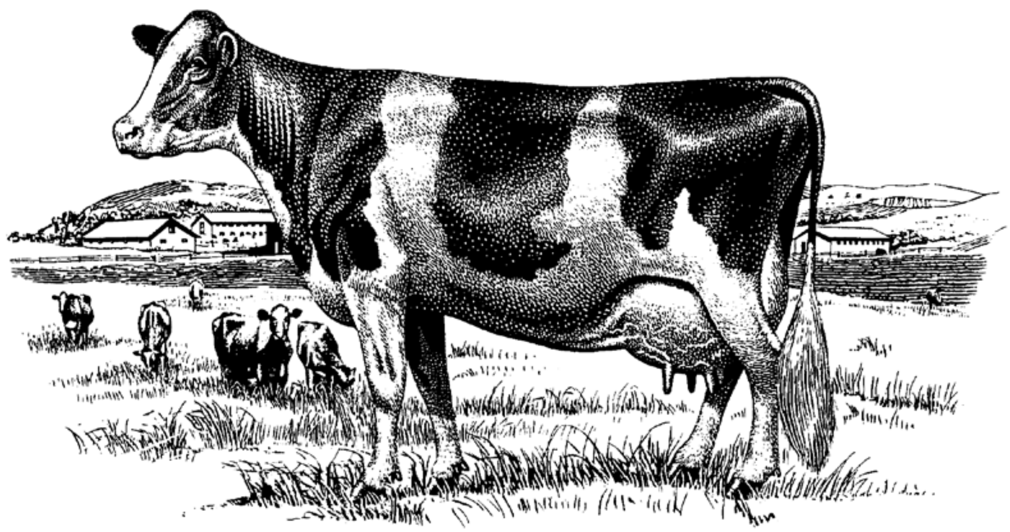
Proceedings of the

2014 Delmarva Dairy Day

Thursday, February 20, 2014
Hartly Fire Hall, Hartly, DE



The University of Delaware

Dairy Research, Teaching, and Extension
UNIVERSITY OF DELAWARE

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Dairy Research, Teaching, and Extension

UNIVERSITY OF DELAWARE

2014 Delmarva Dairy Day

Hartly Fire Hall
Hartly, DE
Thursday Feb 20, 2014

9:30 to 10:15 AM	Visit with Exhibitors, Coffee and Donuts
10:15 to 10:45 AM	***A review on brown midrib corn silage for dairy cows*** Limin Kung, Jr., University of Delaware
10:45 to 11:15 PM	***Secure milk and traceability – how it affects you*** Bob Moore, Delaware Dept. of Agriculture
11:15 to 12:00 PM	***Feed management and nutrition's impact on cash flow plans*** Virginia Ishler, Pennsylvania State University
12:00 to 1:00 PM	**Lunch (*with UD ice cream!*) and visit with Exhibitors**
1:00 to 1:30 PM	***Novus C.O.W.S. – Assessing and benchmarking cow comfort across the USA*** Lindsay Collings, Novus C.O.W.S. Project Manager
1:30 to 1:45 PM	***Novus C.O.W.S. – Key learnings and on-farm application in the Northeast*** Katie Wood, Novus C.O.W.S. Jr. Project Manager
1:45 to 2:15 PM	*Maximizing water consumption and quality to maximize milk* Tanya Gressley, University of Delaware

Contact Info: Susan Garey: (302) 730-4000 (truehart@udel.edu) or Limin Kung, Jr. (302 831 2522 (lksilage@udel.edu)

A Review of BMR Corn Silage for Dairy Cows

Limin Kung, Jr.
Dairy Nutrition & Silage Fermentation Laboratory

Dairy Research, Teaching, and Extension
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Definition of a High Quality Forage/Silage

- High in nutrients (e.g. energy, CP, etc.)
- Nutrients must be digestible by the rumen microbes and/or cow
- Should have good effective fiber that encourages chewing

Primary Factors Contributing to Quality Corn Silage

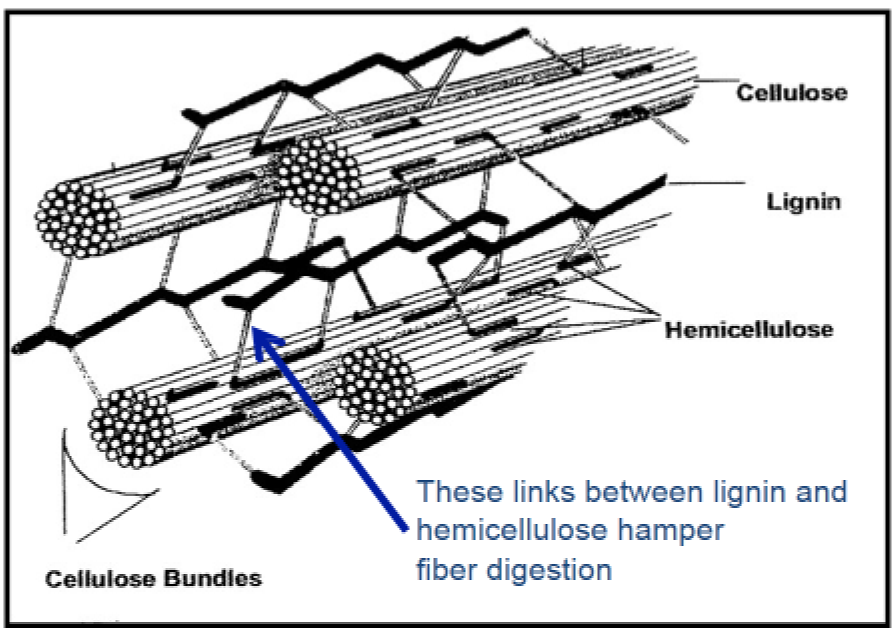
- High starch with high digestion
- High fiber digestion (NDF-D)
- Every increase 1 unit increase in NDF-D has the potential to increase ~ 0.4 lb DM intake and about 0.5 lb milk
  Oba and Allen, 1997

Factors Affecting Fiber Digestion

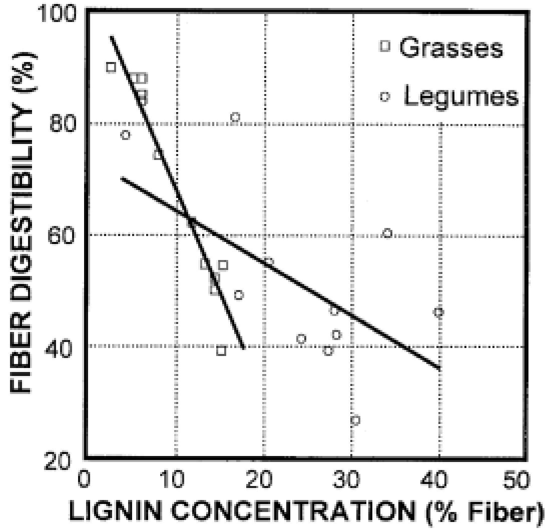
- Maturity] lignin content
- Plant species/Genetics]
- Particle size-
  - Heat damage (interaction with protein/moisture)

Lignin – "intracellular linking cement"

- provides mechanical support, strengthens cells walls
- facilitates water movement because <u>lignin is hydrophobic</u>, prevents cell wall collapse during dehydration
- Provides resistance to insects, disease, etc.



Lignin is Negatively Correlated with Fiber Digestion –> high lignin = low NDF-D, low lignin = high NDF-D



Adapted from Smith et al., 1972

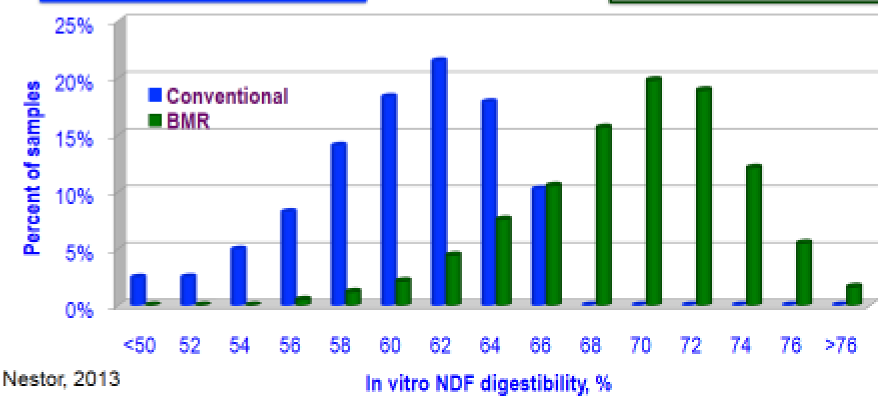
Brown Midrib Corn Mutants Have Low Lignin => High NDF-D

- Four natural mutations identified in the 1930-40's in dent corn
  bm1, bm2, bm3, bm4
- Low in lignin therefore higher fiber digestion
- Brown to red pigment in the leaf midrib, rind and pith

Distribution of in vitro NDF digestibility at 30 h between conventional and BMR corn silage samples (CVAS, Oct. 2012 – Apr. 2013)

Conventional
- n = 18,270
- Ave. = 59.4% ± 4.01

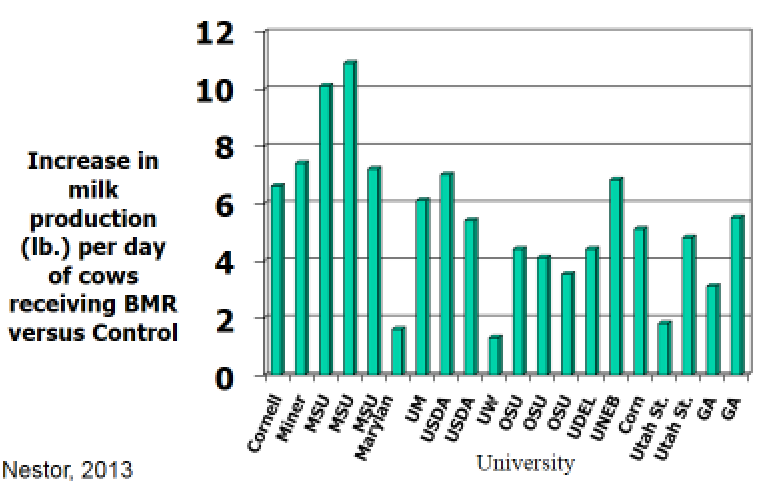
BMR
- n = 1,585
- Ave. = 68.4% ± 4.23



Nestor, 2013

Dow AgroSciences

Modern BMR Milk Production Research



Nestor, 2013

How Does BMR Compare to Normal Hybrids?
Meta Analyses Data

	Control		bm3	
	Average	Std. Dev.	Average	Std. Dev.
DM, % of as fed	33.5	3.3	32.5	3.9
Starch, % of DM	30.5	2.9	29.9	4.2
NDF, % of DM	42.0	1.7	40.9	2.1
ivNDFD[2], % of NDF	46.1	9.2	57.6	7.7

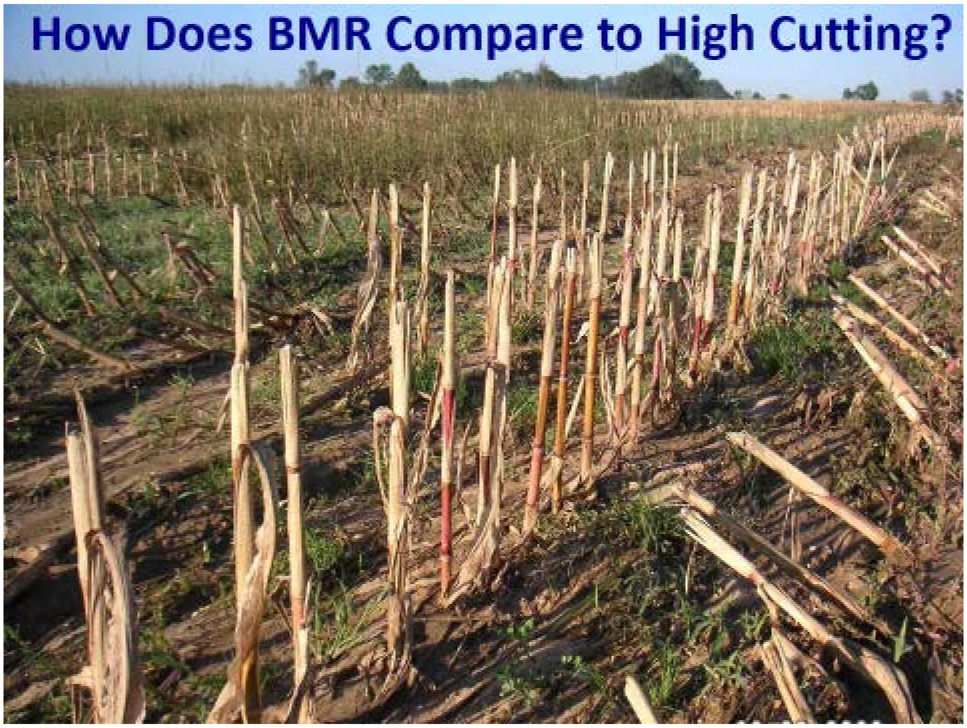
[1]In vitro NDF digestibility measured after in vitro fermentation for 30 h except for trial of Weiss and Wyatt, 2006 where a 48 h determination was performed.

Gencoglu, Shaver and Lauer, UW Madison

Effect of BMR on Production – UW Meta Analysis

Item	Normal	BMR
DMI, kg/d	24.2	25.4
Milk, kg/d	37.7 (83 lb)	39.4 (87 lb)
Fat, %	3.67	3.59

Results are least-square means from meta-analysis (St. Pierre, 2001) performed on data from 11 trials with 17 treatment comparisons published in the Journal of Dairy Science since 1999;Gencoglu, Shaver and Lauer, UW Madison



Low vs. High Cut and Ctrl vs. BMR Corn Silage –% Change

Item	Low Cut vs. High Cut[a]	Ctrl vs. BMR[b]
Ton/ac, DM, %	–7	–10
NDF Digest, %	+5	+19

[a]Roth, 2003 [b]Eastridge, 1999

Effect of High Cutting vs BMR

Item	Normal 7511FQ	High 7511FQ	Normal F2F797 BMR
Yield, t DM/acre	11.16[a]	9.32[b]	9.98[ab]

Kung et al., 2008

Effect of High Cutting vs BMR

Cut = Hybrid =	Normal 7511	High 7511FQ	Normal F2F797 BMR
ADL, %	3.17	2.76	2.20
NDF, %	42.9	39.6	44.7
Starch, %	29.7	31.7	25.7
NDF-D, % 30 h	51.7	51.4	63.5

Kung et al., 2008

Effect of High Cutting vs BMR

Item	Normal Cut 7511FQ	High Cut 7511FQ	Normal cut BMR
DMI, lb/d	59.2	60.1	59.0
Milk, lb/d	103.0[b]	104.9[b]	107.4[a]
Milk fat, %	3.60[a]	3.48[b]	3.50[ab]
3.5% FCM, lb/d	104.3[c]	104.3[c]	106.7[d]
FE, 3.5% FCM/DMI	1.77[ab]	1.75[b]	1.83[a]

Kung et al., 2008

Balancing For Effective NDF with BMR

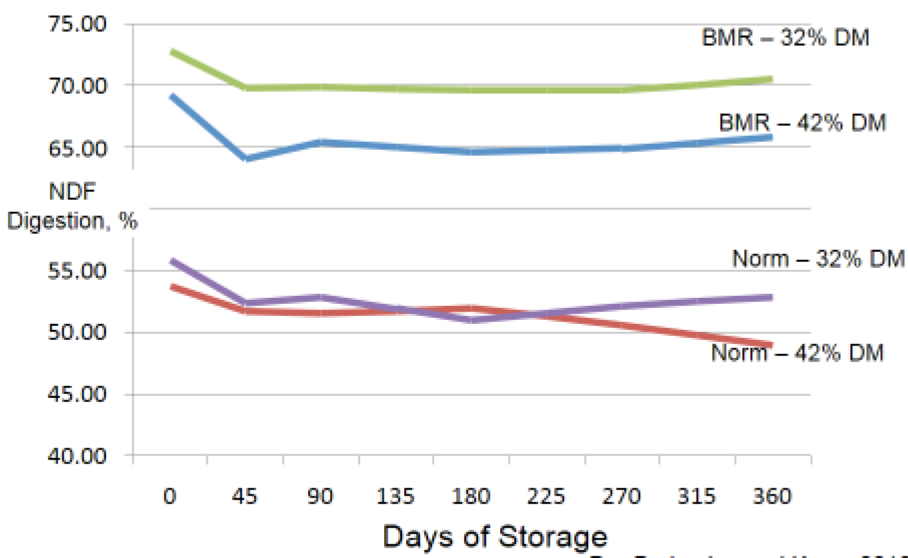
- High NDFD, high fragility forages stimulate less chewing per unit of NDF at similar particle size
- Need to feed more total forage
- Formulate for higher peNDF
- Use pef adjustment factor
- Supplement with lower NDFD, lower fragility forage (like straw)

Grant, 2010

What Factors Affect BMR Quality?

- Maturity (DM)?
- Length of Time in the Silo?
- Processing?
- Additives?

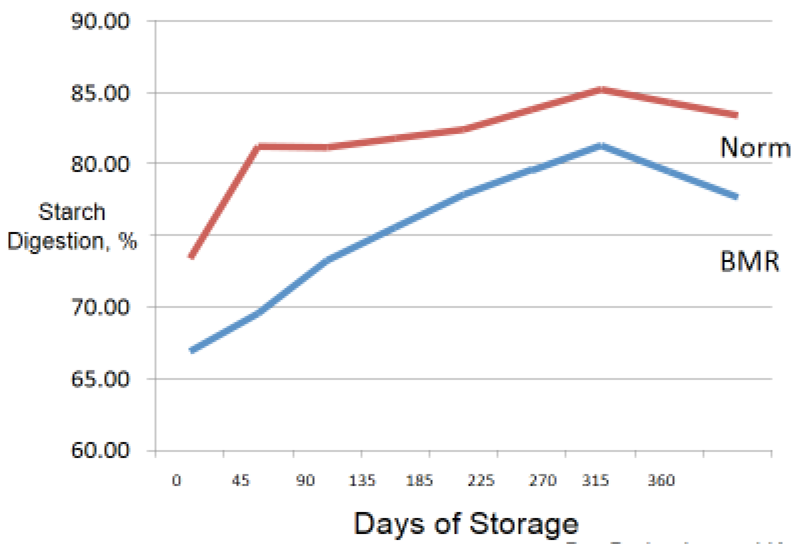
In Vitro NDF Digestion of Corn Silage: By Hybrid, Maturity and Storage



Der Bedrosian and Kung, 2010

It Appears that the Starch in BMR is a Little More Resistant to Ruminal Breakdown than Normal Hybrids

In Vitro Starch Digestion of Corn Silage: By Hybrid and Time of Storage



Der Bedrosian and Kung, 2010

Thumb Rules for Assessing the Degree of Processing

- > 95% of kernels cracked (70% equal to or smaller than 1/3 to ¼ kernel size)
- ***Nicking and crushing are not enough***
- Cob should be broken to >8 pieces

4.75 mm diameter hole

These pieces would Not pass through a 4.75 mm hole….
Thus, they are not processed enough!

L. Kung, Jr., University of Delaware

Separate Kernels from Forage in a Bucket of Water to Assess Kernel Processing

Mechanical Processing Effects On Corn Silage – High Producing/Early Lactation (34% DM - BMR)

Item	Unprocessed	Processed
DM intake, lb/d	52.6	56.8*
Milk, lb/d	94.3	97.9*

Ebling and Kung, 2001

Can Silage Additives Make Turn Normal Corn Silage into BMR?

ANSWER = NO!

Effect of 11CFT on NDF-D (%) of Normal and BMR Corn Silage Hybrids

Days of ensiling	TRT	Plow	Phi	BMR
60	Control	40.5	42.2	59.7
	11CFT	43.2	42.9	58.5
180	Control	42.5	45.4	57.6
	11CFT	44.5	45.4	55.5
360	Control	46.6	45.5[b]	58.4
	11CFT	48.6	50.6[a]	58.7

Hoo err et al. 2008

abMeans with unlike lep ers differ, $P < 0.05$

Do I Still Need an Inoculant on BMR?

- Yes, but the type of inoculant depends on your situation
- Aerobic stability challenges? L. buchneri
- No aerobic stability challenges? Homolactic

BMR Use at the UD Dairy

- Feeding BMR since ~ 2000
- ~10 units higher NDF-D (52 vs 62%)
- 6 lactation studies +4 lb/milk/d, +3 lb 3.5% FCM/d
- Lower MUN in 4/6 comparisons
- Biggest challenge on our farm
  - harvesting rapidly enough to avoid excessive dry down

Effects of Type of Corn Silage and Interplanting with BMR on Production

Ave 100-120 DIM, 2X milking, no BST
50% corn silage: 10% alf silage: 40% conc

Item	NML	MIX	BMR
DMI, kg/d	28.2[a]	26.8[b]	26.8[b]
DMI, % BW	4.09[a]	3.93[b]	3.89[b]
FCM Milk, kg/d	47.3	47.3	48.2
Feed efficiency	1.73[b]	1.84[a]	1.90[a]

Lim and Kung, 2012

Effects of Low and High Levels of BMR for Lactating Cows

- 27 Holstein cows (3 primiparous and 24 multiparous)
  - 742 ± 97 kg BW
  - 94 ± 39 DIM
  - 53 ± 9 kg of milk/d
- Dietary treatments (62:38 F:C ratio DM basis)
  - ➢TMR with 35% NML corn silage (**NML-LOW**)
  - ➢TMR with 35% BMR corn silage (**BMR-LOW**)
  - ➢TMR with 50% BMR corn silage (**BMR-HIGH**)

Effect of Type and Level of Corn Silage on Production

Item	NML-LOW	BMR-LOW	BMR-HIGH
DMI, kg/d	29.81	30.59	29.79
DMI, % BW	3.92	4.06	3.95
Milk production, kg/d	47.91[b]	50.06[a]	51.12[a]
Milk fat			
%	3.56[a]	3.55[a]	3.37[b]
kg/d	1.70	1.76	1.71
Milk protein			
%	2.90[b]	2.93[ab]	2.98[a]
kg/d	1.38[c]	1.46[b]	1.51[a]

[1]Dietary treatments included 35% (DM basis) corn silage from normal (**NML-LOW**), 35% brown midrib (**BMR-LOW**), and 50% brown midrib (**BMR-HIGH**) corn hybrid.
[a,b]Means in rows with unlike superscript differ (*P* < 0.05).

Lim and Kung, 2103

Effect of Type and Level of Corn Silage on Production

Item	NML--LOW	BMR--LOW	BMR--HIGH
MUN, mg/dL	14.7[a]	14.5[ab]	13.9[b]
FCM, lb/d	106[b]	111[a]	110[ab]
ECM, kg/d	103[b]	108[a]	108[a]
Feed efficiency (FCM/DMI)	1.62	1.64	1.67

[a,b]Means in rows with unlike superscript differ ($P < 0.05$).

Lim and Kung, 2103

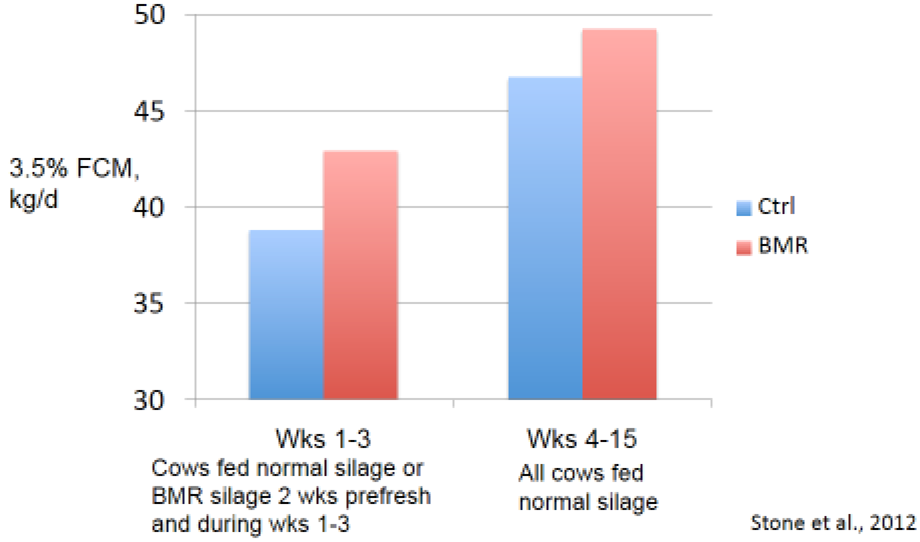
Effect of Type and Level of Corn Silage on Digestibility of the TMR

Item	NML--LOW[1]	BMR--LOW	BMR--HIGH
Dry maper, %	70.6[b]	73.8[a]	74.9[a]
Organic maper, %	72.0[b]	75.4[a]	75.8[a]
NDF, [2] %	43.2[c]	50.9[b]	54.4[a]
Starch, %	97.9[b]	98.3[ab]	98.6[a]
CP, [3] %	71.6[b]	75.6[a]	76.3[a]

[1]Dietary treatments included 35% (DM basis) corn silage from normal (**NML-LOW**), 35% brown midrib (**BMR-LOW**), and 50% brown midrib (**BMR-HIGH**) corn hybrid.
[2]Neutral detergent fiber.
[3]Crude protein.
[a,b]Means in rows with unlike superscript differ ($P < 0.05$).

Lim and Kung, 2103

Milk Production of Cows Fed BMR Corn Silage in the Transition Period and Wk 1-3 of Lactation



2010 UD Test Plots –Planted Late

Item	Normal	BMR
Yield, t/a (35%DM)	20.7	19.7
NDF--D, %, 30 h	57.6	70.8
Milk/ton	3070	3412
Milk/ac	22,431	23,575

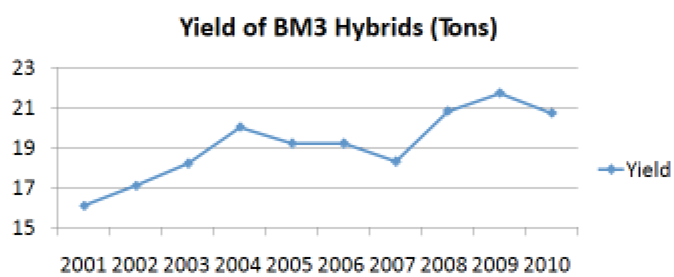
2010, UD – average of 4 TMFs and 6 BMRs, RM ~ 110

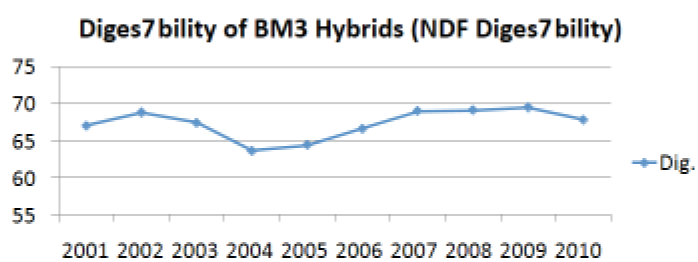
Improvement in Agronomics BM3

- Mycogen is now in the **5th generation** of BMR silage hybrids
  - early generations – short, low yields, high grain to stover ratio
  - middle generations – great improvements in yield of the stover, plant health, standibility, and harvest drydown
  - **latest generations – additional increases in yield, improvements in plant health & disease resistance, taller and more robust plants**

Nestor, 2013

BM3 Hybrids – Improved Yields





Agronomics: Field Selection for BMR

- Plant on what is considered 'the better ground' on the farm
  - since bmr's are high value, we want you to maximize production potential
  - Soils with good water holding capacity.
  - will respond to high fertility, crop rotation, and excellent weed control
  - Eliminate compaction – Huge obstacle often overlooked

Graves, 2013

Agronomics: Fertility

- *A solid fertility program* is necessary (N, P, K, pH)
- Well-balanced fertility improves WUE
  - *Roots don't need to seek nutrients; focuses efforts on growth, instead of maintenance*
- Manure application is beneficial
- Previous cropping history and herbicide programs need to be considered

Graves, 2013

Agronomics: Plant Early

- Grain fill during period of higher sunlight will increase dry matter
- Earlier canopy development, less evaporation
- Take advantage of early season moisture
  - Moisture is usually not limiting in the early part of the growing season
- Warmer soils will lead to more uniform emergence and increase yields
  - Silage hybrids cannot compensate for dry matter loss because the whole plant is harvested versus grain in which the ear is only harvested

Graves, 2013

2010 Farm Corn Silage –UD

Item	BMR	Normal	50:50
Yield, t/ac 35% DM	22.0 (F2F700)	28.7 (TMF2W726)	24.5
NDF, %	43.8	41.3	40.9
NDF--D, % 30 h	76.1	64.9	70.1
Starch, %	27.5	29.0	28.2

2010 UD

BMR Observations

- In cool weather, dry down can be very slow
- In hot, dry weather dry down can be very fast
- Slightly lower yields, thus more acreage needed
- Seepage issues if put up too wet
- Does poorly in extremely dry/hot weather
- Decrease in NDF-D in mature silage

Kung, 2010

Is BMR for Me?

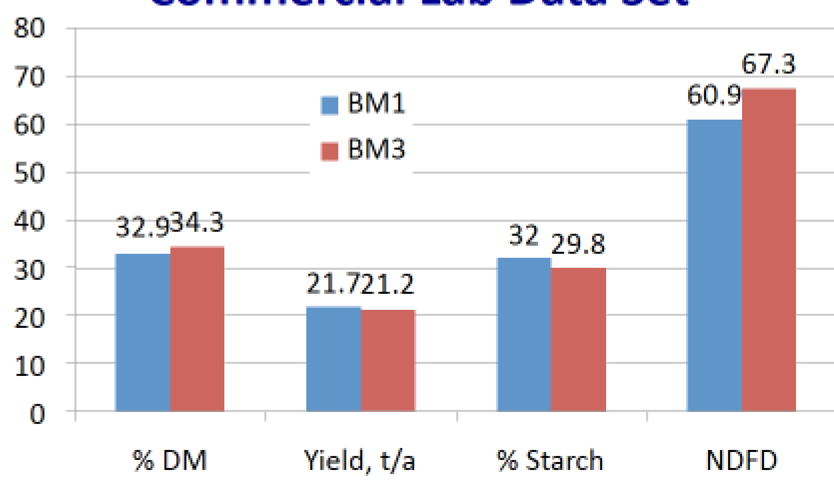
- Work with nutritionists and extension
- Determine growing conditions
- Acreage
- Best uses:
  - pre/post fresh
  - early lactation
  - high groups

Head to Head Comparisons of BM1 vs BM3 Hybrids

- Observations:
  - BM1=68
  - Mycogen BM3 = 131
- PA, NY, OH, MI, IA, NC, WI, MN
- Commercial lab analyses (Cumberland Valley)
  - Wet chemistry

Nestor, 2013

BM3 vs BM1
Commercial Lab Data Set



Nestor, 2013

Summary

- Historically, Mycogen Seeds has been the primary provided of BM3
- Several companies are now selling BM3
- New BM1 hybrid being sold – based on high NDF-D and better yields
- Fact – Majority of published research data is with BM3 from Mycogen
- Fact - No published lactation trials showing better milk with BM1 hybrid
- Wait and see…..

Summary

- BMR contains the most highly digestible fiber of any corn silage hybrid; by a long margin…
- Agronomics are close to equal to many hybrids and catching up
- Use strategically: pre/post fresh, early lactation, high producers

Thank You!

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Virginia Ishler

Extension Dairy Team- Business Management

(Tim Beck, Rob Goodling, Gary Hennip, Logan Horst, Heather Weeks, Rebecca White, & Craig Williams)

FEED MANAGEMENT AND NUTRITION'S IMPACT ON CASH FLOW PLANS

Penn State **Extension**

Outline

- What have we learned?
- Case farms
- The Questions:
  - What is good forage quality?
  - What do successful high forage diets look like?

2013 Summary – Cash Inflow

All Breeds	17%	21%	15%	13%	20%	13%	
	Breakeven Milk Price						
Dairy Summary per Cow	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Total Number of Cows	77	131	149	231	169	90	**141**
Number of Cows Milking	69	114	132	206	145	76	**124**
Percent in Milk	89%	87%	88%	88%	86%	85%	**87%**
Milk Sold per Total Cows	22,561	23,281	23,103	22,454	21,541	18,053	**21,832**
Milk Sold per Milking Cow	25,458	26,860	26,359	25,637	25,086	21,155	**25,093**
Average Lbs Milk per Day	70	74	72	70	69	58	**69**
Average Milk Price Planned	$ 19.15	$ 20.13	$ 19.92	$ 20.19	$ 20.11	$ 20.74	**$ 20.04**
Milk Inflow	$ 4,320	$ 4,672	$ 4,602	$ 4,529	$ 4,351	$ 3,693	**$ 4,361**
Cull Cow Sales	$ 199	$ 193	$ 225	$ 253	$ 200	$ 231	**$ 217**
Bull Calf Sales	$ 42	$ 38	$ 39	$ 51	$ 36	$ 42	**$ 41**
Misc. Dairy Sales	$ 58	$ 31	$ 111	$ 92	$ 214	$ 91	**$ 99**
Non Milk Inflow	$ 306	$ 259	$ 376	$ 370	$ 327	$ 330	**$ 328**
Total Inflow	**$ 4,925**	**$ 5,192**	**$ 5,352**	**$ 5,294**	**$ 5,127**	**$ 4,388**	**$ 5,046**

143 farms

2013 Summary – Feed Costs

All Breeds	17%	21%	15%	13%	20%	13%	
	Breakeven Milk Price						
Dairy Summary per Cow:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Milking Cow Home Raised Feeds	$ 502	$ 658	$ 682	$ 704	$ 644	$ 753	**$ 657**
Milking Cow Purchased Concentrates	$ 1,008	$ 1,044	$ 1,115	$ 1,203	$ 1,180	$ 1,126	**$ 1,113**
Milking Cow Purchased Forages	$ 273	$ 224	$ 152	$ 103	$ 166	$ 415	**$ 222**
Heifer and Dry Cow Home Raised Feed	$ 93	$ 63	$ 214	$ 91	$ 101	$ 119	**$ 114**
Heifer and Dry Cow Pur Concentrates	$ 237	$ 279	$ 337	$ 305	$ 323	$ 322	**$ 301**
Heifer and Dry Cow Pur Forages	$ 144	$ 82	$ 170	$ 130	$ 86	$ 181	**$ 132**
Total Feed	**$ 2,258**	**$ 2,351**	**$ 2,669**	**$ 2,537**	**$ 2,500**	**$ 2,915**	**$ 2,538**
Percent of Milk Inflow (Milking Cows)	**41%**	**41%**	**42%**	**44%**	**46%**	**62%**	**46%**
Home Raised Feeds	$ 595	$ 721	$ 896	$ 795	$ 745	$ 872	**$ 771**
Purchased Concentrates	$ 1,245	$ 1,323	$ 1,452	$ 1,508	$ 1,503	$ 1,447	**$ 1,413**
Purchased Forages	$ 418	$ 306	$ 321	$ 233	$ 252	$ 595	**$ 354**

143 farms

2013 Summary – Cropping Program

All Breeds	17%	21%	15%	13%	20%	13%	
	Breakeven Milk Price						
Cropping Information	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Average Acres Cropped with Double Crop	202	279	392	460	339	265	**323**
Average Acres Available	174	205	353	317	248	206	**250**
Average Double Crop Acres	41	84	51	181	102	83	**90**
Percent Double Cropped Acreage	26%	48%	21%	36%	38%	34%	**34%**
Acres Cropped/Total Cows	2.27	2.24	2.40	2.43	2.03	2.50	**2.31**
Acres Available/Total Cows	1.95	1.63	2.08	1.86	1.56	1.95	**1.84**

Could forage quality explain the difference between profitable and non profitable herds?

Could high forage based rations explain the reduced cost in purchased feeds?

143 farms

Penn State **Extension**

2013 Summary – The Bottom Line

All Breeds	17%	21%	15%	13%	20%	13%	
	Breakeven Milk Price						
Dairy Summary per Cow:	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Gross Milk Price Farm Breakeven	$ 14.28	$ 17.06	$ 18.47	$ 19.39	$ 20.81	$ 25.61	**$ 19.27**
IOFC Breakeven	$ 5.17	$ 6.96	$ 7.87	$ 7.70	$ 8.26	$ 8.21	**$ 7.36**
Gross Margin to Guarantee	$ 7.46	$ 9.50	$ 10.88	$ 10.95	$ 11.96	$ 14.20	**$ 10.83**
Total Inflow - Total Outflow	$ 475	$ 320	$ (383)	$ (379)	$ (228)	$ (1,501)	**$ (283)**

143 farms

Penn State **Extension**

Case Farms (Cash Flow Project) – Tying together cropping strategy & feed management with cash flow plans

- 10 Farms
- Average Herd Size- 247 (range 52-573)

Milk Price Historical	$ 18.20
2012 Average Milk Price Used	$ 19.81
Change	$ 1.61
CWT Sold (n=10)	571,266.35

What farms did before - after

- Before 2012
  - Shortage of home-raised corn grain and haylage or hay
  - Traditional corn/alfalfa rotation with limited small grains
- After – 2012 forward
  - Reduced alfalfa silage feeding rate
  - Increased corn silage acreage / feeding rate
  - Reduced corn grain feeding rate / increased acreage
  - Increased small grain acreage / feeding rate
- Reduced purchased corn grain and hay

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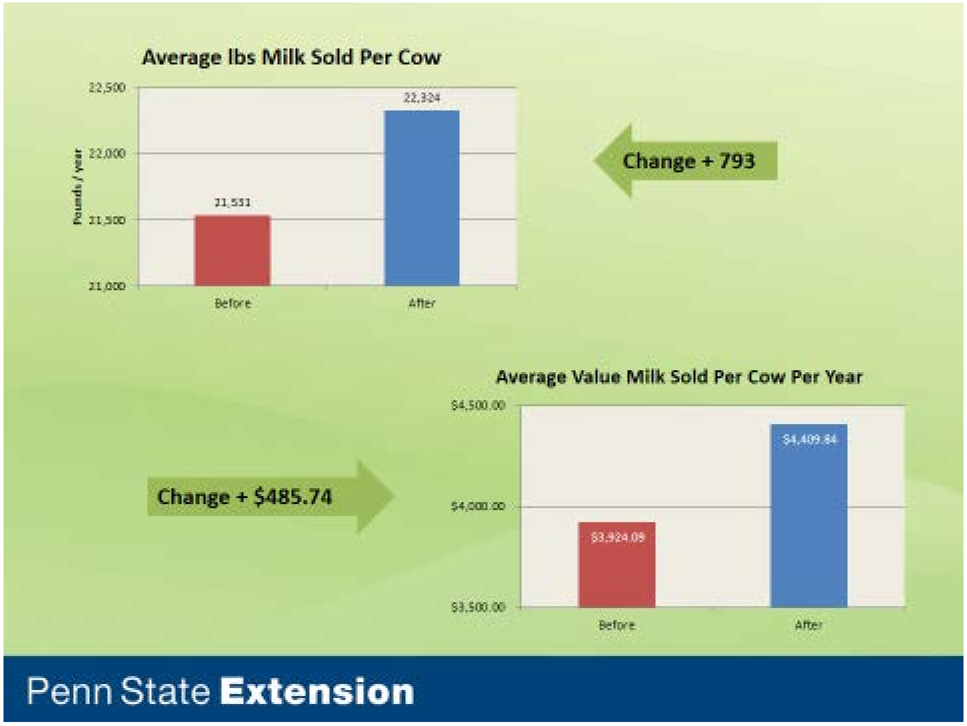
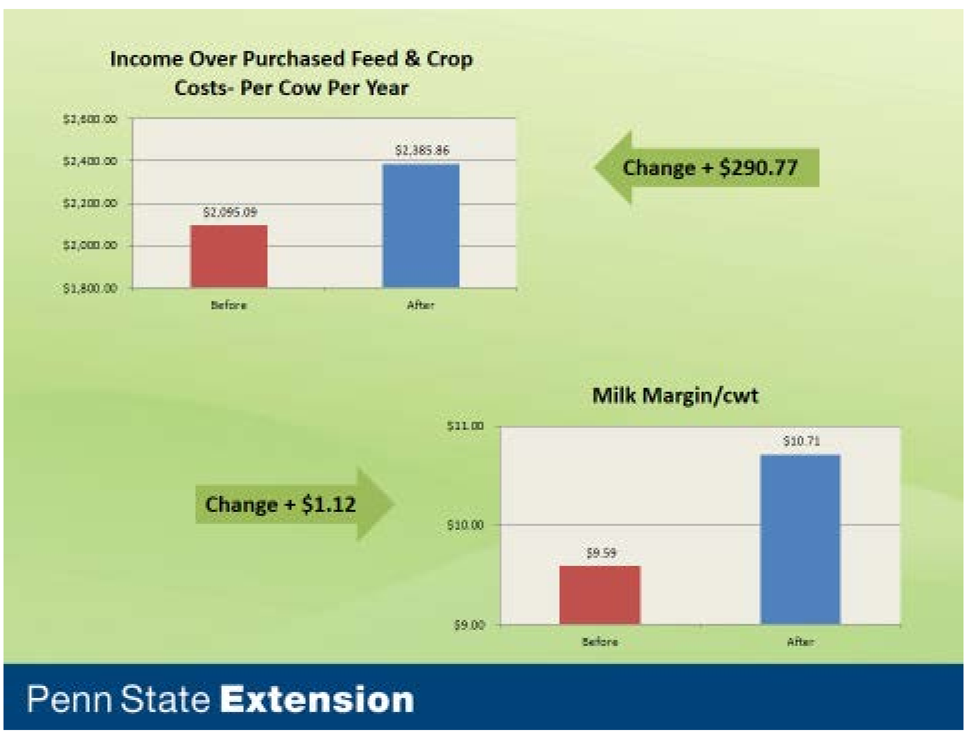


Average lbs Milk Sold Per Cow
Pounds / year
22,500
22,000
21,500
21,000
21,531
22,324
Before
After
Change + 793
Average Value Milk Sold Per Cow Per Year
$4,500.00
$4,000.00
$3,500.00
$3,924.09
$4,409.84
Before
After
Change + $485.74
Penn State Extension



Income Over Purchased Feed & Crop Costs- Per Cow Per Year
$2,600.00
$2,400.00
$2,200.00
$2,000.00
$1,800.00
$2,095.09
$2,385.86
Before
After
Change + $290.77
Milk Margin/cwt
$11.00
$10.00
$9.00
$9.59
$10.71
Before
After
Change + $1.12
Penn State Extension

Penn State **Extension**

Case Farm Summary

- High Forage Diet > 55% Forage
- High Corn Silage Diet: 21-28 lbs. DM/day
  - Allowed diets formulated closer to cow's requirement for metabolizable protein
  - More energy via carbohydrates:
    - Increased microbial protein production

Put Strategies into Practice

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What is good forage quality?



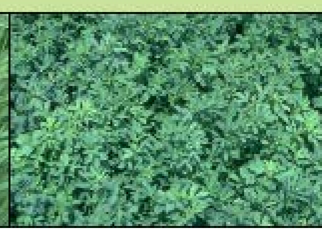
Feeding high forage based rations.


Keys to Success

- Harvesting
- Chopping
- Packing
- Feed out rate
- Measure:
  - ADF, NDF, 30hr NDF digestibility
  - Starch (CS), 7hr starch digestibility
  - Protein: soluble and heat damaged
  - Minerals
  - Fat
  - Ash
  - VFA profile
  - pH


Feeding high forage diets

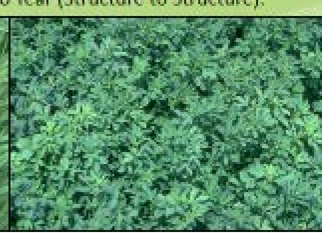
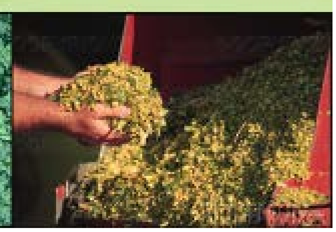
- If total forage ≥ 55% it must be high quality
- Max NDF content:
  - Alfalfa - 40%
  - Grasses - 55%
  - Corn silage - 40 to 45% (Tylutki and Fox, 2000)


Ranges in 30hr in vitro digestibility (%NDF): High quality Forages

Mostly legume haylage	high 50%s
Grass haylage	60%+
Corn silage (conventional)	high 50%s

Note: Do Not Compare Between Labs – Different Procedures – Stick with One Lab and Track Your Results from Year to Year (Structure to Structure).

Alfalfa Haylage Quality – Penn State Dairy Herd

Structure[1]	Year Tested	NDF, %DM[2]	NDF-D 30hr, %NDF[3]
Bag	2013	42.9	
Upright	2012	36.1	
Upright	2012	43.6	
Bag	2012	42.6	
Bag	2012	34.3	
Upright	2012	47.2	
Upright	2012	39.4	
Upright	2011	49.3	42.5
Bag	2011	43.0	37.9
Upright	2011	41.4	
Upright	2011	34.3	32.2

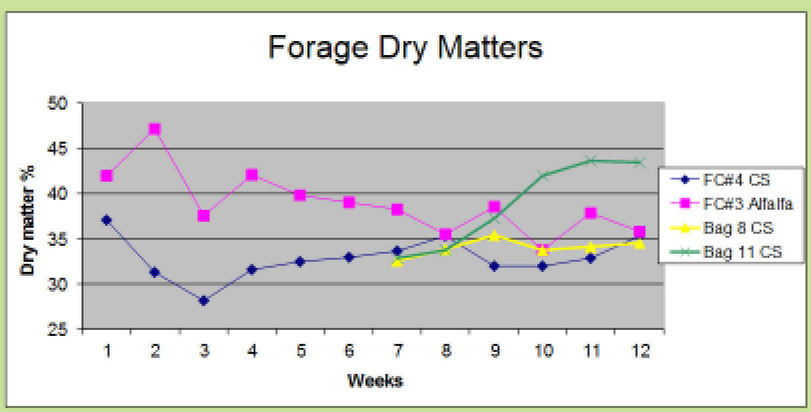
[1] Bag = Ag Bag; Upright Concrete Silo, top unloading
[2] NDF = Neutral Detergent Fiber reported on a dry matter (DM) basis
[3] NDF-D = Neutral Detergent Fiber Digestibility – 30 hours reported as a percent of NDF

Corn Silage Quality – Penn State Dairy Herd

Type	Structure	Year Harvested	NDF, %DM	NDF-D 30hr, %NDF	Starch, %DM	Starch 7-hr Dig., % Starch
BMR	**Bunk**	**2012**	**36.9**		**35.3**	**73.0**
BMR	**Bag**	**2012**	**33.4**	**68.2**	**39.2**	**68.0**
BMR	**Upright**	**2011**	**36.7**	**63.8**	**37.4**	
BMR	**Bunk**	**2011**	**41.7**	**62.1**	**28.8**	
BMR	**Bunk**	**2010**	**39.1**	**76.3**	**36.0**	

Type	Structure	Year Tested/ Harvested	NDF, %DM	NDF-D 30hr, %NDF	Starch, %DM	Starch 7-hr Dig., % Starch
Conv	Bag	2013/2013	44.4	50.7	27.0	70.4
Conv	Bunk	2013/2012	31.7	56.1	42.9	79.8
Conv	Bunk	2013/2012	34.3	57.0	42.5	76.7
Conv	Upright	2013/2012	31.1		43.3	71.6
Conv	Bag	2012/2012	29.1	60.7	48.6	66.5
Conv	Bag	2012/2012	33.1		44.8	68.2
Conv	Upright	2012/2012	31.1	61.3	43.4	68.2
Conv	Upright	2012/2012	33.6		40.7	
Conv	Bag	2012/2012	38.3		33.2	
Conv	Bag	2012/2011	38.6		36.8	
Conv	Bunk	2012/2011	41.6		32.4	
Conv	Bag	2012/2011	37.1		38.2	
Conv	Upright	2011/2010	35.5		39.3	

Monitoring Dry Matter



PSU's high forage based ration

- Prior to 2008
  - herd was fed a 50/50 forage : concentrate diet
- Since 2008– 60-65% forage on a dry matter basis
- High CS based diet w/ alfalfa haylage and grass hay
- Production and components have improved

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2nd cut alf hlg- 2013- Bag

CUMBERLAND VALLE
Laboratory services for agricultur

Farm: PSU DAIRY
Desc: BAG 8 HLG ('13 2ND CUT)
Submitter: SWOPE, RANDY
Account: PSU-DEPT. DAIRY/ANIMAL SCIENCE
Copies to

BAG 8 HLG ('13 2ND CUT)

SAMPLE INFORMATION			
Lab ID:	15293 211	Series:	
Crop Year:	2013	Version:	1.0
Cutting#:			
Feed Type:	ALFALFA FORAGE		

NIR ANALYSIS RESULTS	
Moisture	63.0
Dry Matter	37.0

PROTEINS	% SP	% CP	% DM
Crude Protein			19.4
Adjusted Protein		95.6	18.5
Soluble Protein		55.8	10.8
Ammonia	21.9	12.2	2.37
ADF Protein (ADICP)		14.4	2.79
NDF Protein (NDICP)		17.9	3.47
NDR Protein (NDRCP)			
Rumen Degr. Protein		77.9	15.1
Rumen Deg. CP (Strep.G)			

FIBER	% NDF	% DM
ADF	90.7	38.3
aNDF		42.2
aNDFom		
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	23.09	9.75
NDF Digestibility (12 hr)		

Forages Fed in Fall 2013

CS – 2012 - Bunk

CUMBERLAND VALLEY
Laboratory services for agriculture

Farm: PSU DAIRY
Desc: BUNK 1 CS 2012 CROP YEAR
Submitter: SWOPE, RANDY
Account: PSU-DEPT. DAIRY/ANIMAL SCIENCE
Copies to:

BUNK 1 CS 2012 CROP YEAR

SAMPLE INFORMATION			
Lab ID:	15294 003	Series:	
Crop Year:	2012	Version:	2.0
Cutting#:			
Feed Type:	CORN SILAGE		

NIR ANALYSIS RESULTS	
Moisture	63.7
Dry Matter	36.3

PROTEINS	% SP	% CP	% DM
Crude Protein			7.3
Adjusted Protein			
Soluble Protein		70.3	5.1
Ammonia	29.0	20.4	1.48
ADF Protein (ADICP)		9.8	0.71
NDF Protein (NDICP)		9.6	0.70
NDR Protein (NDRCP)			
Rumen Degr. Protein		85.1	6.2
Rumen Deg. CP (Strep.G)			

FIBER	% NDF	% DM
ADF	63.0	20.0
aNDF		31.7
aNDFom		
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	7.54	2.39
NDF Digestibility (12 hr)		
NDF Digestibility (24 hr)		
NDF Digestibility (30 hr)	56.1	17.8
NDF Digestibility (48 hr)		
NDF Digestibility (240 hr)		
Indigestible NDF		

CARBOHYDRATES	% Starch	% NFC	% DM
Silage Acids			
Ethanol Soluble CHO (Sugar)		2.0	1.1
Water Soluble CHO (Sugar)			
Starch		70.2	42.9

7 hour invitro starch degradability = 79.8% of starch

Total Ration Specification – DM basis

65% Forage

Protein, % 15%
MP, lbs -0.19 lbs

NDF, % 31.6
Starch, % 26.5

Milk prod, lbs 86.0
Milk fat, % 3.61
Milk protein, % 3.12

Fall 2013 Ration		
Ingredient Name	DM Basis	As Fed Basis
	----- lbs. -----	
Bunk CS - 2012	26.2	72.1
2nd cut Alf HLG-2013	9.0	24.3
Grass Hay	2.6	3.0
Cottonseed Hulls	1.4	1.5
Fine Ground Corn	5.4	6.1
Candy Meal	3.5	4.0
Sugar	2.5	4.5
Canola Meal	3.6	4.2
Soybeans, Cooked	3.7	4.0
Optigen®	0.34	0.35
Min-Vit Mix	1.80	1.90
	--------	--------
Total	60.1	126

2013 CS

Low Starch

Low Starch Dig

High NDF

Low NDFD

CUMBERLAND VALLE
Laboratory services for agricultu

Type: CORN SILAGE
Farm: PSU DAIRY
Desc: BAG 9-13 CS
SWOPE RANDY
PSU-DEPT. DAIRY/ANIMAL SCIENCE

Copies to:

Regressio

BAG 9-13 CS

SAMPLE INFORMATION			
Lab ID:	15563 102	Series:	
Crop Year:	2013	Version:	3.0
Cutting#:			
Feed Type:	CORN SILAGE		

CHEMISTRY ANALYSIS RESULTS			
Moisture			68.5
Dry Matter			31.5
PROTEINS	**% SP**	**% CP**	**% DM**
Crude Protein			6.8
Adjusted Protein			6.8
Soluble Protein		40.3	2.8
Ammonia			
ADF Protein (ADICP)			
NDF Protein (NDICP)			
NDR Protein (NDRCP)			
Rumen Degr. Protein		70.2	4.8
Rumen Deg. CP (Strep.G)			
FIBER		**% NDF**	**% DM**
ADF		61.0	27.1
NDF			44.4
aNDFom			
NDR (NDF w/o sulfite)			
peNDF			
Crude Fiber			
Lignin			
NDF Digestibility (12 hr)			
NDF Digestibility (24 hr)			
NDF Digestibility (30 hr)		50.7	22.5
NDF Digestibility (48 hr)			
NDF Digestibility (240 hr)			
uNDF (30 hr)		49.3	21.9
uNDF (240 hr)			
CARBOHYDRATES	**% Starch**	**% NFC**	**% DM**
Silage Acids			
Ethanol Soluble CHO (Sugar)			
Water soluble CHO (Sugar)			
Starch		62.8	27.0
Soluble Fiber			
Starch Digestibility (7 hr)	70.4		

Total Ration Specification – DM basis

60% Forage

Protein, %	**14.5%**
MP, lbs	**-0.28 lbs**
NDF, %	**32.8**
Starch, %	**22.0**
Milk prod, lbs	**86.0**
Milk fat, %	**3.70**
Milk protein, %	**3.15**

Dec 2013/Jan 2014 Ration

Ingredient Name	DM Basis	As Fed Basis
	----- lbs. -----	
Bag CS - 2013	24.1	60.3
2nd cut Alf HLG-2013	12.0	32.4
Grass Hay	0	0
Cottonseed Hulls	0	0
Fine Ground Corn	8.1	9.1
Candy Meal	4.5	5.0
Sugar	3.1	5.5
Canola Meal	3.3	3.7
Soybeans, Cooked	3.1	3.3
Optigen®	0.2	0.2
Min-Vit Mix	1.80	1.90
	--------	--------
Total	60.2	121

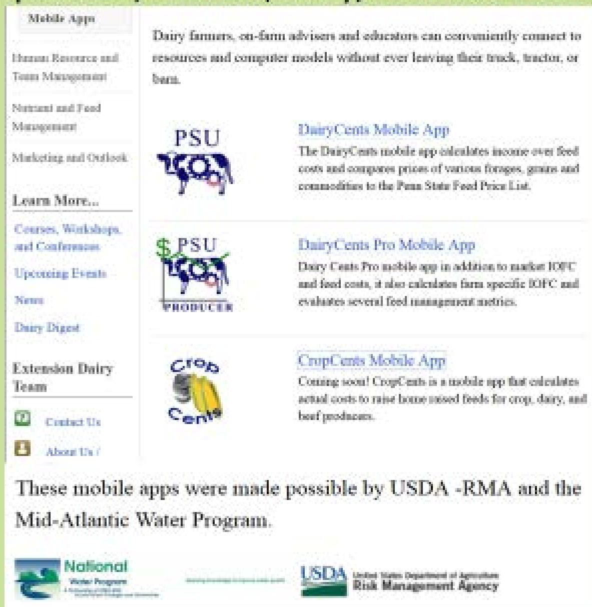
Penn State **Extension**

Summary

- Over $11/CWT range in breakeven milk price
- $500/cow difference in cost of purchased and home-raised feeds (best + vs. worse – cash flow)
- Total feed costs increased in 2013, but Income Over Purchased Feed improved more than $200/cow on the + cash flow herds
- Forage quality and feeding management are vital to realize these gains
- High corn silage rations allow for efficient protein utilization
  - Look closely at carbohydrate balance

Mobile Apps

extension.psu.edu/animals/dairy/business-management/



Virginia Ishler and Tim Beck
Extension Dairy Team
Penn State University
vishler@psu.edu
tbeck@psu.edu

In today's economy dairy producers need to be on top of all aspects of their business. Producers need to be prepared to deal with unprecedented volatility in both feed and milk prices. There are the complexities of animal husbandry, cropping, financial decisions, and equipment to deal with, along with many other important management areas. It appears based on the grain markets that feed will be cheaper in 2014. This could bring added relief to feed costs however it does mean producers need to closely evaluate their true crop production costs. Hopefully costs are less than the market is offering. In a year's time the market can make a dramatic change and the old saying "knowledge is power" is very true. If crop prices do stay at predicted levels, it's not clear where the milk price will settle out, so managing the milk margin remains a critically important item for dairy producers.

In the cash flow workshops conducted in the winter of 2013 by the Extension Dairy Team, the influence of double cropping on farms showing a positive cash balance compared to farms in negative balance was examined. The farms with a breakeven gross milk price less than $16/cwt utilized 26% of their acreage as a double crop. The next group of producers with a positive cash balance (breakeven milk price of $16-$18/cwt) utilized 48% of their acreage for double crops. Farms in a negative cash balance (>$18/cwt breakeven) had a range of 21 to 38 percent of the acreage as a double crop. The farms with a negative cash balance were spending on average $200 more per cow per year in purchased feed and $350/cow/year more on purchased and home raised feed compared to the farms with a positive cash balance. Approximately 70% of additional purchased feed was for the milk cows and 30% for the dry cows and heifers. There are two potential reasons why this could be happening. Forage quality may be poor and more purchased concentrates are needed to compensate for missing nutrients, or the producer is missing an opportunity to feed a high forage ration and is feeding more grain than necessary.

The average herd size of producers conducting a cash flow plan with the Extension Dairy Team was 124 lactating cows. In this data base, herds with a positive cash balance spent $200 less/cow/year in purchased feed. This equates to approximately $25,000 that is available to cover other expenses. It takes the same dollar inputs to make excellent quality forage as it does to make poor quality feed. It seems there are many missed opportunities to optimize forage quality.

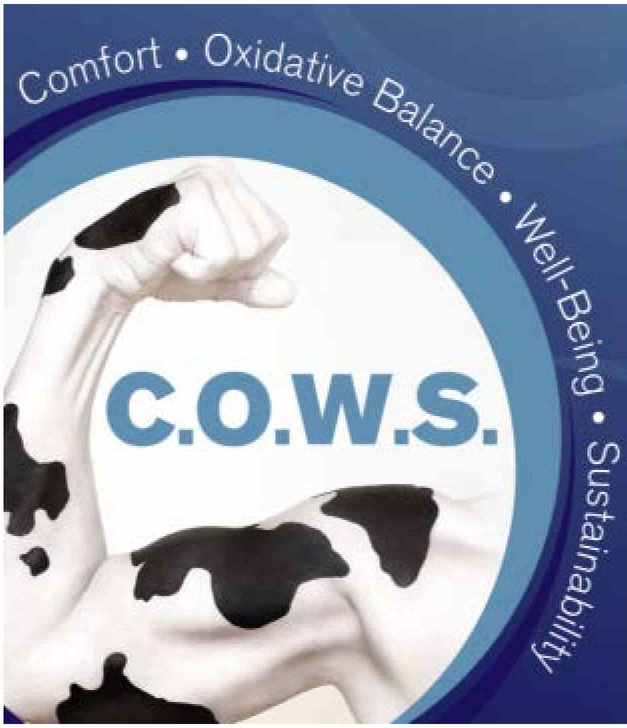
The two main areas that will impact forage quality are ensiling the material at the proper moisture content to ensure a good fermentation, and nutrient levels that reflect highly digestible forage. Producers that consistently feed high quality forage are doing everything correctly at harvest, storage and feed out. Assuming forages have been ensiled properly, neutral detergent fiber (NDF) and its digestibility would be one key area to examine. Herds feeding forages in excess of 55% of the total ration dry matter typically have a neutral detergent fiber level not exceeding 40% for alfalfa, 55% for grass and 40% for corn silage. The NDF digestibility (30 hr) for alfalfa and conventional corn silage should be in the 50s and in the 60s for grass forages. Corn silage provides the other key nutrient--starch. The level of starch and its digestibility are important numbers to evaluate as they greatly influence how much added grain is needed to balance a ration.

With the historic high feed prices the emphasis has been on optimizing home raised feeds. The herds that have kept feed costs in line have had the opportunity to raise corn grain and/or soybeans. There are two questions that keep surfacing: 1) how much yield do I need to keep cost of production low enough to take advantage of the market if I want to sell corn or beans? And 2) how much land rent can I afford before it negatively impacts the cost of production? With the grain market prices dropping for corn and soybeans, knowing the cost to produce them on farm becomes very important. These costs were evaluated from the cash flow plans completed in 2013.

Focusing on the producers falling into the category of lowest and highest yielding corn grain, the average low yield was 116 bu. /acre and the average high yield was 190 bu. /acre. It cost the low yielding producers $3.49/bu. compared to $2.28/bu. for the high yield. Both costs of production are still competitive if the corn price stays around $4.67/bu. (December futures). However, if the corn is being grown on rented land, that adds another dynamic. On the low yielding production, land rent exceeding $200/acre results in a price of $4.60/bu. On the high yielding production, a producer could tolerate land rent slightly over $300/acre.

Currently soybean futures are holding around $12/bu. Producers with the lowest yielding soybeans averaged 33 bu/acre compared to the high yielding group with 65 bu. /acre. Costs for the low yielding group were $7.70/bu. and the high yielding was $6.06/bu. Both costs still offer opportunity if the beans were to be sold. Taking into account land rent, the low yielding group could tolerate $100/acre but $200 would bring the cost right in at $12/bu. The high yielding group could tolerate $400/acre.

The bottom line this year is determining what it costs to produce home raised feeds. This is going to be important, especially if market prices continue to decline. The most critical factor will be how much can one pay for rented land and still be competitive. Every farm is different and the key is to know these numbers.



Novus C.O.W.S.^{SM} – Assessing and benchmarking cow comfort across the USA

Lindsay Collings
Novus C.O.W.S.
Project Manager

Feb 20, 2014
Delmarva Dairy Day
Hartly, DE

NOVUS
SOLUTIONS SERVICE SUSTAINABILITY

Agenda

- What is the Novus C.O.W.S. Program?
- What do we measure?
- C.O.W.S. benchmark data across the USA
  - Lying time
  - Hock injuries
  - Knee injuries
  - Lameness

NOVUS

Novus C.O.W.S. Program

Comprehensive on-farm assessment program offered to Novus customers aimed at:

- Identifying and unlocking bottlenecks
- Optimizing cow comfort and well-being
- Improving productive efficiency
- Contributing to sustainability

Novus C.O.W.S. Program

- Focus on 1 pen for each farm (usually the high producing, mature cows)
- Voluntary assessment (not an audit)
- Information is kept confidential between Novus, the producer, and their nutrition consultant

Novus C.O.W.S. Program

- Started as a Master's project at the University of British Columbia (UBC), Canada in 2009
- Novus partnered with UBC in 2010

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Novus C.O.W.S. Program

Phase One
Benchmarking

Phase Two
Implementation

March 2010 — May 2011 — Feb 2014

CA	NY/PA/VT	TX/NM	Nation-wide C.O.W.S.
43	40	35	344 (CA, CT, FL, ID, IN, MD, ME, MI, MN, ND, NM, NY, OH, OR, PA, SD, TX, UT, VT, WA, WI)

462 assessments

NOVUS

How does Novus C.O.W.S. work?

1. On-farm assessment

•Cow-based measures

- Lying time
- Hock & knee injuries
- Lameness

•Management/facility measures

- Stall design
- Bedding quality
- Stocking density, etc.

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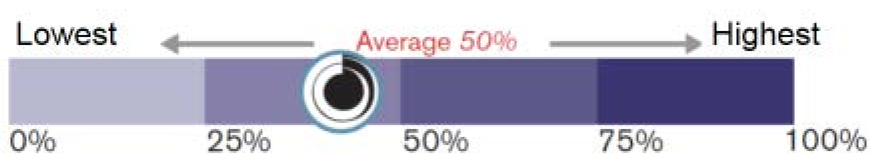
How does Novus C.O.W.S. work?

2. Feedback to the dairy relative to region benchmark



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Part A: Cow-based Measures

1. On-farm assessment

A: Cow-based measures

- Lying time
- Hock & knee injuries
- Lameness

B: Management/facility measures

- Stall design
- Bedding quality
- Stocking density, etc.

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LYING TIME

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How does Novus measure lying time?

Data loggers recorded lying times of 40 cows (randomly selected from assessment pen)

- At 1-min intervals
- Averaged over 3 days

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Why is lying important for cows?

- Motivation to lie down for ~12 hours/day (Jensen et al., 2005)
- Lying is a high priority behavior (Munksgaard et al., 2005)
  - Lying behavior takes precedence over eating and social behavior when opportunities to perform these behaviors are restricted
- Link to lameness (Cook and Nordlund, 2009)
  - Standing on concrete instead of lying down in stalls
  - Reduced rest due to uncomfortable stalls
- Every cow has different lying time requirements

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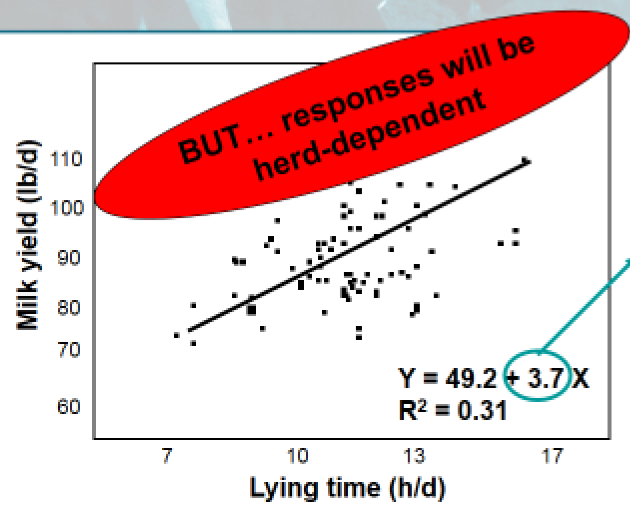
Economics of lying time

- Relationship between milk yield and lying time



~3.7 lb/d more milk for each extra hour of lying down

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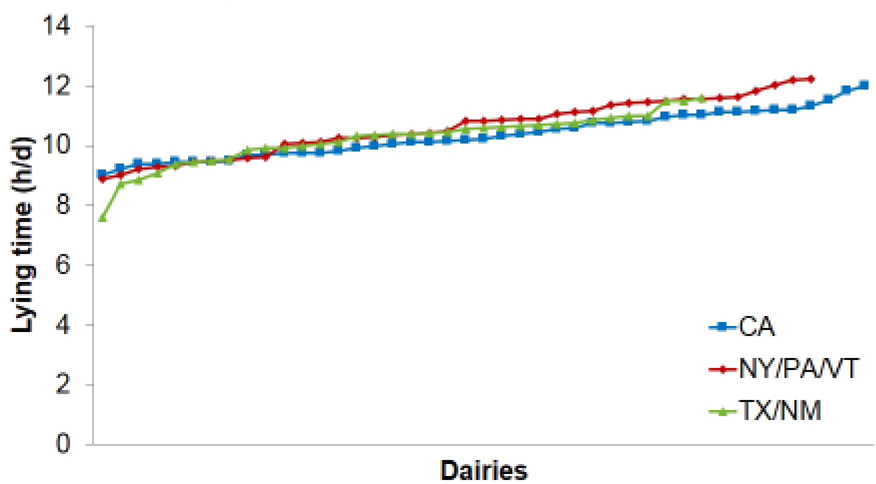
25

(Miner Institute Database; Grant, 2007)

Lying Time: Regional Benchmarks



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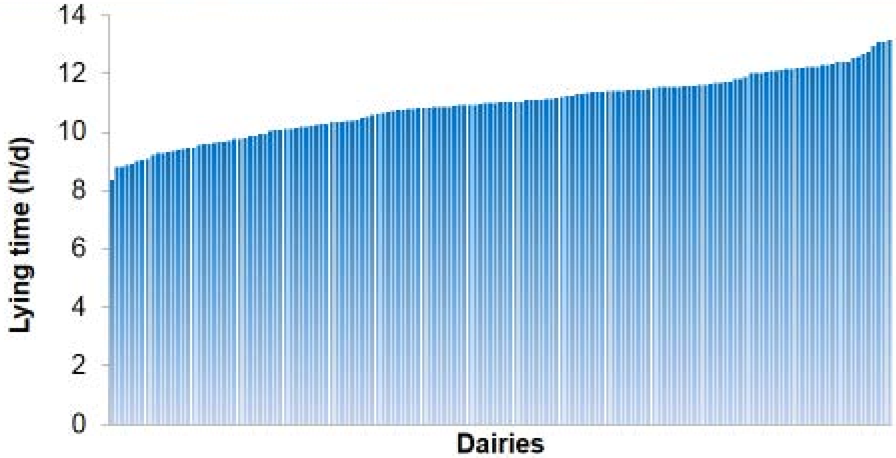
27

(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

Lying Time: Northeast (153 freestall dairies)

- Average: 11 hr 00 min (range: 8.5 to 13 h/d)



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(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

HOCK EVALUATIONS

NOVUS

How does Novus score hocks?

Every cow in the assessment pen was scored for hock injuries

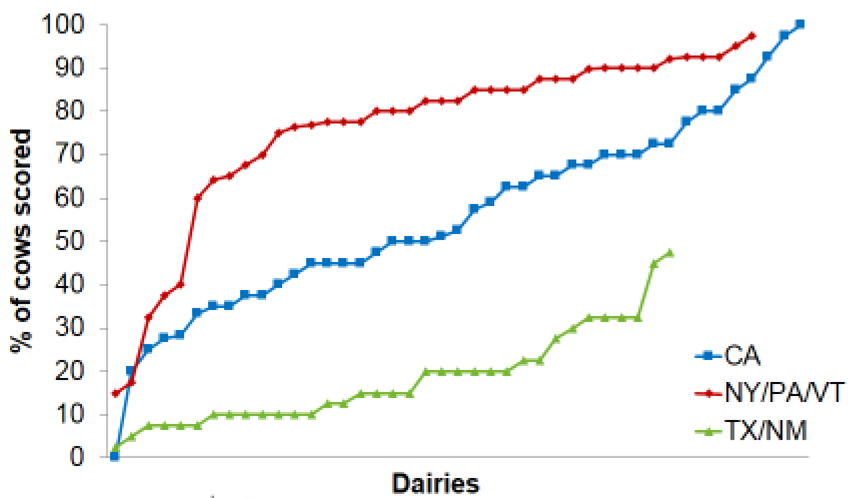
Cornell University Cooperative Extension **Hock Assessment Chart for Cattle**

Score = 1 No Swelling. No hair is missing.

Score = 2 No swelling. Bald area on the hock.

Score = 3 Swelling is evident or there is a lesion through the hide.

Overall Hock Injuries: Regional Benchmarks



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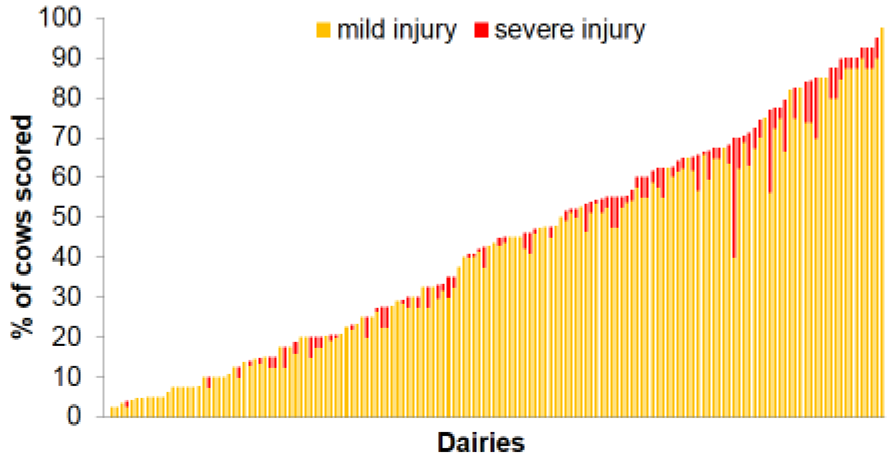
(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

Hock Injuries: Northeast (153 freestall dairies)

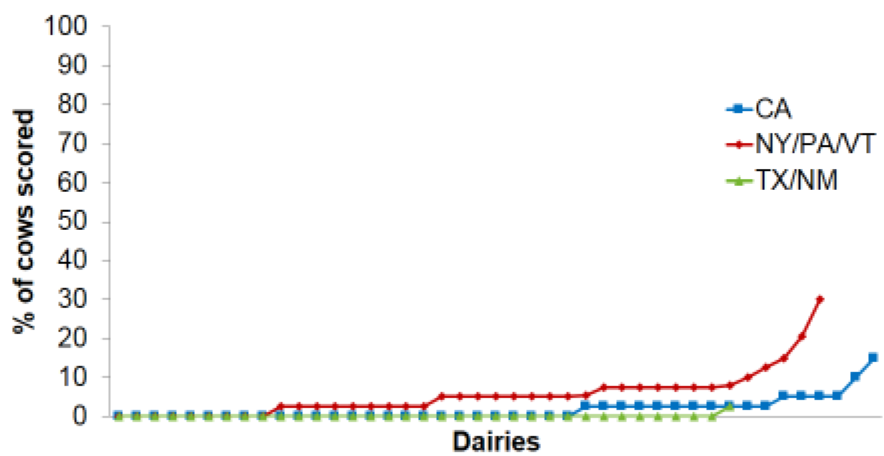
- Average: 44% had at least hair loss (range: 0 to 98%)



NOVUS

(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

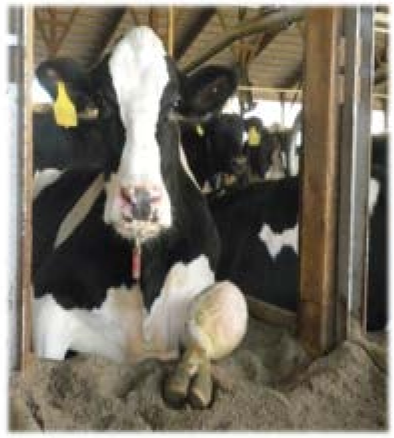
Severe Hock Injuries: Regional Benchmarks



NOVUS

(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

KNEE EVALUATION



NOVUS

How does Novus score knees?

Every cow in the assessment pen was scored for knee injuries

Not swollen/injured

Swollen and/or injured

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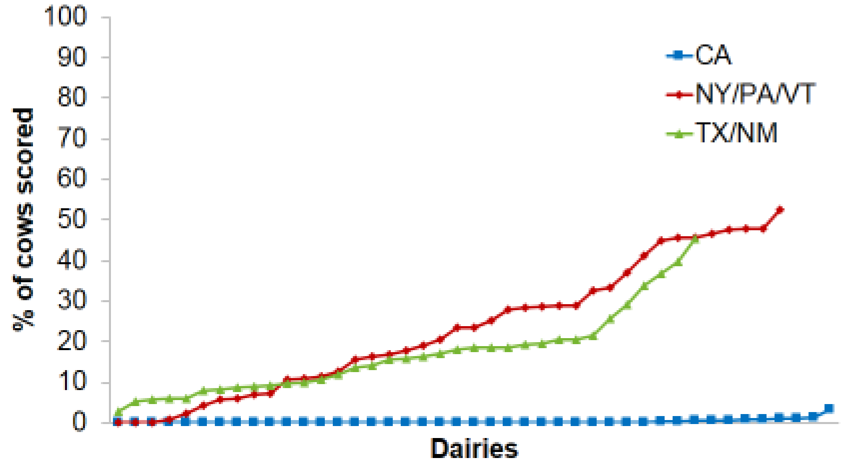
Swollen Knees: Regional Benchmarks



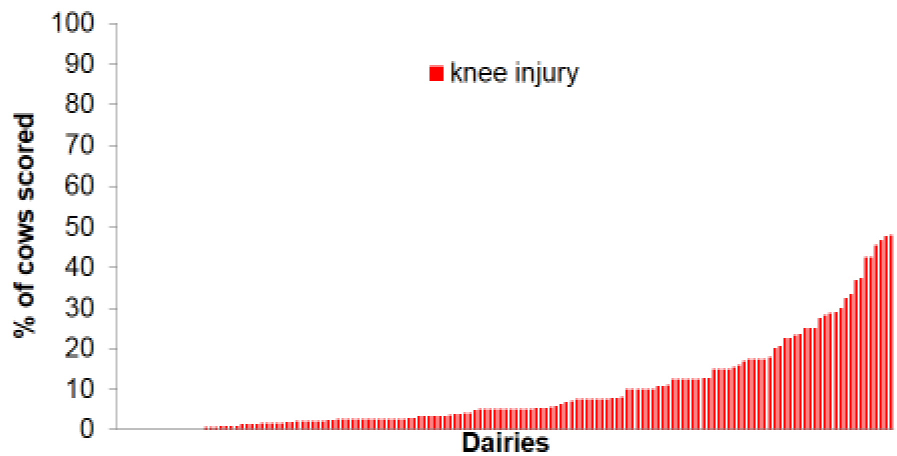
NOVUS

45

(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

Swollen Knees: Northeast (153 freestall dairies)

- Average: 5% had swollen knee (range: 0 to 48%)



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47

(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

LAMENESS

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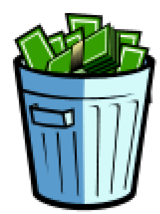
Lameness is a costly problem

- Reduced fertility (Bicalho et al., 2007)
  - 15% for mildly lame cows
  - 24% for severely lame cows

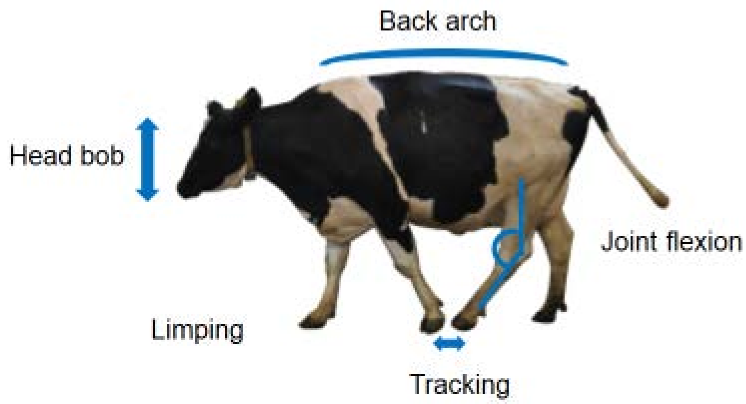


- Increased risk of culling (Bicalho et al., 2007)
  - + 45% for mildly lame cows
  - + 74% for severely lame cows
- Reduced milk yield (Green et al., 2002; Bicalho et al., 2008)
  - 800 to 900 lb over lactation
- Welfare implications (Whay et al., 2003)

NOVUS

How does Novus score lameness?

Every cow in the assessment pen was scored for lameness



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(Adopted from Flower and Weary, 2006)

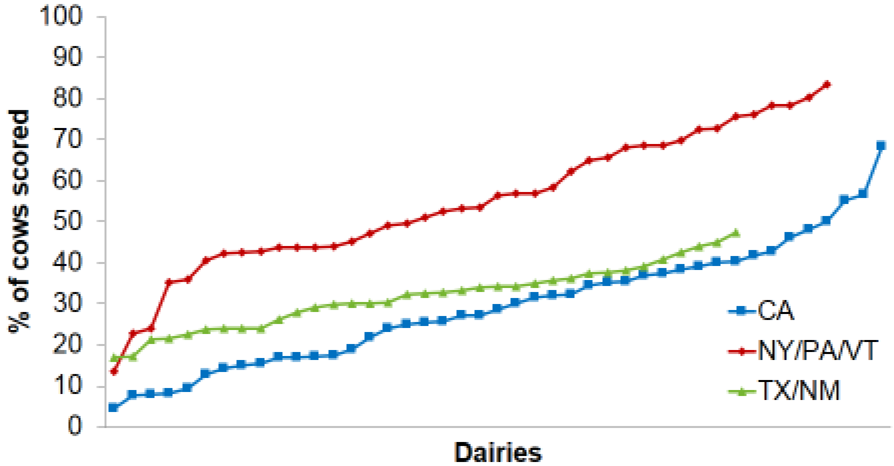
How does Novus score lameness?

Gait Score	Category	Description
1 (Sound)	**Not lame**	walks with a smooth and fluid locomotion, a flat back and even steps.
2 (Imperfect gait)		walks with a slightly uneven gait and slight joint stiffness but with no limp.
3 (Mildly lame)	**Mildly lame**	walks with shortened strides, an arched back and a slight limp.
4 (Moderately lame)	**Severely lame**	walks with an obvious limp, an arched back and a jerky head bob.
5 (Severely lame)		Unwilling to bear weight on one limb and/or must be vigorously encouraged to stand or move.

NOVUS

(Adopted from Flower and Weary, 2006)

Overall Lameness: Regional Benchmarks



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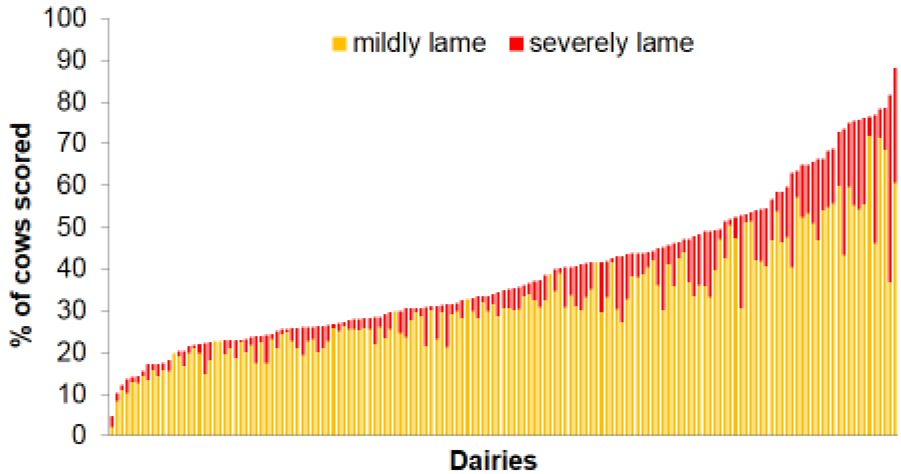
57
(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

Lameness: Northeast (153 freestall dairies)

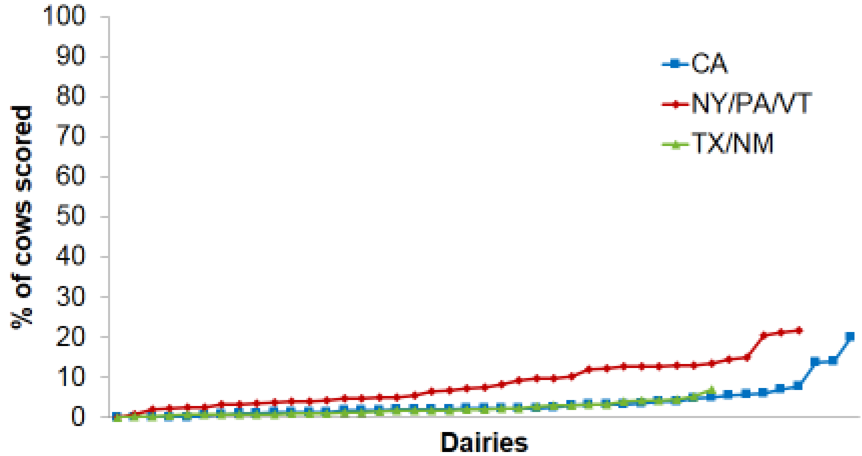
- Average: 35% (range: 5 to 88%)



NOVUS

59
(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

Severe Lameness: Regional Benchmarks



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(von Keyserlingk et al., 2012; Novus C.O.W.S. data)

Summary

- Novus C.O.W.S. Program is an on-farm cow comfort assessment providing valuable feedback to producers on cow comfort on their farm relative to the regional benchmarks
- In each region, there are dairies with cow comfort issues
- Common issues in the northeast include hock injuries and lameness
- Good cow comfort can be achieved anywhere in the US

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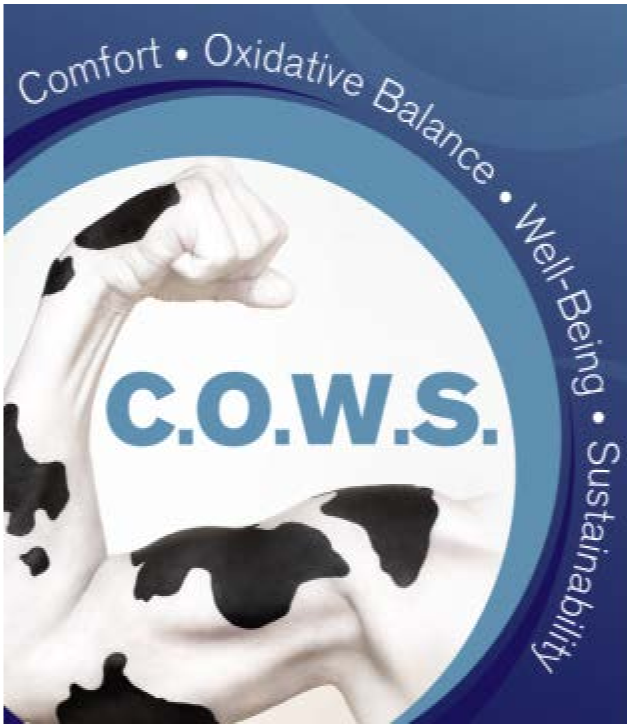
Questions?



Novus C.O.W.S.℠ – Key learnings and on-farm application in the Northeast

Katie Wood
Novus C.O.W.S.
Project Manager

Feb 20, 2014
Delmarva Dairy Day
Hartly, DE

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SOLUTIONS SERVICE SUSTAINABILITY™

Agenda

- Highlight the importance of management and facilities in understanding cow comfort
- Novus C.O.W.S. published data
- Common issues in the Northeast
- Multifactorial issues

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Management affects milk production

47 herds with similar genetics were fed same TMR

- production ranged by **29 lb/d** (avg: 45 to 74 lb/day)
- non-dietary factors accounted for **56%** of variation in milk yield
  - Stocking density (+1.7 lb/cow per 10% reduction)
  - Feeding for refusals (+3.5 lb/cow)
  - Feed push-ups (+8.7 lb/cow)

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(Bach et al., 2008)

What are we seeing on-farm? Published C.O.W.S. Data

1. Barrientos et al., 2013. **Herd-level risk factors for hock injuries in freestall-housed dairy cows in the northeastern United States and California**. JDS. 96:3758-3765
2. Chapinal et al., 2013. Herd-level risk factors for lameness in freestall farms in the northeastern United States and California. JDS. 96:318-328.

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1. Overall Hock Injuries - Northeast

- **Deep-bedding**
  - deep-bedded stalls associated with fewer hock injuries

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(Barrientos et al., 2013)

1. Severe Hock Injuries - Northeast

- **Deep-bedding**
  - deep-bedded stalls associated with fewer severe hock injuries
- **Automatic alley scrapers**
  - automatic alley scrapers associated with more severe hock injuries

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(Barrientos et al., 2013)

What are we seeing on-farm? Published C.O.W.S. Data

1. Barrientos et al., 2013. Herd-level risk factors for hock injuries in freestall-housed dairy cows in the northeastern United States and California. JDS. 96:3758-3765

2. Chapinal et al., 2013. **Herd-level risk factors for <u>lameness</u> in freestall farms in the northeastern United States and California.** JDS. 96:318-328.

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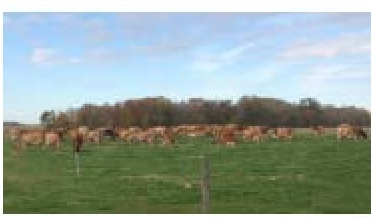
2. Overall Lameness - Northeast



- **Herd size (100-cow increase)**
  - larger herds associated with lower overall lameness
- **Deep-bedding**
  - deep-bedded stalls associated with lower overall lameness
- **Access to pasture**
  - access to pasture associated with lower overall lameness

(Chapinal et al., 2013)

2. Severe Lameness - Northeast

- **Deep-bedding**
  - deep-bedded stalls associated with lower severe lameness
- **Herd size (100-cow increase)**
  - larger herds associated with lower severe lameness

(Chapinal et al., 2013)

Many factors affect cow comfort

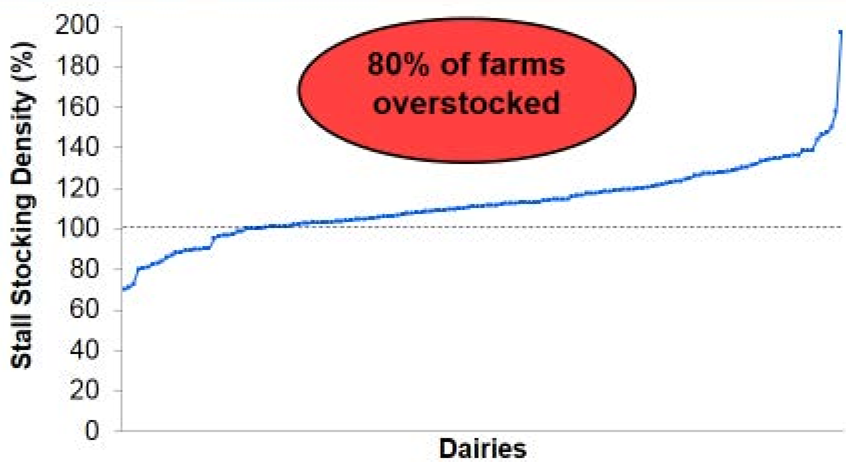
Stocking density

Stalls

Feed bunk

Stall Stocking Density: Northeast (153 dairies)

- Average: 111% (range: 70 to 197%)



(Novus C.O.W.S. data)

Effects of Overstocking at the Stalls

- Reduced lying time (Fregonesi et al., 2007)
- Reduced latency to lie down after return from parlor (Fregonesi et al., 2007)
  - cows lying down sooner upon return from parlor, instead of staying at feed bunk longer
- Reduced production (Bach et al., 2008)
  - heifers and lame cows affected the most
- Reduced milk fat % (Hill, 2006)
- Lower conception rates (Schefers et al., 2010)

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Stocking density

Stalls

Feed bunk

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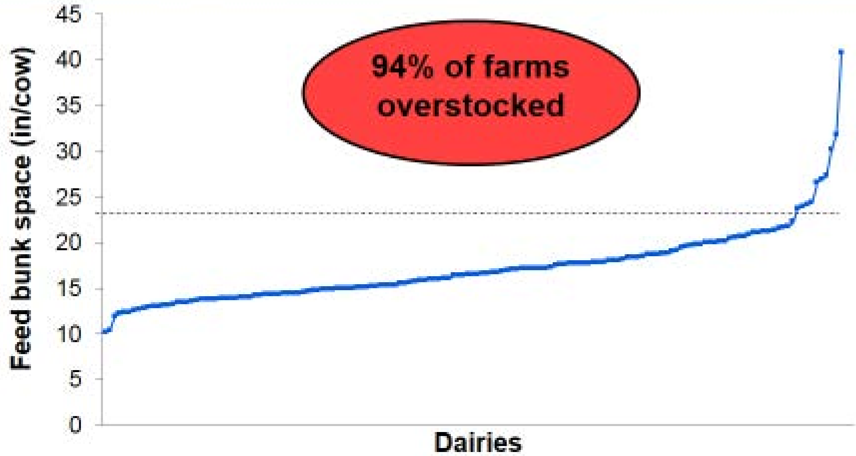
Feed Bunk Space: Northeast (153 dairies)

- Average: 16 in/cow (range: 10 to 41 in/cow)



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(Novus C.O.W.S. data)

Effects of Overstocking at the Feed Bunk

- Increased competition (Collings et al., 2011; Proudfoot et al., 2009)
- Increased feeding rate (Hosseinkhani et al., 2008; Proudfoot et al., 2009)
- DMI can be reduced (Grant et al., 2010)
  - seen in heifers
- Reduced milk fat % (Hill et al., 2006; Sova et al., 2013)
- Increased SCC (Sova et al., 2013)
- Compromised reproduction (Caraviello et al., 2006)

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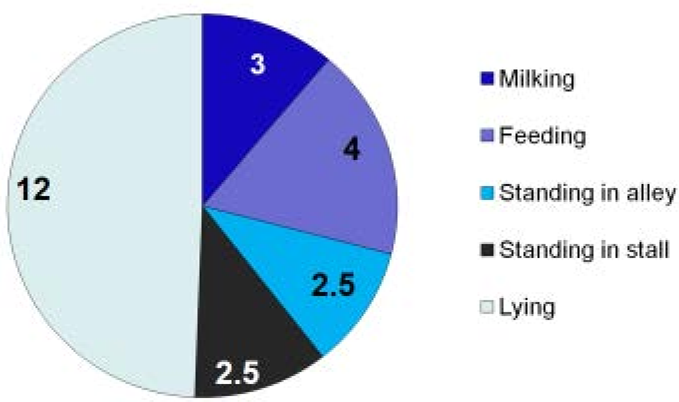
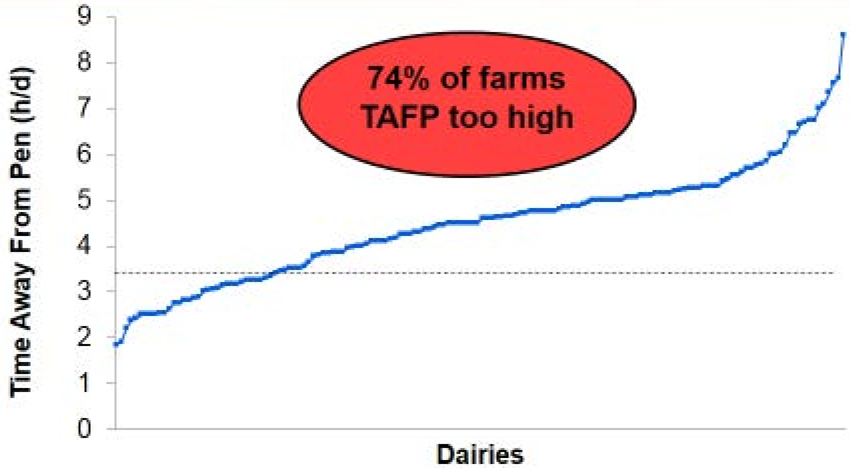
Time budgets and time away from the pen (TAFP)

Time budget of a dairy cow



(Gomez and Cook, 2010)

Time Away from Pen (TAFP): Northeast (153 dairies)
- Average: 4.6 h/d (range: 1.8 to 8.6 h/d)



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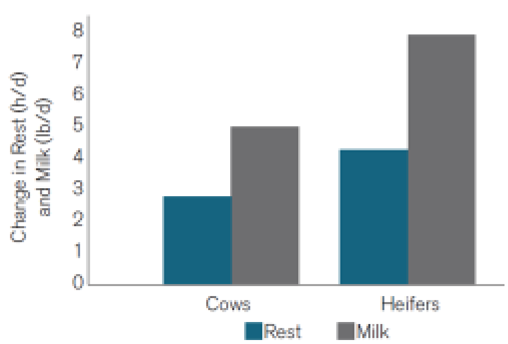
(Novus C.O.W.S. data)

High Time Away from Pen for Milking

- Higher lameness prevelance (Espejo and Endres, 2007)
- Reduced lying time (Matzke, 2003)
- Reduced production (Matzke, 2003)

When TAFP reduced from 6 to 3 h/d



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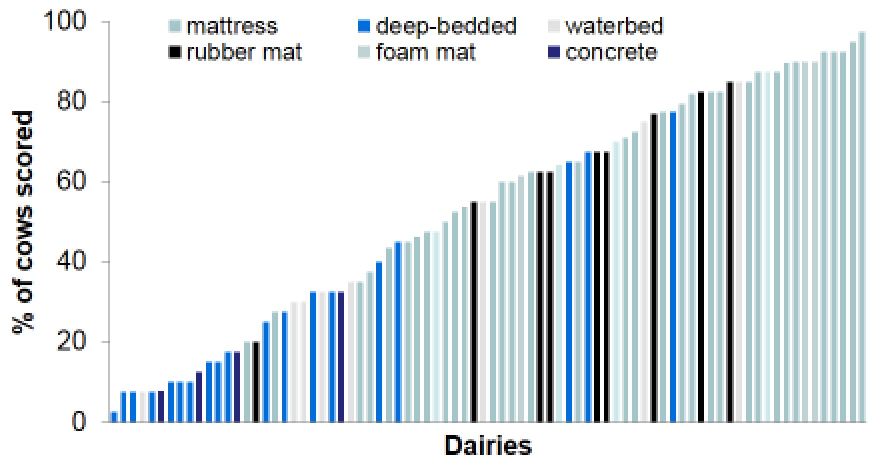
(Matzke, 2003)

COW COMFORT ISSUES ARE MULTIFACTORIAL

Focusing on one factor: Stall Base

- Deep-beds are associated with fewer hock injuries and less lameness compared to non-deep-bedded stalls
- But it is just one factor of many!

Herds with deep-beds are associated with fewer hock injuries…



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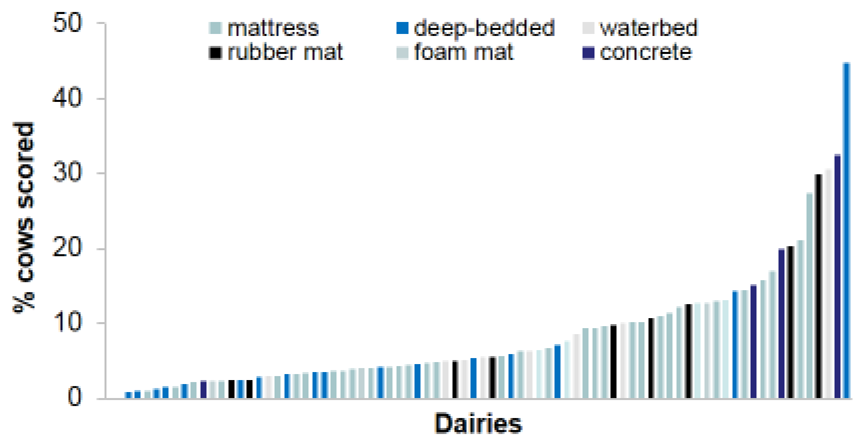
(Novus C.O.W.S. data)

Herds with deep-beds are associated with less severe lameness…



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47
(Novus C.O.W.S. data)

Focusing on one factor: Herd Size

- Larger herds are associated with lower lameness and lower severe lameness compared to smaller herds
- But it is just one factor of many!

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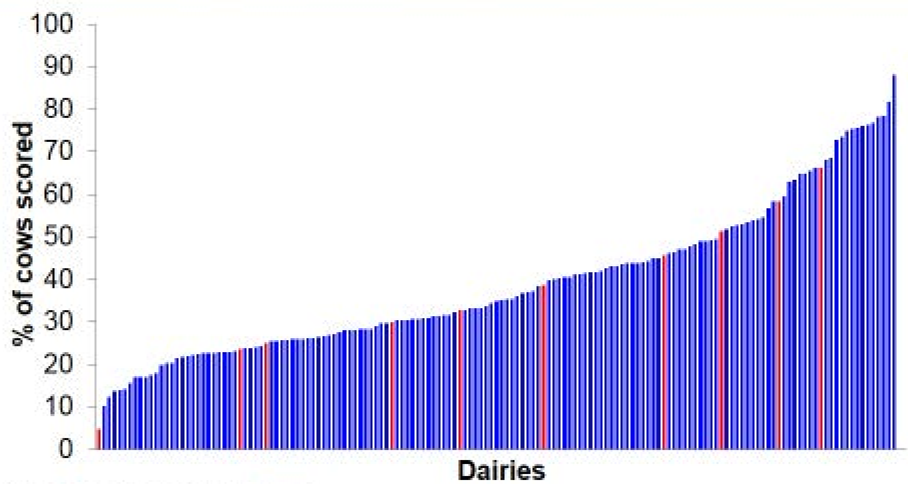
Lameness: Northeast (153 freestall dairies)

- 10 smallest dairies (<200 milking cows) in red



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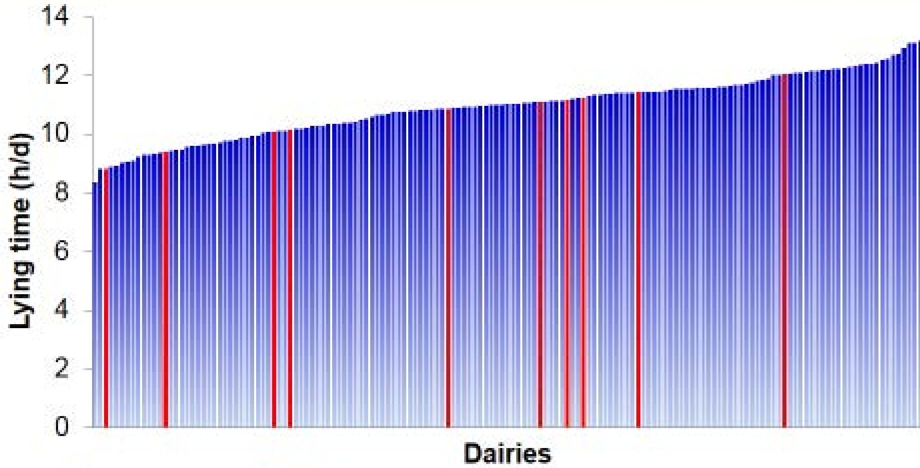
(Novus C.O.W.S. data)

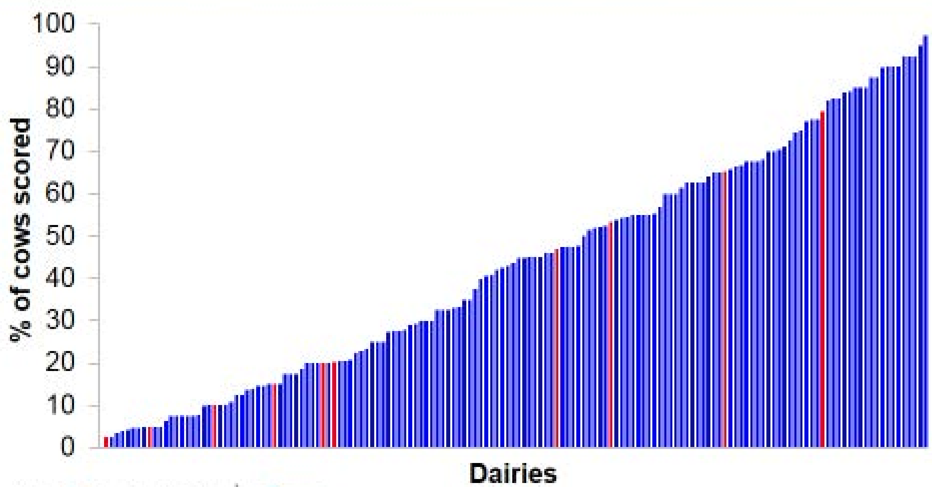
Lying Time: Northeast (153 freestall dairies)
- 10 smallest dairies (<200 milking cows) in red



NOVUS

53
(Novus C.O.W.S. data)

Hock Injuries: Northeast (153 freestall dairies)
- 10 smallest dairies (<200 milking cows) in red



NOVUS

55
(Novus C.O.W.S. data)

Novus C.O.W.S. Key Learnings

- Deep-bedding is associated with fewer hock injuries and less lameness
- Common issues in the Northeast include overcrowding and high time away from pen for milking
- Cow comfort issues and solutions are multi-factorial
  - Look at the system as a whole
  - Changes in one area can affect many areas (even small changes can have huge impacts on improving cow comfort and the bottom line)

Maximizing Water Consumption and Quality to Maximize Milk

Tanya Gressley, University of Delaware

Acknowledgement & Resources

- Dr. Dave Beede
  - Michigan State University
  - https://www.msu.edu/~beede/extension.html
- Michigan Dairy Review, vol. 16, no. 1-3
  - Thumb H_2O Project, Craig Thomas
- Penn State Extension
  - Water sample evaluation by Bryan Swistock
  - http://extension.psu.edu/natural-resources/water/webinar-series/past-webinars/results-from-testing-of-livestock-water-supplies-in-pennsylvania

Two Major Questions to Consider

- Is water consumption normal?
  - Measure water intake
  - Identify bottlenecks
- Are anti-quality factors in water limiting performance?
  - Conduct regular water sample analysis
  - Change water source or treat water if necessary

Measuring Water Intake

- Measure water intake through in-line water meters for 5-10 consecutive days
  - Record numbers and types of animals using that water source
- Is water intake normal?
  - Compare results to expected water intake

Expected Water Intake

- Expected water intake (kg/d) =
  - $2.53 \times$ (Milk, kg/d) + $0.45 \times$ (ration DM%) – 15.3
    - Castle and Thomas, 1975
  - $0.90 \times$ (Milk, kg/d) + $1.58 \times$ (DMI, kg/d) + $0.05 \times$ (sodium intake, g/d) + $1.20 \times$ (average daily temperature, °C) + 15.99
    - Murphy et al., 1983
  - Conversion factors:
    - °C = (°F – 32) × (5/9)
    - kg/d = lb/d × 0.4536
    - 1 gallon water = 3.79 kg water

Beede, D. 2006. High Plains Dairy Conference. p 18-20

Michigan Thumb - Water Project - 1

Drinking Water Delivery Practices – Milking Parlor

Waterer Receptacle Location	Water provided	Recommended	Waterer linear inches/ cow	Water from plate cooler
Holding pen	**41%**	N/A	**7.3**	**100%**
Exit lanes	**19%**	24 inches/parlor stall	**24.4**	**50%**

Thomas, C. (2011). Michigan Dairy Review. Vol. 16: pp 9 – 11, 20.
Slide courtesy of Dr. Dave Beede, Michigan State University

Cows can drink 50% or more of daily water intake following milking

Michigan Thumb - Water Project - 2

Drinking Water Delivery Practices – Free Stall Barns

Criterion	Farms met criterion, %	Avg.	Most	Least
Min 2 waterers/ group	100	3.6	5.0	2.0
Max walking distance to waterer (< 50 ft)	21	73 ft	109 ft	40 ft
Linear waterer space (4 inch/cow; recommended)	20	2.2 in	5.8 in	0.7 in

Thomas, C. (2011). Michigan Dairy Review. Vol. 16: pp 9 – 11, 20.
Slide courtesy of Dr. Dave Beede, Michigan State University

Water Cleanliness

- Water trough cleaning should be a high priority regular chore
  - Daily or weekly
- Would you be willing to drink from it?
  - If "no", then clean it

Thomas, C. (2011). Michigan Dairy Review. Vol. 16: pp 9 – 11, 20.

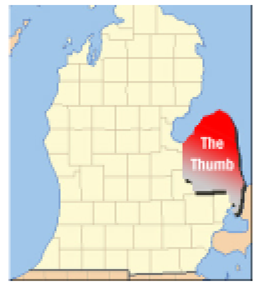
Taking Water Samples

1. **Guidelines** on taking drinking water samples and standard water analysis refer to: http://www.msu.edu/~beede/, click on Extension and then **"Taking a Water Sample".**
2. Take 2 samples; 1 near the well-head, 1 after the storage or reserve tank (that the cows drink).
3. Standard laboratory analyses done by a certified laboratory; acidify for iron analysis (?)
4. If iron > 0.3 ppm; or, either sulfate and/or chloride > 250 - 500 ppm, 2 more samples, send to different certified labs. **Know for sure concentrations are in excess – MAJOR costs could follow (?!).**
5. Take, seal, and label 2 additional samples as back-ups for historical record.

Slide Courtesy of Dave Beede, Michigan State University

Michigan State Thumb Water Project

- 37 water samples from thumb region of Michigan
  - 27% of samples had water quality issues
  - 13.5% had high total dissolved solids (TDS)
  - 8.1% had high sulfate (SO_4) plus chloride (Cl)
  - 10.8% had high iron (Fe)



Thomas, C. (2011). Michigan Dairy Review. Vol. 16

Total Dissolved Solids (TDS)

- TDS = sum of all dissolved and suspended inorganic matter in water
- If TDS is high, it can be due to high levels of potentially detrimental ions (e.g. sulfate, chloride, iron, manganese, nitrate) or to fairly innocuous ions (e.g. calcium, magnesium)
  - If TDS is >1,000 ppm, determine which ions are causing the elevation and address if needed
- TDS should be below 3,000 ppm

Michigan Thumb - Water Project

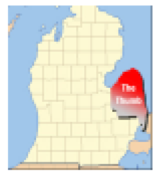
Drinking Water Quality (analyte, ppm)

Item	TDS	SO_4 + Cl	Fe	NO_3-N
Avg.	610	237	0.12	0.1
High	3,770	2,016	0.81	1.8
Low	114	6	0.0	0.0
Re- test	> 500	> 250	> 0.3	> 10
Action		> 1,000	> 0.3	> 20

C. Thomas (2011).

If total dissolved solids (TDS) are high, determine which inorganic components are driving the value up

Slide Courtesy of Dr. Dave Beede, Michigan State University



Sulfate and Chloride

- High sulfate (SO_4^{2-}) and chloride (Cl^-)
  - Can reduce water intake, feed intake, and milk yield
  - Can increase risk of displaced abomasum and retained placenta
- Action levels
  - Sulfate should be less than 1000 ppm, ideally less than 500 ppm
  - Chloride should be less than 250 ppm
  - Dr. Beede suggestion: SO_4^{2-} and Cl^- combined should be <1,000 ppm (or 500 ppm more conservatively)

Michigan Thumb - Water Project

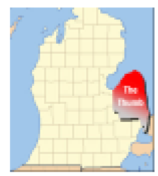
Drinking Water Quality (analyte, ppm)

Item	TDS	SO_4 + Cl	Fe	NO_3-N
Avg.	610	237	0.12	0.1
High	3,770	2,016	0.81	1.8
Low	114	6	0.0	0.0
Re- test	> 500	> 250	> 0.3	> 10
Action		> 1,000	> 0.3	> 20

C. Thomas (2011).

SO_4 + Cl action level of > 500 ppm may be better

Slide Courtesy of Dr. Dave Beede, Michigan State University



Iron and Manganese

- High iron (Fe^{2+}) can result in:
  - Reduced water intake (palatability) and consequently performance
  - Reduced absorption of copper and zinc
- Laboratory should acidify sample prior to iron analysis to increase iron recovery
- High manganese (Mn) can reduce water intake through reduced palatability
- Recommendations:
  - Iron < 0.3 ppm
  - Manganese < 0.05 ppm

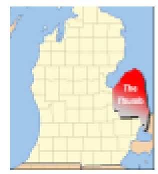
Michigan Thumb - Water Project

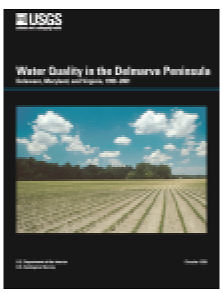
Drinking Water Quality (analyte, ppm)

Item	TDS	SO_4 + Cl	Fe	NO_3-N
Avg.	610	237	0.12	0.1
High	3,770	2,016	0.81	1.8
Low	114	6	0.0	0.0
Re- test	> 500	> 250	> 0.3	> 10
Action		> 1,000	> 0.3	> 20

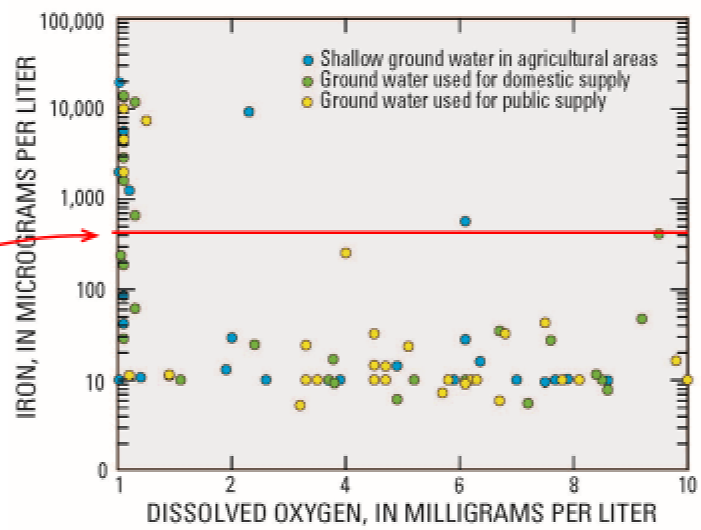
C. Thomas (2011).

Slide Courtesy of Dr. Dave Beede, Michigan State University





Action level
= 0.3 ppm



Nitrate

- Nitrate (NO_3^-)
  - Reduced reproductive performance
  - Toxic at high levels
- Recommendation:
  - Nitrate-N < 20 ppm

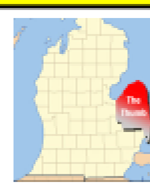
Michigan Thumb - Water Project

Drinking Water Quality (analyte, ppm)

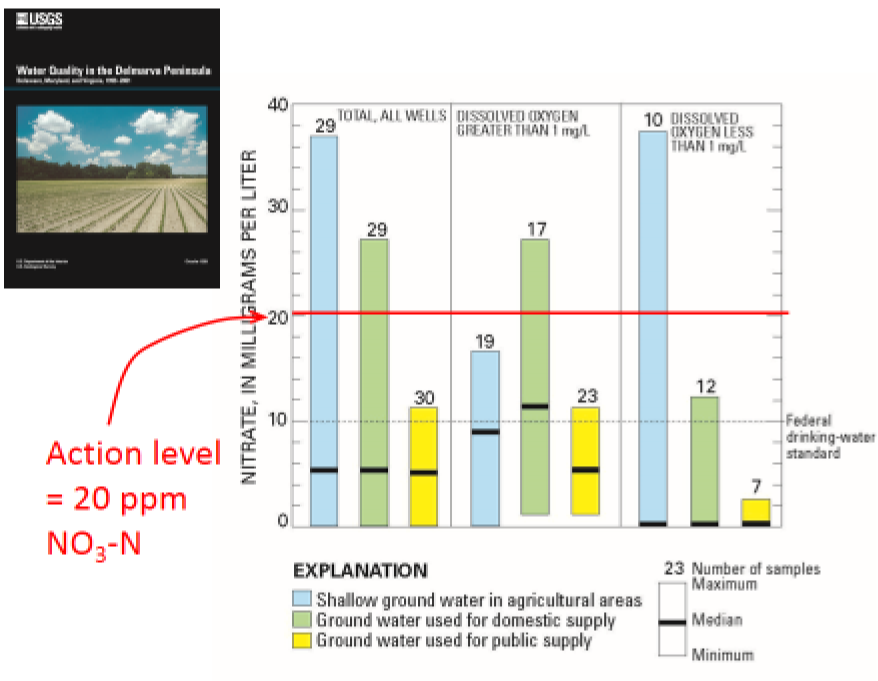
Item	TDS	SO_4 + Cl	Fe	NO_3-N
Avg.	610	237	0.12	0.1
High	3,770	2,016	0.81	1.8
Low	114	6	0.0	0.0
Re- test	> 500	> 250	> 0.3	> 10
Action		> 1,000	> 0.3	> 20

C. Thomas (2011).

20 ppm NO_3-N = 88 ppm NO_3



Slide Courtesy of Dr. Dave Beede, Michigan State University



Michigan State National Study

- Water samples collected from commercial dairies in various states in US
- Many samples had no water quality issues
- Some did (subset on next slide)

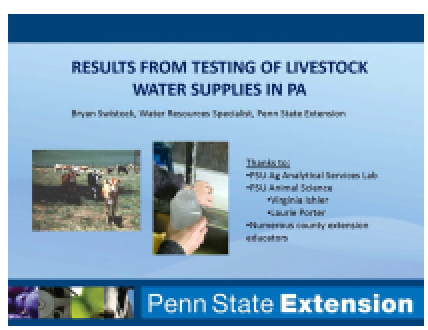
Selected "problem" Water Analyses

State	TDS	SO_4	Cl	Fe	Mn
Caution Level	> 500	> 250	> 250	> 0.3	> 0.05
CO	2,985	1,622	61	0.11	n.a.
IA	1,310	263	12	0.18	0.15
IN	650	44	24	3.47	0.12
MI	1,950	217	577	2.54	0.08
MN	625	2	6	1.37	0.06
NM	1,788	268	511	<0.01	n.a.
OH	950	399	26	0.14	0.01
OK	2,178	1,899	198	n.d.	n.a.
TX	1,339	1,159	15	0.32	n.a.
WI	605	18	18	0.09	0.09

Slide Courtesy of Dr. Dave Beede, Michigan State University

Penn State Study

- Bryan Swistock, Water Resources Specialist, Penn State Extension
- Surveys and water sample kits sent to Pennsylvania dairy producers



Penn State Study Results

- 87% of producers could not estimate water intake; 3% had water meters
- ~60% had some past water testing
- 23% used some sort of water treatment
- Though not measured in this study, coliform bacteria in water was indicated as a primary water quality issue

Penn State Study Results

- 26% of water samples had at least one result that could potentially reduce milk yield
  - Main problems were manganese, iron, nitrate, and chloride
  - Average yield of 56 lbs/cow/d
- 74% of samples did not show water quality problems
  - Average yield of 62 lbs/cow/d

Fixing Water Quality Problems

- Switch to a different water source
  - Collect performance data before and after switch
- Water treatment options
  - Consider costs and effectiveness
  - Consult extension publications from Dave Beede, Bryan Swistock, and others

Conclusions

- Assess water consumption and water availability
  - Are cows drinking expected amounts?
  - Is water availability adequate?
- Assess water quality
  - Regular water sampling and analysis (quarterly to annual, spanning across seasons)
    - Save additional samples on farm in airtight containers
  - Analysis should be done by a certified laboratory
  - Regularly clean waterers