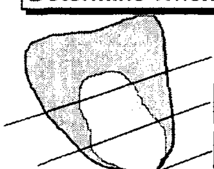
Silage always comes out wetter than they went in....aerobic activity dictates this fact.

Stay Within Harvest Moisture Guidelines

Too Dry = Mold and Yeast Activity
Excessive Nutrient Losses
Forage Inconsistency

Too Wet = Clostridial Activity
Excessive Nutrient Losses
Forage Inconsistency

How Reliable is Kernel Milk Line to Determine When to Chop Corn Silage...

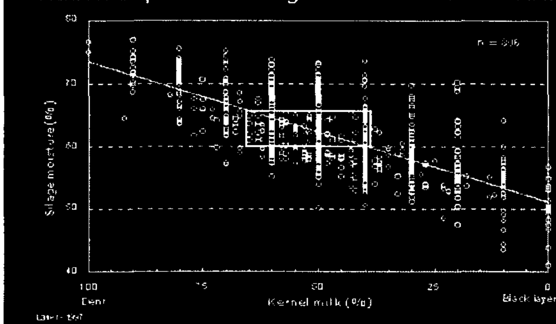


1/3 milk line - Upright silos (approx. 67-72%moisture)

2/3 milk line - Upright silos (approx. 63-68%moisture)

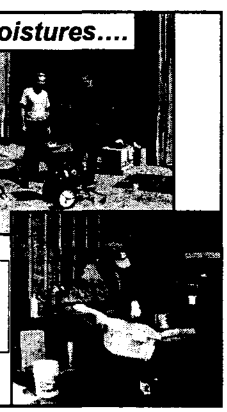
Blacklayer- Sealed structures (approx. 50-60%moisture)

Whole plant corn silage should be harvested between 60-70% whole plant moisture (depending upon storage structure) for maximum yield and optimum fermentation. If a silage moisture tester is unavailable, the "milk line" on the grain kernel can be a helpful indicator to pull the harvest "trigger", but should not be relied upon as a credible method to determine whole plant moisture (especially the further East of Nebraska that you farm).



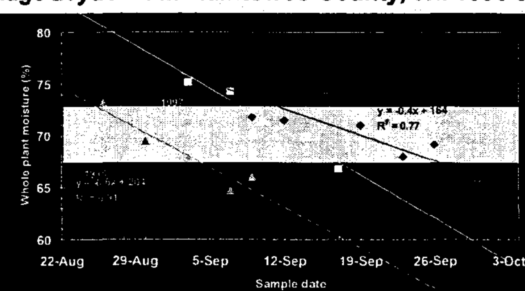
Monitoring Silage Harvest Moistures....

- Correct Moisture
  - Kernel Milk Line not reliable
- Silage Processing
  - not an excuse or reason to harvest too dry
- Sample Fields
  - 10 plants from several locations
  - chop in chipper/shreader
  - cook out sub-sample in Koster...20-30 minutes
- Develop harvest strategy
  - » maturity
  - » planting dates
  - » soil moisture
  - » staygreen and dry down



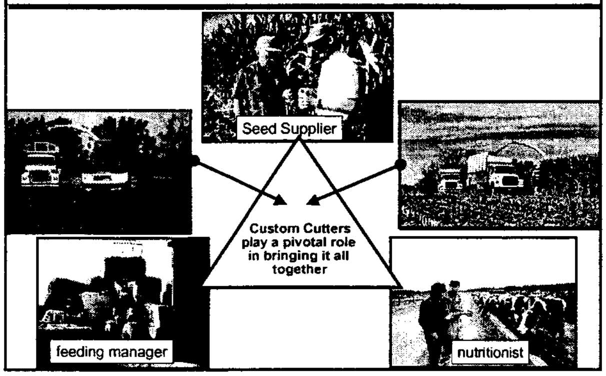
Crop consultant, Curt Weisenbeck and LPS, Randy Frost monitoring silage moistures at Marty Hallock Corn Silage Field Day, Mondovi, WI 8_25_99

Silage Drydown in Manitowoc County, WI. 1996-98

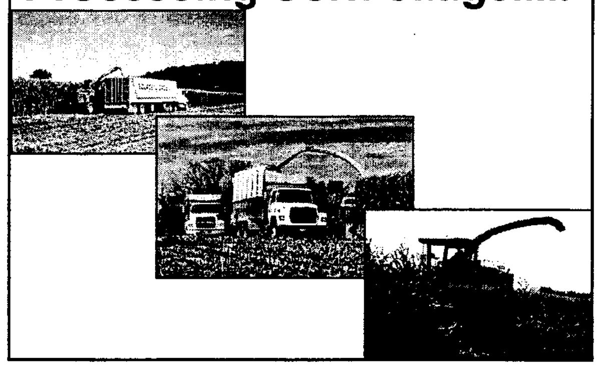


There is tremendous year-to-year variation as to the date when "ideal" chopping moisture is reached.

Producing Quality Silage for a Dairy <u>has</u> to be a Group Effort



Processing Corn Silage.....



Wisconsin Research - Recommendations

(Bal, Jirovec, Shaver, Shinners, and Coors in Hoard's Dairyman 8/10/98)

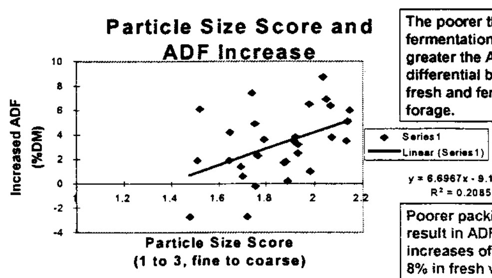
- **We recommend a 3/4 inch theoretical length of cut setting on the harvester when processing corn silage at this time for several reasons.**
  - Feed intake and milk production were excellent for this coarsely chopped and processed silage.
  - Observed trends in particle length and rumen fiber mat formation may prove beneficial in certain feeding situations.
  - Power requirements will be lower and machine capacity greater when TLC is set longer, with or without the crop processor present.
    - » May cause excessive wear on processor and depending upon chopper, reduce roller throughput
  - **We cannot support chopping at lengths greater than 3/4 inch TLC at this time.** We have no evidence that coarser chopping with processing greatly improves how cows respond. We also are concerned about adequate packing of coarsely chopped silage in the silo and the quality of the resulting fermentation. Also, there have been reports from the field about excessive crop processor wear when chopping and processing silages at 1 inch TLC or greater.

Managing Processed Corn Silage: Chop Length

- Processed CS allows for lengthening the chop on CS (3/4") and shortening the chop on alfalfa(1/4-3/8").
- This allows for more effective fiber from corn silage while improving the fermentation potential of haycrop silages.

Feed removal will also be easier with finer chop allowing for better bunker face management.....

Economic Benefits of Finer-Chopped Alfalfa Silage



The poorer the fermentation, the greater the ADF differential between fresh and fermented forage.

Poorer packing can result in ADF increases of up to 6-8% in fresh vs fermented silage.

Source: Ruppel, KA. Cornell Univ MS Thesis, 1993

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Wisconsin Research - Recommendations

(Bal, Jirovec, Shaver, Shinners, and Coors in Hoard's Dairyman 8/10/98)

- Rolls should be set and maintained at less than 1 mm spacing so that kernel and cob breakage is complete.
- UW research:
  - 3mm setting = 3% <u>un</u>damaged kernels
  - 5mm setting = 5% <u>un</u>damaged kernels
  - 1mm setting = virtually all kernels damaged
- However, "damage" is subjective....knicked, halved, comes apart when squeezed, completely crushed??

Experienced users recommend not >3/4" TLC with roller mills set at 2-3mm for immature corn silage (1/3ML, >68% moisture) and at 1mm for silage >3/4 milk line(<68% moisture) maturity.

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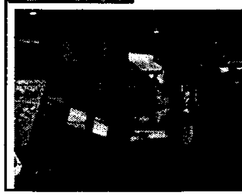
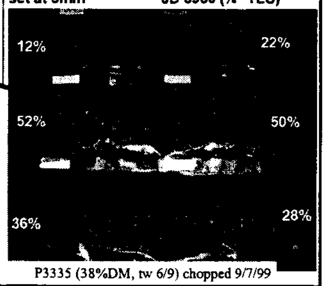
Typical Particle Size Reductions When Processing...

For a given TLC, crop processors reduce particle size by about 15-30% (Schrug&Rodel, 1993; Roberge, 1996). Be careful that bagging, TMR mixing etc does not reduce e-fiber below desired ration (in front of the cow) levels.

Particle distribution is important but don't forget to monitor extent of kernel damage, especially on middle screen

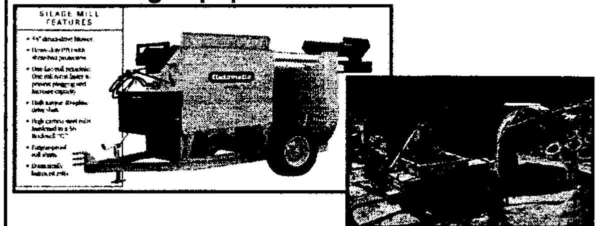


Automatic Roller Mill set at 3mm **JD 3950 (¼" TLC)**



P3335 (38%DM, tw 6/9) chopped 9/7/99

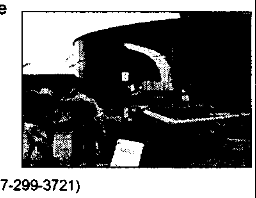
Processing Equipment for Smaller Producers



- Rollers exist to process silage between field and silo or mixer wagon. (i.e. Automatic Equip Mfg. Co., Pender, NE 402-385-3051)
- ATS3600 mill shown above will process 1.5-2.0 tons/minute. Cost is $26,500.
- Prototypes exist without blower for bunker silos or for between bunker and mixer wagon. Approximate cost (w/o blower) is $24,000.
- CS processed post fermentation will have to be chopped finer to limit ensiling losses (i.e. can't chop longer to provide more effective fiber)

Processing Equipment for Smaller Producers

- Gehl introduced several pull type choppers with processors in the Fall 97. Chopper costs $48,000, $12,000 more than the 1265 model w/o the processor. About a 2 hour job to put the processor in place for silage, or remove for haylage. Price includes the 3 row corn head.



- Other sources of roller/blowers and add-on kits for pull type choppers
  - Paul Smucker, Lancaster Silo Company (717-299-3721)
  - Glen Horst, near Guelph, Ontario (519-669-5439)
  - Roger Shantz, U of Guelph Farm Manager (519-824-4120)
  - Georgetown Manufacturing Co, Christiana, PA (610-593-2753) (Gehl, New Holland Choppers)

Cracker Plates....

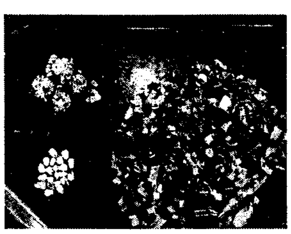
- This type of rub bar or plate processor has been offered for years in Europe.
- Research indicates that they are effective with immature CS, but effectiveness tends to decline with advancing crop maturity.
- TLC still needs to be short.
- Positioned for smaller producers not wanting to spend $$ for roller mills and for harvesters wanting to regain lost ground speed.
- Kooima - Rock Valley, Iowa. www.Kooima.com Dean Foster
  - Voice: 800-522-8874, Fax: 712-476-5403 or Dean.Foster@kooima.com

Kernel Cracker Plate
Kooima Part#: K51112HP
Replaces OEM# :

- Fits All 6000 series JD Harvestors, JD 3960 and 3970 Pull-types and Self Propelled New Holland Choppers
- Cracks 85 to 90% of kernels with minimal Power Requirements
- Bolt in installation
- Solid one-piece construction
- Heat treated & Single milled teeth to retain sharp edge

$800.00 each

Field Observations of Kooima Cracker Plate Mounted on John Deere Pull-Type Chopper



Hybrid: 36H75 Moisture: 64% @ 1/2 milkline
Harvested in Southern Minnesota, Fall 1999

- On site observations at harvest with 2 handfuls of forage showed:
  - 12-15 cob-pieces
  - 60-80% kernels left intact (some nicked or scratched)
- Customer noted more kernel damage at higher moistures.
- No observed increase in implement power demands.
- Took several hours to install plate - manufacturer claims 1 hour.
- Hand sorting of silage in the lab showed lots of cob pieces and upwards of 80% of the kernels undamaged.

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Research Review by Dr. Larry Satter - USDA DFRC at MN Forage Conference 2/10-11/99

- It is recommended that processed silage be **cut at 3/4" theoretical length of cut, and that the roller mill spacing or gap be at 1-2 mm.**
- The optimum gap setting may vary with corn hybrid and corn maturity, but in any case should result in **all kernels being broken.**
- Processing has been **shown to improve starch digestibility**, and possibly increase packing density in the silo.
- **Milk production is increased slightly with processing, with the average increase from 15 trials equaling 1 lb of milk per cow daily.**
- The added cost of a roller mill for a forage chopper is approximately $9,000 to $15,000. **Using a milk production response of .6 lb per cow per day (includes only 11 trials where the cows produced > 60 lbs. milk per day) and a projected machine cost (roller mill) of $2,440 per year of operation, a minimum of 130 lactations per year will be needed to breakeven with the added machine cost.** Only moderate to large dairy operations or custom corn silage harvesters have sufficient volume to pay for the cost of corn silage processing.

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Comments on "Table 8" in Review by Dr. Larry Satter - USDA DFRC at MN Forage Conference 2/10-11/99

- To be sure, these are very modest responses, and it could be argued that they fall within the range of experimental variation. On the other hand, upon considering all the information, including starch digestion and steer growth rate data, it appears that processing of corn silage is having some beneficial effect, albeit small
- The trials comparing processed with control corn silages had the benefit, generally speaking, of good quality corn silage. Overly mature or dry corn silages were generally absent from this group of studies. One might expect more benefit from processing when applied to corn silage having more mature or harder kernels. The responses in Table 8 should therefore be considered as minimal responses.
- Most of the studies with processed corn silage have been short term switch-back studies where changes in body weight or body condition could not be reliably measured. If starch digestion is increased with processing, then either an increase in feed efficiency or in body condition should be observed. These potential benefits have not been given much opportunity to be measured in the trials conducted thus far.

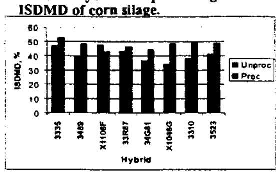
Early Studies with Kernel Processing Showed Improvement in Both Starch and Stover Digestibility

Nutrient	No Silage Processing	JD 5830 w/ Kernel Proc	Stationary Roller Mill
Dry Matter	50.4[a]	62.2[b]	59.5[b]
NDF	24.1[a]	36.3[c]	30.5[b]
Starch	53.3[a]	75.7[b]	79.9[b]

Values in same row with no superscripts in common differ (P<.05)
Source: Harrison/Hunt:National Silage Conference, 2/11-13/97.

Recent Studies with Kernel Processing Suggest a Negative Associative Effect Between Improved Starch Digestibility and Digestibility of NDF (cell walls) (Hunt et.al.- abstract presented at 1999 ASAS meetings)

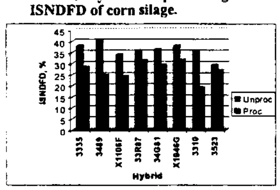
Effect of hybrid and processing on ISDMD of corn silage.



Hybrid x Processing Interaction (P < .05)

Balancing the ration for starch level and ruminal degradation kinetics should reduce the negative effect on fiber digestibility.

Effect of hybrid and processing on ISNDFD of corn silage.



Hybrid effect (P = .06) Processing effect (P < .01)
Hybrid x Processing Interaction (P = .13)

Beef Data from 1998 KSU Cattlemen's Day.....

CS Treatment	# of heifers	Initial Wt,lbs	Daily DMI,lbs	ADG lbs/day	F:G Ratio
Pre	20	591 [x]	21.2 [x]	3.21[a]	6.6 [a]
Post	20	591	20.1 [y]	3.12	6.4 [a]
Control	20	590	20.6 [xy]	2.93[b]	7.0 [b]

ab Means within a column with different letters differ (P<.05)
xy Means within a column with different letters differ (P<.10)

Hybrid was Pioneer brand 3394 harvested at 36% moisture (90% milkline) and harvested with Claas Jaguar 880 at 3/8 inch chop.

"Watch-outs" with Processed Corn Silage

- Assuming any grain hybrid "can" become a good silage hybrid…now that access to kernel starch is assured.
- Harvesting at below 65% moisture and expecting high stover digestibility and good packing in the storage structure.
- Chopping too long which is tough on the chopper, may impair good kernel processing and can lead to sorting in the TMR.
- Improper setting of the roller mill (should be 1-3mm depending upon maturity of crop, not 5-7mm…even though cobs will be broken up at 5-7mm, the kernels will not be properly processed).
- Not letting custom choppers know your expectations. It is recommended to routinely monitoring loads for degree of processing.
- Outstripping bunker packing capacity….filling at 2x rates with the same pack tractors as previous years.
- Reluctance to pull grain or modify ration to account for improved nutrient availability in first 24 hrs of rumen retention time.

Particle Size - Start with the TMR (e.g.12% on top screen) & work backwards to the particle size needed in the various forages...

Look at the contribution of long particles from forages

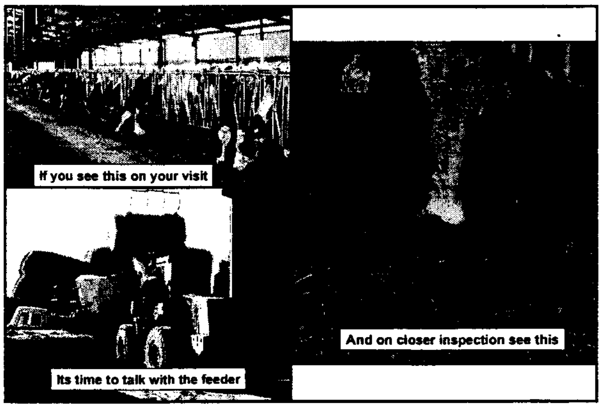
Corn Silage → Haylage → Hay

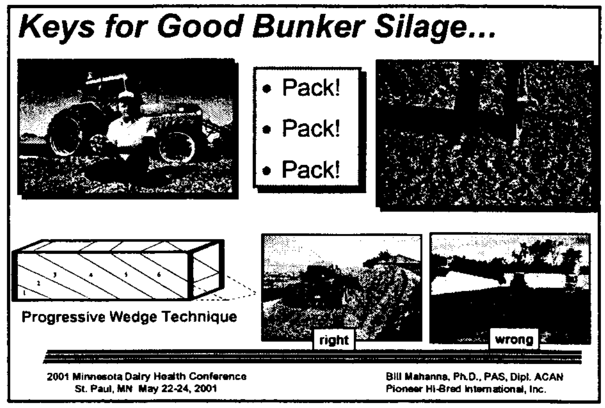
Check at feed delivery and again 4-6 hrs later

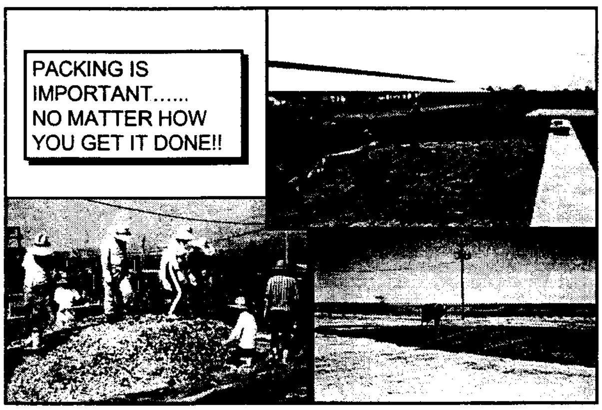
Typical goal of 25 % > 1 1/2 inch from the forages

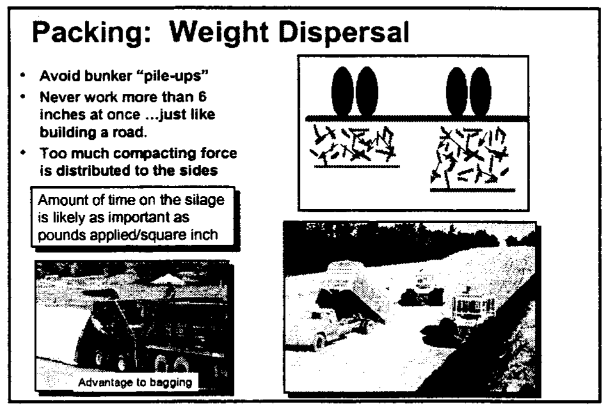
Concentrates ⟶ ↓ Likely "diluted" nearly in half by the addition of grain/proteins.

Goal for the TMR (e.g.12 % > 1 1/2 inch - typical range is 8 to 15%) in the bunk after feed handling and delivery.

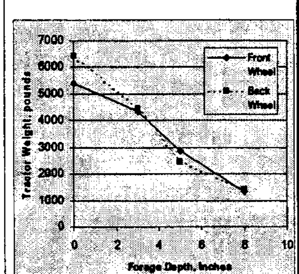




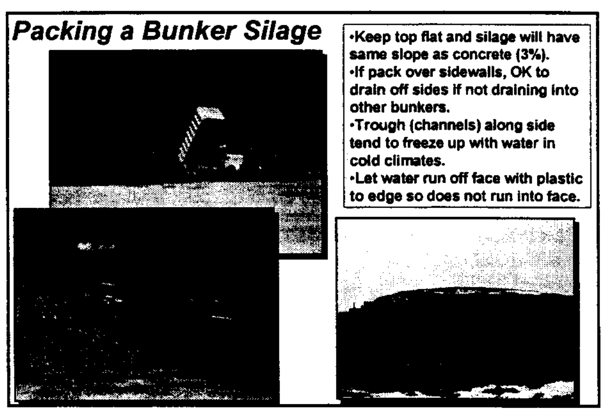




PACKING IN THIN LAYERS. To get silage fully compressed so air is forced out and kept out, heavy tractors are needed. Faster filling rates have forced many to go to larger and/or more packing tractors. An easy way to tell if you are keeping up with packing is to monitor how much new, unconsolidated forage you have under your wheels at any one time. My 'feeling' has been that six inches or less is needed to get good compaction. Survey results from a Wisconsin study support that thinner layers of silage result in denser silage. To try and measure the effect of forage depth under the wheels on compaction, I recently took some portable pad scales out to a bunker silo being filled with grass. I placed the electronic pad scale in the silo and measured the weight of the tractor. Then as the pad scale was buried, I kept track of the weight being recorded as the tractor passed over the top, noting the inches of silage between the pad scale and the tire. For every one inch of silage depth, the weight of the tractor tire reaching the pad scale was reduced by about 10%. So, at five inches, only about one-half of the tire pressure is felt in the silage.

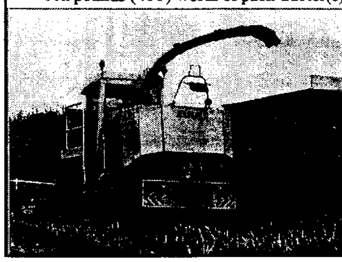


Source: K.A. Ruppel, Pioneer Dairy Update June 8, 2000, Vol 7, No 5.



Matching Packing Capacity to Filling Rates...

- Example:
  - 100 tons per hour chopper potential
  - Tons/hour x 800 = total packing wt needed
  - 80k pounds (40T) worth of pack tractor(s)



May Require:
- Beefing-up
  - adding weights
  - increasing tire pressure
  - using larger vehicles
- Ganging-up
  - more tractors at once

Table 1. Summary of samples collected from 168 bunker silos

Characteristic	Haycrop silage (87 silos) Avg.	Haycrop silage (87 silos) Range	Corn silage (81 silos) Avg.	Corn silage (81 silos) Range
Dry Matter, %	42	24-67	34	25-46
Wet density, lbs/ft^3	37	13-61	43	23-60
Dry density, lbs/ft^3	14.8	6.6-27.1	14.5	7.8-23.6
Avg. particle size, in.	0.46	0.27-1.23	0.43	0.28-0.68

Source: Holmes, B.J., and R.E. Muck. Pack Silage to Achieve High Density, Quality Feed. Hoard's Dairyman, May 25, 2000

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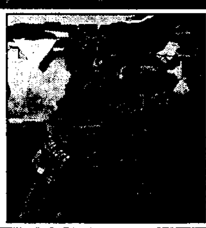

Silage Density Probe Calculator
© K.A. Ruppel, 1999 PHII

silage weight, gms	1400	73	Probe Diameter, mm
depth of hole in cm.	40	---->	(read from etched calibrations when you remove the last silage from the hole)
silage DM in %	33	---->	(estimate, or ask farmer for recent analysis or send sample away for analysis)
Distance above hole to top of silage stack (ft.):	15		
As Fed Density - pounds per cubic foot		51	pounds per cubic foot
Dry Matter Density - pounds per cubic foot		16.8	pounds per cubic foot

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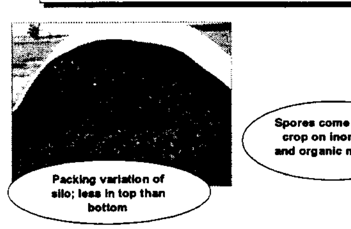
Example of micro-environments that may exist within storage structures that have erratic compaction.....



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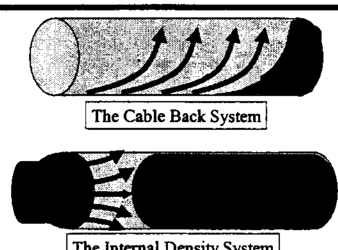
How Engineers Have Designs Bagging Machines To Produce More Consistent Pack



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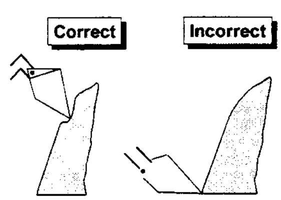
Techniques for Proper Feed-out



Source: Heap Silos, Canada Plan Service

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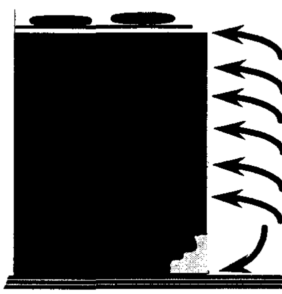
Bunker Face Removal Technique



Depth and Width Set for Amount Needed for 1 Day Feed Out

Then - Chip Down With Bucket Blade One Section at a Time Starting From Bottom

First - Scoop Out Lowest Section

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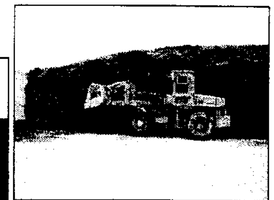
Another Option: Shaving across the Face.....



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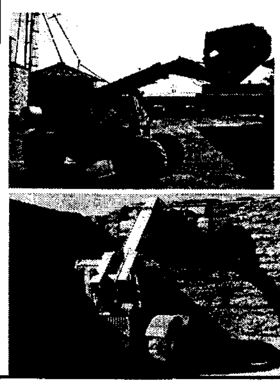
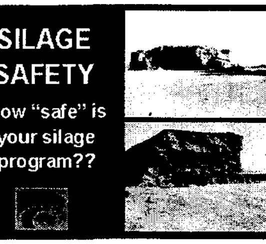
Reaching High....

- Piling high is good because it reduces tons exposed to the top 3 feet
- BUT....you need to be able to feed off the face correctly



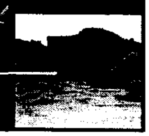
SILAGE SAFETY

How "safe" is your silage program??



Front-end loader windshields can be replaced.... lives can not!

Before an "avalanche"



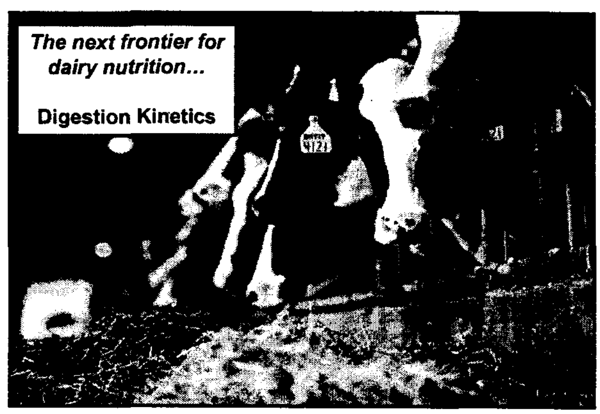
After an "avalanche"

<u>CONCLUSIONS ABOUT SILAGE MANAGEMENT IN NORTH AMERICA - Keith Bolsen, KSU</u>

In general, silages in North America have improved considerably in "visually appraised" quality in the past 8 to 10 years. Many beef and dairy cattle producers have initiated significant changes to improve their silage programs. These include: shorter chop lengths, correct sizing of the silo's width and height, faster removal rates, improved maize and/or sorghum hybrids, more effective packing and sealing, and the use of an inoculant.

However, problematic silages still occur far too often and many of them are caused by:

1. **Delayed filling and too rapid filling** -- a few bunkers, trenches, and drive-over piles take 2 to 3 weeks to fill. High-capacity forage harvesters often chop more tons per hour than the packing tractor(s) can properly consolidate.
2. **Forages ensiled too wet or too dry** -- this is often related to the corn or sorghum hybrids grown and unfavorable field-wilting conditions for alfalfa, ryegrass, and other "hay crop" silages.
3. **Chop lengths that are too long** -- this is particularly evident in alfalfa, wheat, barley, oats, and ryegrass silages in bunker, trench, or pile silos.
4. **Inadequate sealing of the ensiled forage** -- in most instances, the polyethylene sheets are not properly weighted.
5. **Slow removal of silage during the feedout phase** -- this is usually the result of the exposed face being too large. Corn silage is especially prone to aerobic deterioration, heating and loss of nutrients.
6. **Failure to apply an effective bacterial inoculant** -- inoculants are responsible for more uniform and consistent silages throughout the silo, and this is probably the most important reason to use an inoculant!



Where we are vs. Where we need to go

- Balancing around the **amount** of chemical entities such as fiber, protein and minerals is not very sophisticated
  - » Fiber:ADF, NDF, lignin
  - » Protein: soluble, degradable, undegradable
- We need to better understand how nutrients will be metabolized in different parts of the *digestive tract*
  - » site, rate and extent of digestion
  - » in the rumen and in the intestines

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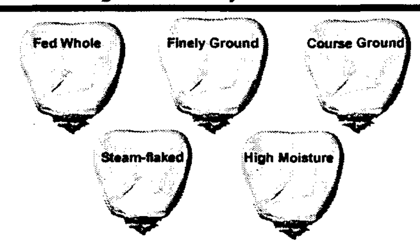
Traditional Analysis

- **Static NE values**
- **Doesn't indicate how animal will respond**
- **Doesn't account for processing**
- **ADF is used to predict NE values**

A N A L Y S I S   R E S U L T S

Corn Silage	As Sampled	Dry Matter	Unit
Moisture	71.1	.....	%
Dry matter	28.9	.....	%
Crude Protein	2.5	8.5	% DM
Available Protein	2.2	7.6	% DM
Unavailable Protein	0.3	0.9	% DM
Adjusted Protein	2.5	8.5	% DM
Soluble Protein	1.4	4.7	% DM
		55.6	% CP
Degradable Protein (calc.)	1.9	6.6	% DM
		77.8	% CP
Ammonia	0.2	0.8	% DM
		9.2	% CP
TDN	20.3	70.1	% DM
Net Energy Lactation	0.21	0.73	Mcal/lb
Net Energy Maintenance	0.21	0.74	Mcal/lb
Net Energy Gain	0.13	0.47	Mcal/lb
Acid Detergent Fiber	7.3	25.4	% DM
Neutral Detergent Fiber	11.2	38.7	% DM
Ash	2.1	7.4	% DM
Starch	9.3	32.1	% DM
NFC	12.5	43.4	% DM
Calcium	0.08	0.27	% DM
Phosphorus	0.07	0.25	% DM
Magnesium	0.04	0.15	% DM
Potassium	0.42	1.45	% DM
Iron	50	172	PPM
Manganese	11	38	PPM
Zinc	5	16	PPM
Copper	2	9	PPM

For example: Take identical genetics....They all "Test" the Same at the Forage Lab. Do they all "Feed" the Same??



Standard regression equations can not "predict" the true feeding "value" as a result of different processing methods....nor can they "predict" the nutritional differences between specific germplasms or growing environments

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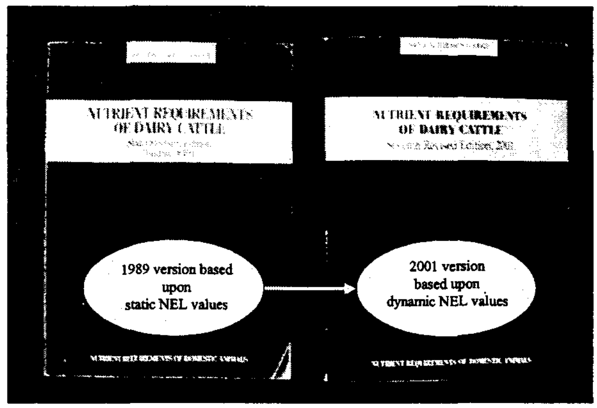

Ideally, we need forage analyses that reflects what happens here!!

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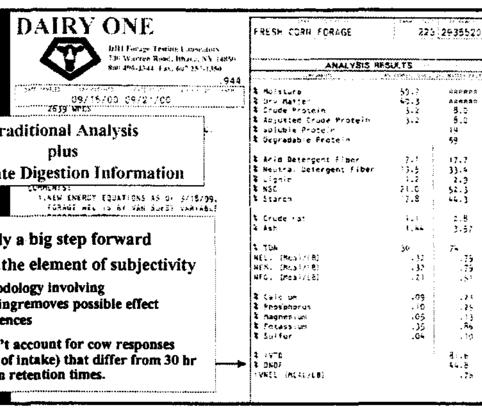
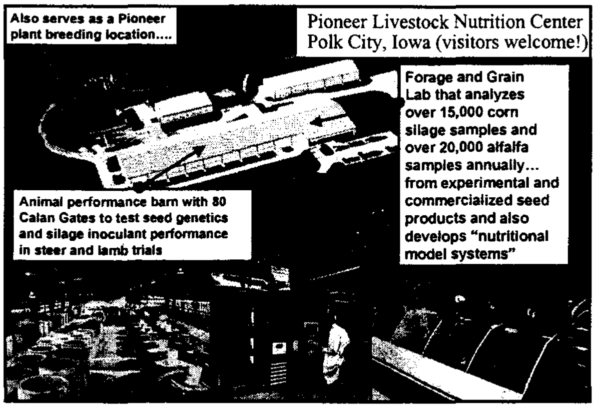
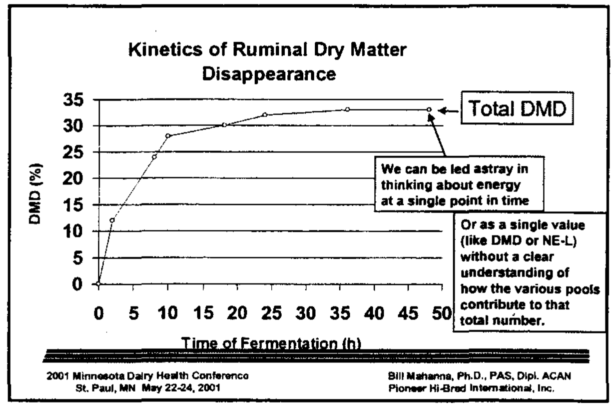


Traditional Analysis plus End-State Digestion Information

- Certainly a big step forward
- Enter…the element of subjectivity
  - methodology involving grindingremoves possible effect differences
  - doesn't account for cow responses (level of intake) that differ from 30 hr rumen retention times.


Also serves as a Pioneer plant breeding location....
Pioneer Livestock Nutrition Center
Polk City, Iowa (visitors welcome!)
Forage and Grain Lab that analyzes over 15,000 corn silage samples and over 20,000 alfalfa samples annually... from experimental and commercialized seed products and also develops "nutritional model systems"
Animal performance barn with 80 Calan Gates to test seed genetics and silage inoculant performance in steer and lamb trials


Kinetics of Ruminal Dry Matter Disappearance
DMD (%)
35
30
25
20
15
10
5
0
0 5 10 15 20 25 30 35 40 45 50
Time of Fermentation (h)
Total DMD
We can be led astray in thinking about energy at a single point in time
Or as a single value (like DMD or NE-L) without a clear understanding of how the various pools contribute to that total number.
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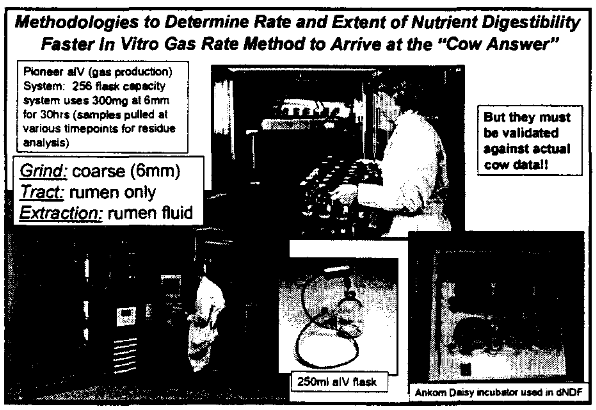
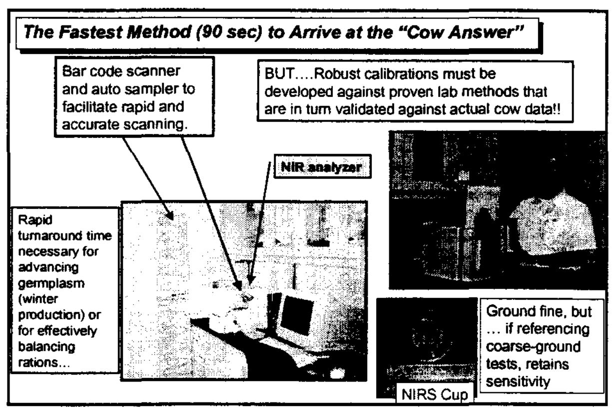
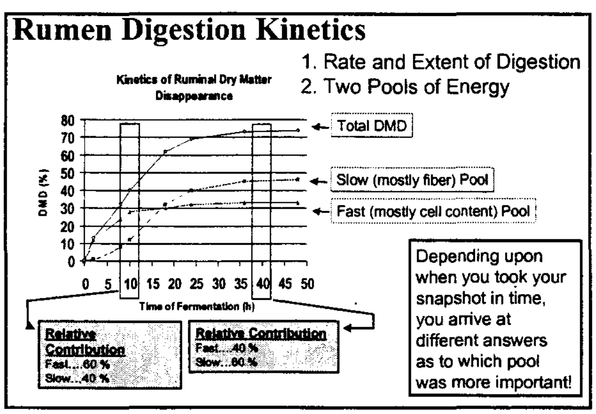
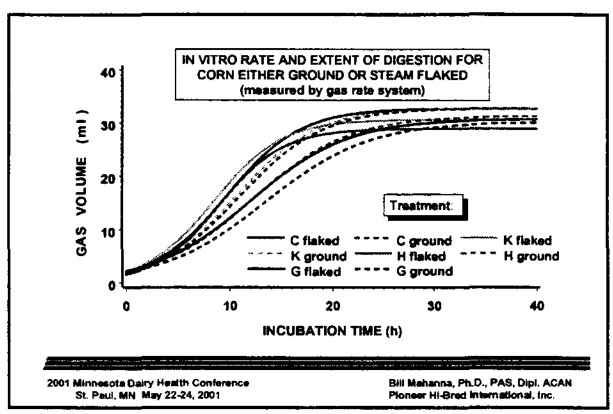

Methodologies to Determine Rate and Extent of Nutrient Digestibility
Faster In Vitro Gas Rate Method to Arrive at the "Cow Answer"
Pioneer aIV (gas production) System: 256 flask capacity system uses 300mg at 6mm for 30hrs (samples pulled at various timepoints for residue analysis)
Grind: coarse (6mm)
Tract: rumen only
Extraction: rumen fluid
But they must be validated against actual cow data!!
250ml aIV flask
Ankom Daisy incubator used in dNDF


The Fastest Method (90 sec) to Arrive at the "Cow Answer"
Bar code scanner and auto sampler to facilitate rapid and accurate scanning.
BUT....Robust calibrations must be developed against proven lab methods that are in turn validated against actual cow data!!
NIR analyzer
Rapid turnaround time necessary for advancing germplasm (winter production) or for effectively balancing rations...
Ground fine, but ... if referencing coarse-ground tests, retains sensitivity
NIRS Cup


Rumen Digestion Kinetics
1. Rate and Extent of Digestion
2. Two Pools of Energy
Kinetics of Ruminal Dry Matter Disappearance
DMD (%)
80
70
60
50
40
30
20
10
0
0 5 10 15 20 25 30 35 40 45 50
Time of Fermentation (h)
Total DMD
Slow (mostly fiber) Pool
Fast (mostly cell content) Pool
Relative Contribution
Fast...60 %
Slow...40 %
Relative Contribution
Fast...40 %
Slow...60 %
Depending upon when you took your snapshot in time, you arrive at different answers as to which pool was more important!


IN VITRO RATE AND EXTENT OF DIGESTION FOR CORN EITHER GROUND OR STEAM FLAKED (measured by gas rate system)
GAS VOLUME (ml)
40
30
20
10
0
0 10 20 30 40
INCUBATION TIME (h)
Treatment
C flaked
K ground
G flaked
C ground
H flaked
G ground
K flaked
H ground
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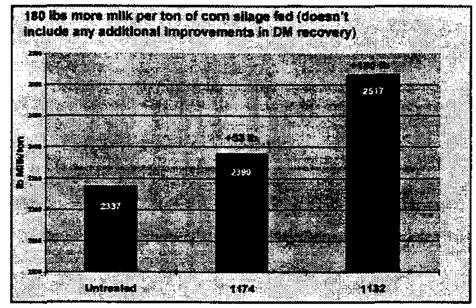
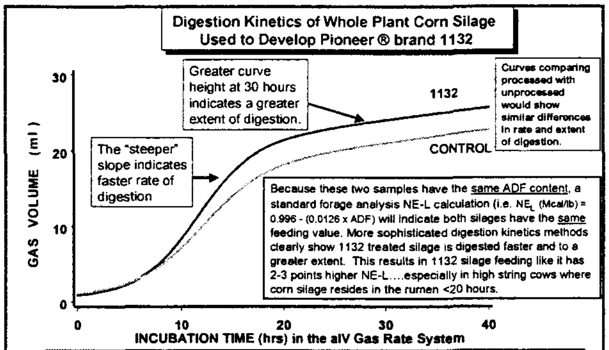
A Practical Example of using Kinetics Research to Advance New Products

What causes this improvement in production

Washington State University 1132 Dairy Trial





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Benchmarking corn silage (or any silage) to prevent "new crop slump".....

- **Recognizing the need for "bench-marking" "current silage" to "new-crop" given NE-L regression equations do not adequately address the rate or extent of CS digestion in early lactation cows:**
  - Getting a handle on the Yellow (and cell contents) Pool
    - » starch content;
    - » physical examination of extent of kernel maturity/processing (rate of starch release),
  - Getting a handle on the Green (cell wall) Pool
    - » dNDF (not just lignin) at 24-30 hours, not 48 hrs.
- Commercial labs
  - Dairy One Forage Lab - Ithaca, NY (607-257-1272) or Dairyland Labs - Arcadia, WI (608-323-2123)
    - » starch ($9)
    - » 30 hour IVTD (also dNDF and OSU NE-L estimates for ~ $24)

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Benchmarking Silage Hybrids: A Practical Example

- **Example of Wisconsin dairyman feeding very-well processed 3563 treated with Pioneer brand ® 1132:**
  - » Lab reported NE-L of .71 Mcal/lb DM (32% starch vs typically27-28%)
  - » Dairyman **increased to .73 because of using 1132 and backed out grain**
  - » After feeding for several months finally increased to .80-.82 as impact of both processing and 1132
  - » adding 10% to the NE-L is a place to start for very well processed silage

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What Can Happen if the Kinetics of Inoculated, Elite Corn Silage Hybrids Is Not Considered.........

Sent: September 15, 1998 11:27 AM
To: Mgmt, DSM's, STF Agronomists
From: Dr. Doug Yungblut, Canadian Field Nutritionist
Subject: Urgent message re feeding new crop corn silage

It is very important that you stay in contact with dairymen who are feeding silage from 37H97 and 37M81 for the first time, especially if it is inoculated with 1132.

We have had a situation with a producer who started feeding 37H97 as soon as he finished filling silo. He encountered some symptoms of grain overload and had to have one cow operated on and lost one cow. The cows were receiving a TMR with haylage and corn silage 50:50, high moisture corn plus dry corn and a supplement plus 4 - 5 pounds of hay free choice. They were also receiving corn as a top dress. There appears to have been a few things done incorrectly

(1) **Feeding silage while it was fermenting**. This can at the least cause digestive upsets and may have started some of the problems.

(2) No adjustments were made to the ration. **Feed intake jumped by almost 10%, probably because the 37M81 genetics is more digestible, plus the 1132 increased this even further.** It is quite possible that hay intake was voluntarily reduced by some cows, making them more vulnerable to acidosis.

(3) **The haylage portion of the ration was very finely chopped** and was quite low in fibre, so some of the cows may have been marginal in fibre intake.

(4) The producer did not contact either us or his nutritionist for about 3 weeks after the problems started.

This situation could probably have been avoided if action had been taken earlier. I think the producer will be very happy with the performance of his cows once the ration is properly balanced. If you have any questions please let me know.


Thank You!!!