WESTERN DAIRY MANAGEMENT CONFERENCE

2023

Proceeding

RUMINANTIA®
Libero confronto d'idee

A Million Reasons Why Conformation Matters

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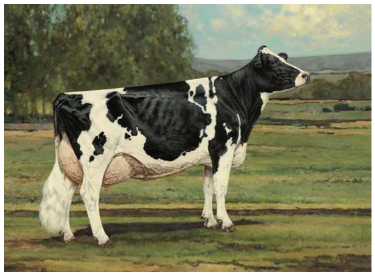
Notes:

PowerPoint Slides on next page

A Million Reasons Why Conformation Matters



Lindsey Worden, Daren Sheffield, Jeffrey Bewley

1

Data

- Holstein Association USA official classification scores were used for linear classification data
- The first classification score for a cow assigned in her first lactation was used for analyses
- Official DHIA records were used for production and culling data
- Only cows born after 1/1/90 were included in analyses
- Only test dates after 1/1/00 were included in test day analyses

2

Data

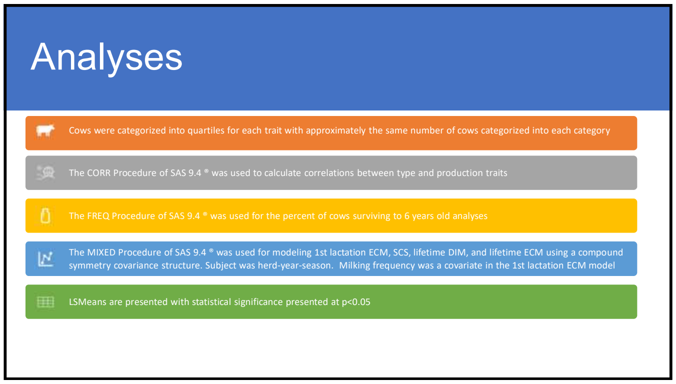
- Lactations starting between 1/1/00 and 8/27/21 were included in analyses
- For lifetime production analyses only first 6 lactations were included
- Only cows calving for first time before 1/1/16 were included in lifetime analyses
- Only animals with complete 305-day lactations were included in 305-day milk analyses
- All DHIA data was edited to remove biologically unlikely test day results

3

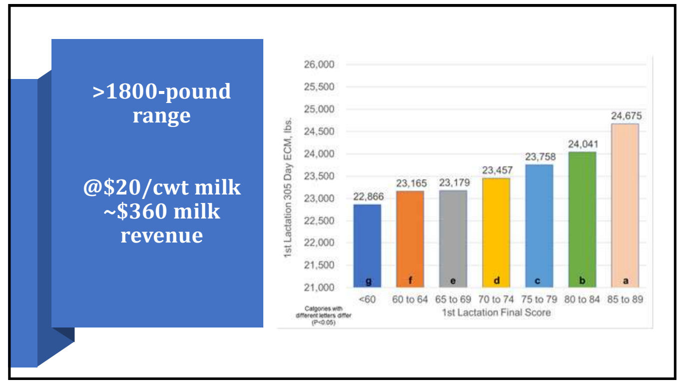
Data

- Only 1st lactation records with age at first calving between 18 to 35 months were included
- Lactation records with milking frequencies >3 were removed
- After edits, 937,603 cows were available for analyses
- 5,496 unique herds were represented in the data set
- Cows were only included in the final analysis if there were at least 5 herdmates in their herd, year, and season of calving

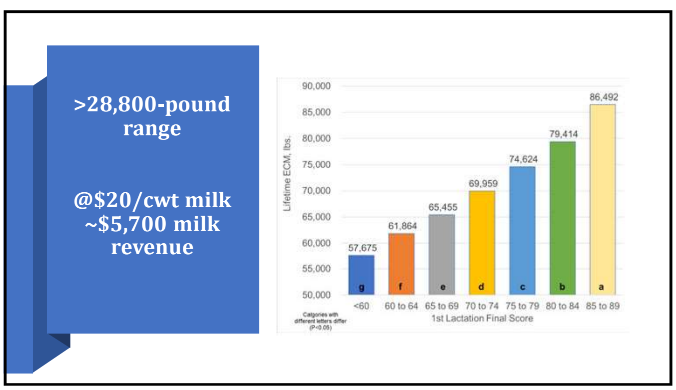
4


Analyses
Cows were categorized into quartiles for each trait with approximately the same number of cows categorized into each category
The CORR Procedure of SAS 9.4 ® was used to calculate correlations between type and production traits
The FREQ Procedure of SAS 9.4 ® was used for the percent of cows surviving to 6 years old analyses
The MIXED Procedure of SAS 9.4 ® was used for modeling 1st lactation ECM, SCS, lifetime DIM, and lifetime ECM using a compound symmetry covariance structure. Subject was herd-year-season. Milking frequency was a covariate in the 1st lactation ECM model
LSMeans are presented with statistical significance presented at p<0.05

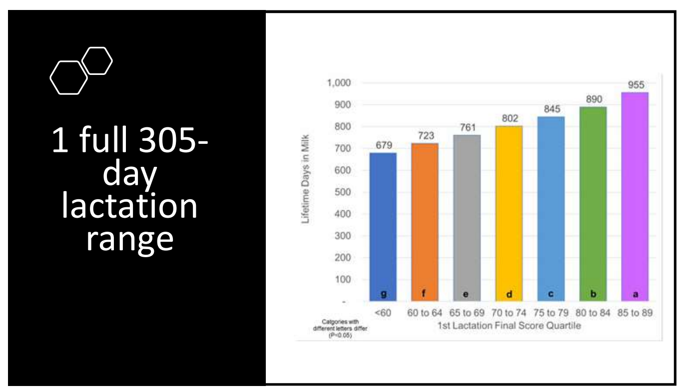
5


>1800-pound range
@$20/cwt milk ~$360 milk revenue
1st Lactation 305 Day ECM, lbs.
22,866
23,165
23,179
23,457
23,758
24,041
24,675
g
f
e
d
c
b
a
<60
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85 to 89
1st Lactation Final Score

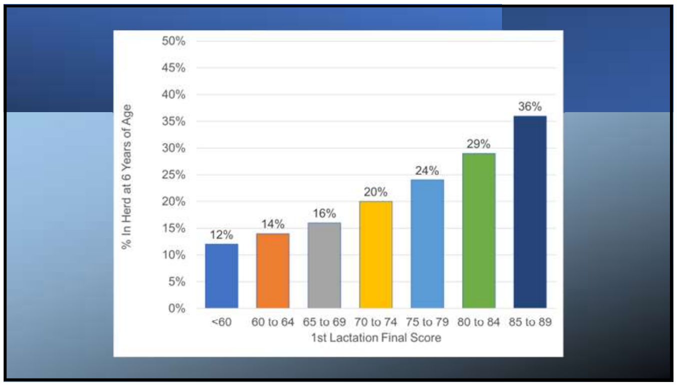
6


>28,800-pound range
@$20/cwt milk ~$5,700 milk revenue
Lifetime ECM, lbs.
57,675
61,864
65,455
69,959
74,624
79,414
86,492
g
f
e
d
c
b
a
<60
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85 to 89
1st Lactation Final Score

7

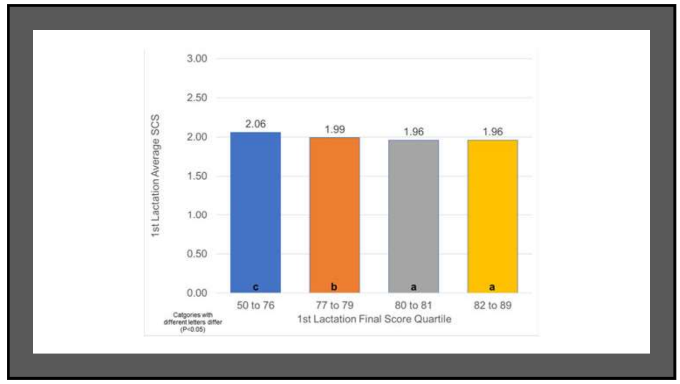

1 full 305-day lactation range
Lifetime Days in Milk
679
723
761
802
845
890
955
g
f
e
d
c
b
a
<60
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85 to 89
1st Lactation Final Score Quartile

8



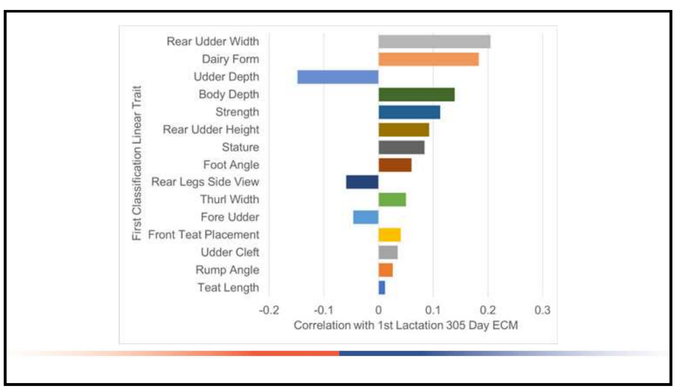
% In Herd at 6 Years of Age
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
12%
14%
16%
20%
24%
29%
36%
<60
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85 to 89
1st Lactation Final Score

9



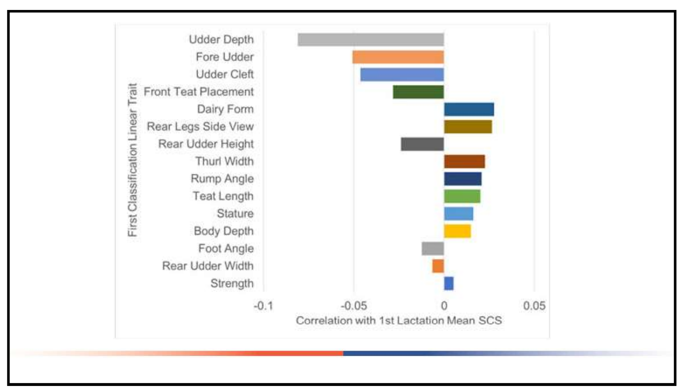
1st Lactation Average SCS
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.06
1.99
1.96
1.96
c
b
a
a
50 to 76
77 to 79
80 to 81
82 to 89
1st Lactation Final Score Quartile

10



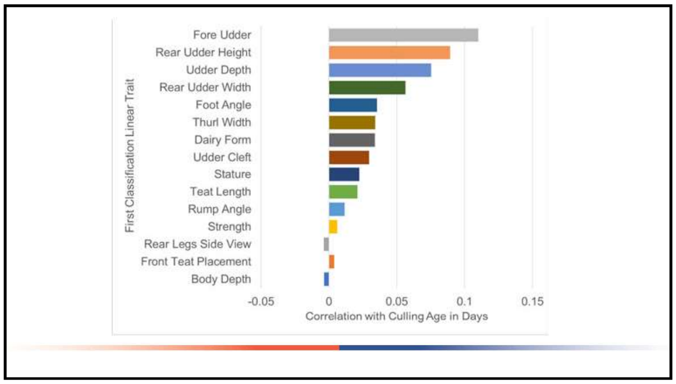
First Classification Linear Trait
Rear Udder Width
Dairy Form
Udder Depth
Body Depth
Strength
Rear Udder Height
Stature
Foot Angle
Rear Legs Side View
Thurl Width
Fore Udder
Front Teat Placement
Udder Cleft
Rump Angle
Teat Length
-0.2
-0.1
0
0.1
0.2
0.3
Correlation with 1st Lactation 305 Day ECM

11



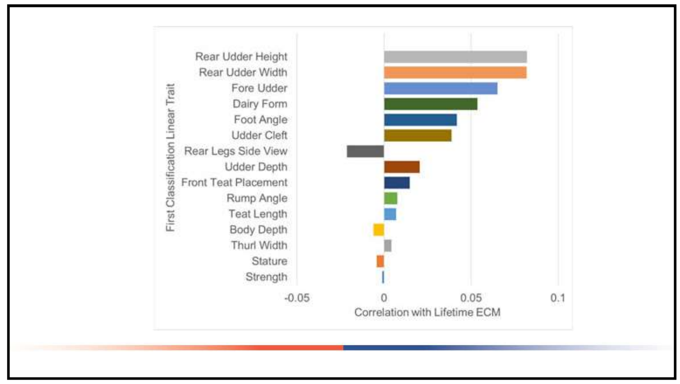
First Classification Linear Trait
Udder Depth
Fore Udder
Udder Cleft
Front Teat Placement
Dairy Form
Rear Legs Side View
Rear Udder Height
Thurl Width
Rump Angle
Teat Length
Stature
Body Depth
Foot Angle
Rear Udder Width
Strength
-0.1
-0.05
0
0.05
Correlation with 1st Lactation Mean SCS

12



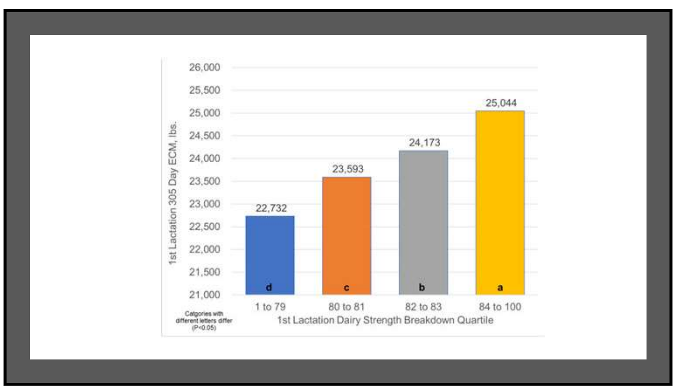
First Classification Linear Trait
Fore Udder
Rear Udder Height
Udder Depth
Rear Udder Width
Foot Angle
Thurl Width
Dairy Form
Udder Cleft
Stature
Teat Length
Rump Angle
Strength
Rear Legs Side View
Front Teat Placement
Body Depth
-0.05
0
0.05
0.1
0.15
Correlation with Culling Age in Days

13



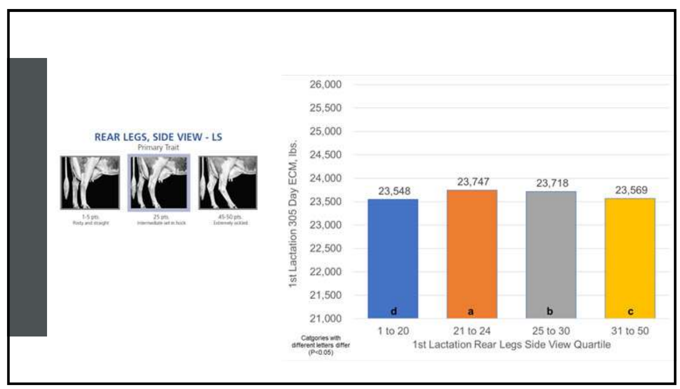
First Classification Linear Trait
Rear Udder Height
Rear Udder Width
Fore Udder
Dairy Form
Foot Angle
Udder Cleft
Rear Legs Side View
Udder Depth
Front Teat Placement
Rump Angle
Teat Length
Body Depth
Thurl Width
Stature
Strength
-0.05
0
0.05
0.1
Correlation with Lifetime ECM

14



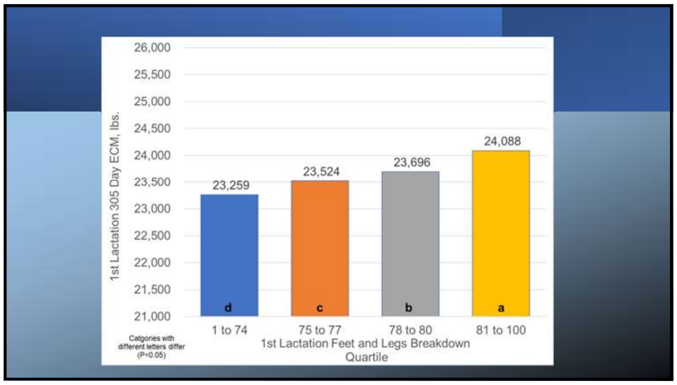
1st Lactation 305 Day ECM, lbs.
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
22,732
23,593
24,173
25,044
d
c
b
a
1 to 79
80 to 81
82 to 83
84 to 100
1st Lactation Dairy Strength Breakdown Quartile
Catgories with different letters differ (P<0.05)

15



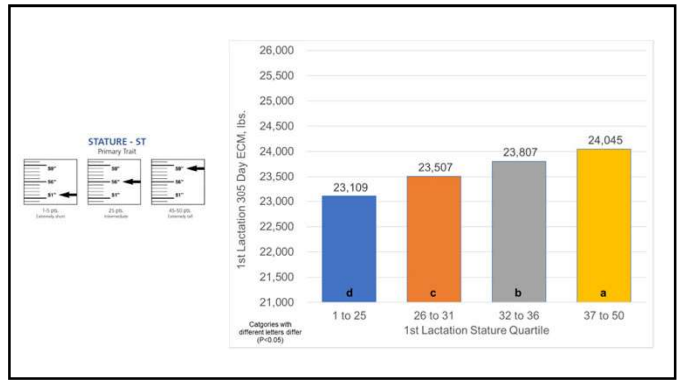
REAR LEGS, SIDE VIEW - LS
Primary Trait
1st Lactation 305 Day ECM, lbs.
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
23,548
23,747
23,718
23,569
d
a
b
c
1 to 20
21 to 24
25 to 30
31 to 50
1st Lactation Rear Legs Side View Quartile
Catgories with different letters differ (P<0.05)

16



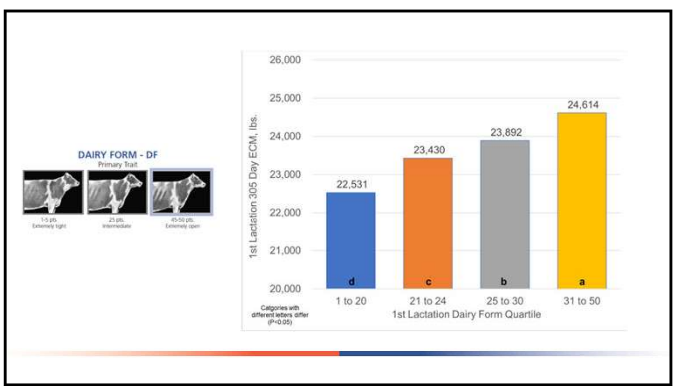
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
1st Lactation 305 Day ECM, lbs.
23,259
23,524
23,696
24,088
d
c
b
a
1 to 74
75 to 77
78 to 80
81 to 100
1st Lactation Feet and Legs Breakdown Quartile
Catgories with different letters differ (P<0.05)

17



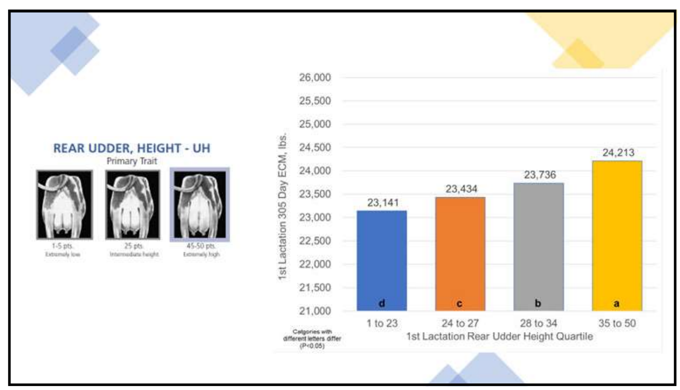
STATURE - ST
Primary Trait
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
1st Lactation 305 Day ECM, lbs.
23,109
23,507
23,807
24,045
d
c
b
a
1 to 25
26 to 31
32 to 36
37 to 50
1st Lactation Stature Quartile
Catgories with different letters differ (P<0.05)

18



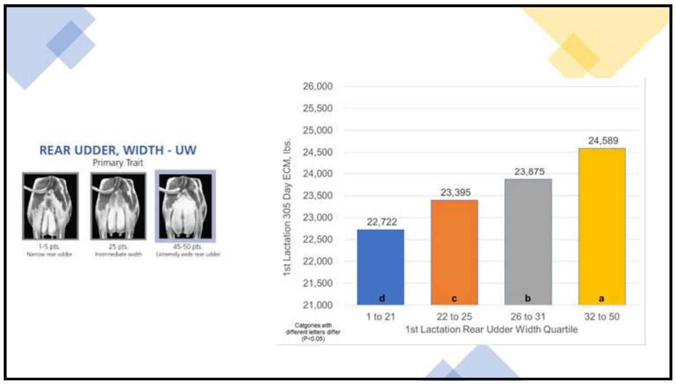
DAIRY FORM - DF
Primary Trait
26,000
25,000
24,000
23,000
22,000
21,000
20,000
1st Lactation 305 Day ECM, lbs.
22,531
23,430
23,892
24,614
d
c
b
a
1 to 20
21 to 24
25 to 30
31 to 50
1st Lactation Dairy Form Quartile
Catgories with different letters differ (P<0.05)

19

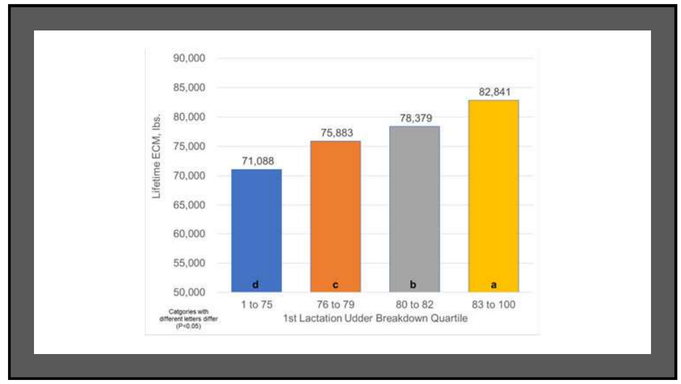


REAR UDDER, HEIGHT - UH
Primary Trait
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
1st Lactation 305 Day ECM, lbs.
23,141
23,434
23,736
24,213
d
c
b
a
1 to 23
24 to 27
28 to 34
35 to 50
1st Lactation Rear Udder Height Quartile
Catgories with different letters differ (P<0.05)

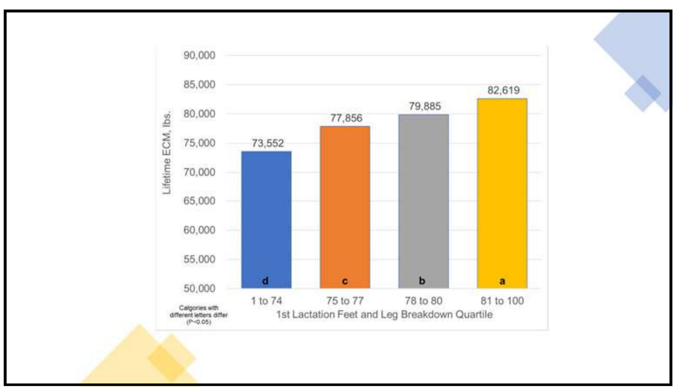
20


REAR UDDER, WIDTH - UW
Primary Trait
1st Lactation 305 Day ECM, lbs.
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
22,722
23,395
23,875
24,589
d
c
b
a
1 to 21
22 to 25
26 to 31
32 to 50
1st Lactation Rear Udder Width Quartile
Catgories with different letters differ (P<0.05)

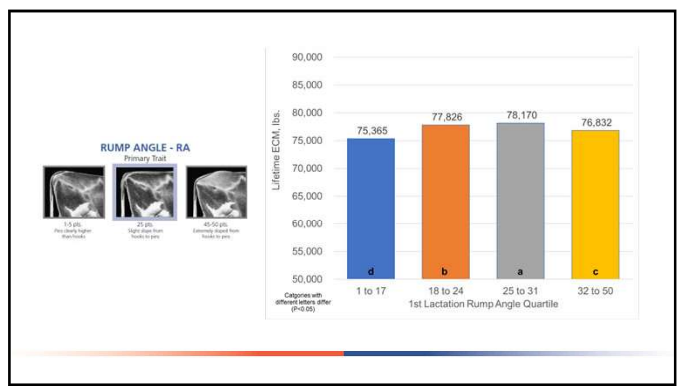
21


Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
71,088
75,883
78,379
82,841
d
c
b
a
1 to 75
76 to 79
80 to 82
83 to 100
1st Lactation Udder Breakdown Quartile
Catgories with different letters differ (P<0.05)

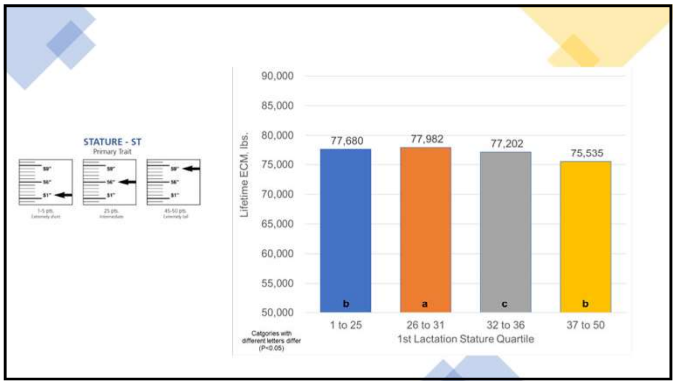
22


Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
73,552
77,856
79,885
82,619
d
c
b
a
1 to 74
75 to 77
78 to 80
81 to 100
1st Lactation Feet and Leg Breakdown Quartile
Catgories with different letters differ (P<0.05)

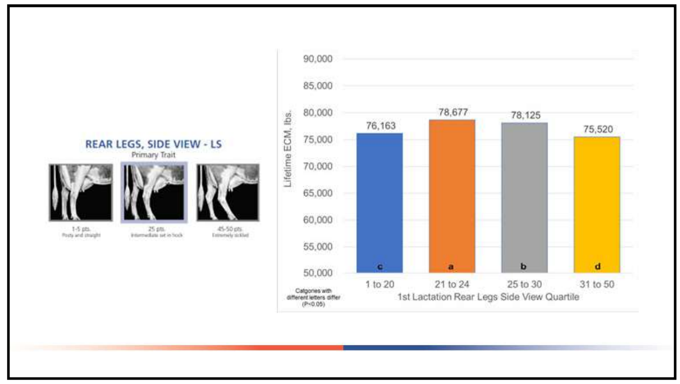
23


RUMP ANGLE - RA
Primary Trait
Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
75,365
77,826
78,170
76,832
d
b
a
c
1 to 17
18 to 24
25 to 31
32 to 50
1st Lactation Rump Angle Quartile
Catgories with different letters differ (P<0.05)

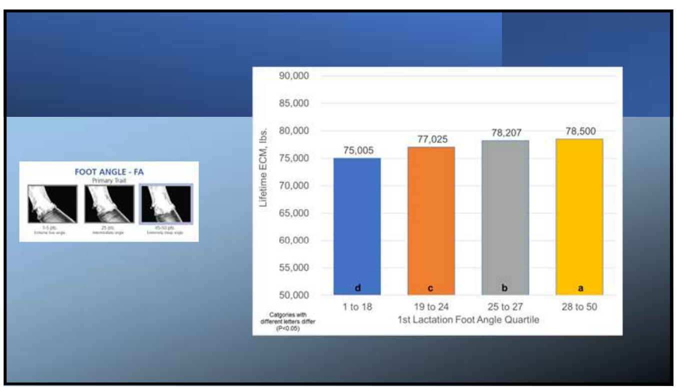
24


STATURE - ST
Primary Trait
Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
77,680
77,982
77,202
75,535
b
a
c
b
1 to 25
26 to 31
32 to 36
37 to 50
1st Lactation Stature Quartile
Catgories with different letters differ (P<0.05)

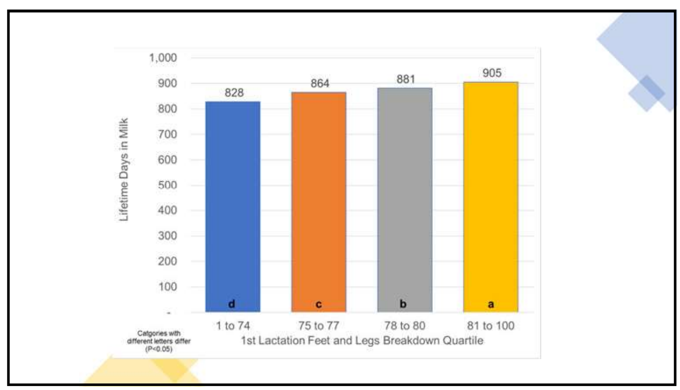
25


REAR LEGS, SIDE VIEW - LS
Primary Trait
Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
76,163
78,677
78,125
75,520
c
a
b
d
1 to 20
21 to 24
25 to 30
31 to 50
1st Lactation Rear Legs Side View Quartile
Catgories with different letters differ (P<0.05)

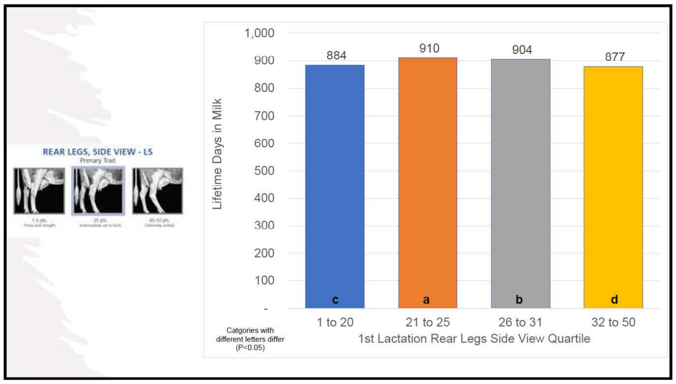
26


FOOT ANGLE - FA
Primary Trait
Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
75,005
77,025
78,207
78,500
d
c
b
a
1 to 18
19 to 24
25 to 27
28 to 50
1st Lactation Foot Angle Quartile
Catgories with different letters differ (P<0.05)

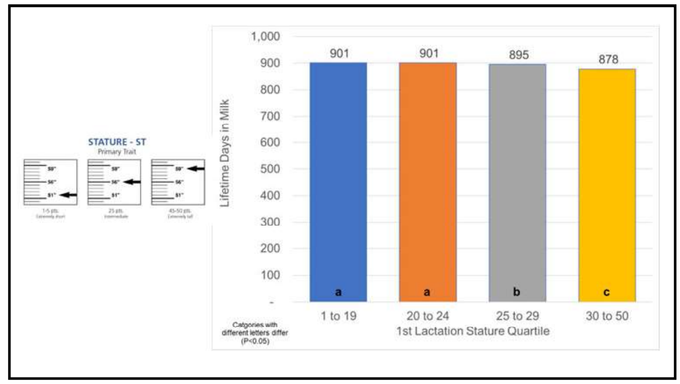
27


Lifetime Days in Milk
1,000
900
800
700
600
500
400
300
200
100
-
828
864
881
905
d
c
b
a
1 to 74
75 to 77
78 to 80
81 to 100
1st Lactation Feet and Legs Breakdown Quartile
Catgories with different letters differ (P<0.05)

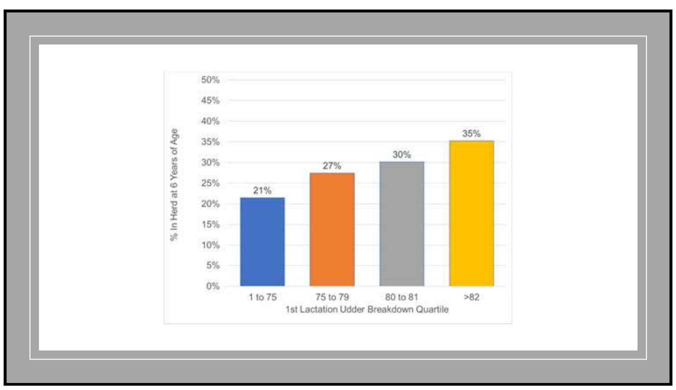
28


REAR LEGS, SIDE VIEW - LS
Primary Trait
Lifetime Days in Milk
1,000
900
800
700
600
500
400
300
200
100
-
884
910
904
877
c
a
b
d
1 to 20
21 to 25
26 to 31
32 to 50
1st Lactation Rear Legs Side View Quartile
Catgories with different letters differ (P<0.05)

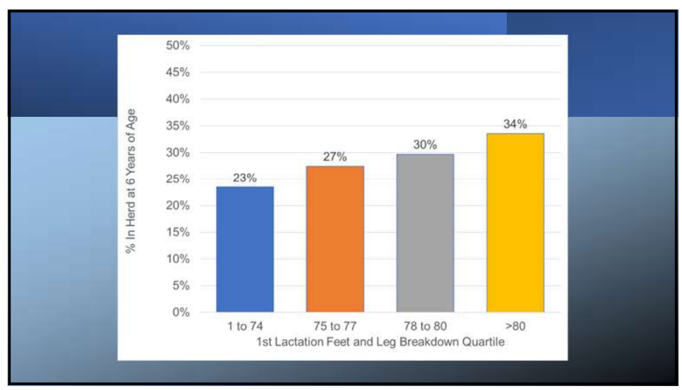
29


STATURE - ST
Primary Trait
Lifetime Days in Milk
1,000
900
800
700
600
500
400
300
200
100
-
901
901
895
878
a
a
b
c
1 to 19
20 to 24
25 to 29
30 to 50
1st Lactation Stature Quartile
Catgories with different letters differ (P<0.05)

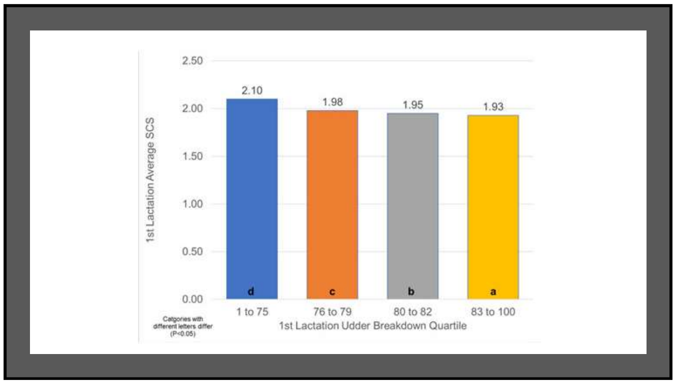
30


% In Herd at 6 Years of Age
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
21%
27%
30%
35%
1 to 75
75 to 79
80 to 81
>82
1st Lactation Udder Breakdown Quartile

31

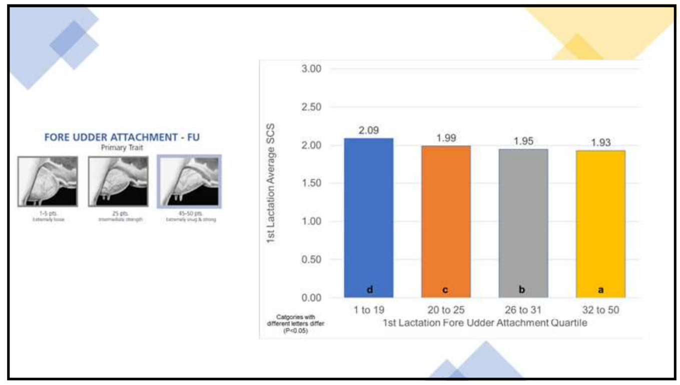

% In Herd at 6 Years of Age
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
23%
27%
30%
34%
1 to 74
75 to 77
78 to 80
>80
1st Lactation Feet and Leg Breakdown Quartile

32



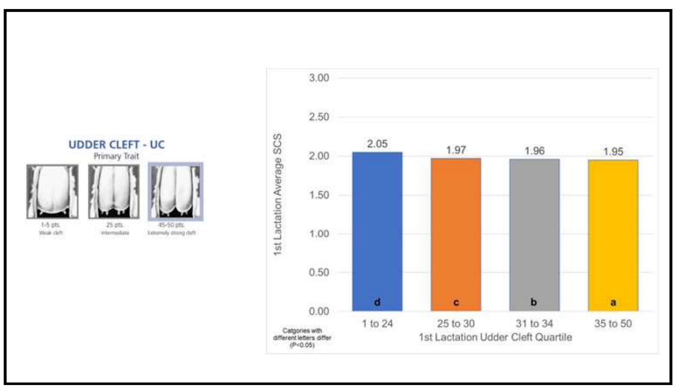
1st Lactation Average SCS
2.50
2.00
1.50
1.00
0.50
0.00
2.10
1.98
1.95
1.93
d
c
b
a
1 to 75
76 to 79
80 to 82
83 to 100
1st Lactation Udder Breakdown Quartile
Catgories with different letters differ (P<0.05)

33



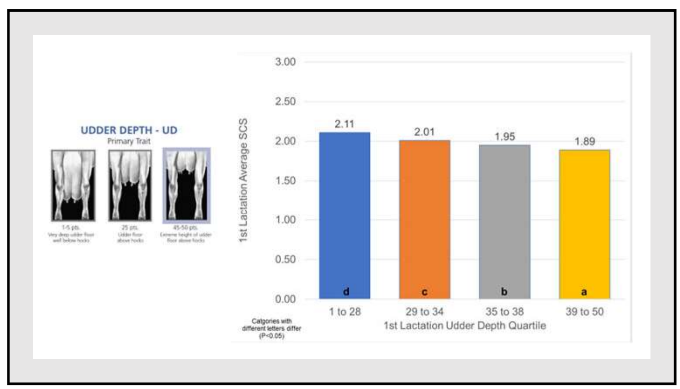
FORE UDDER ATTACHMENT - FU
Primary Trait
1st Lactation Average SCS
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.09
1.99
1.95
1.93
d
c
b
a
1 to 19
20 to 25
26 to 31
32 to 50
1st Lactation Fore Udder Attachment Quartile
Catgories with different letters differ (P<0.05)

34



UDDER CLEFT - UC
Primary Trait
1st Lactation Average SCS
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.05
1.97
1.96
1.95
d
c
b
a
1 to 24
25 to 30
31 to 34
35 to 50
1st Lactation Udder Cleft Quartile
Catgories with different letters differ (P<0.05)

35



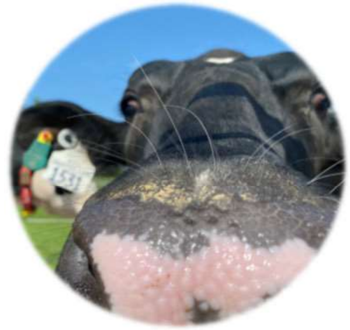
UDDER DEPTH - UD
Primary Trait
1st Lactation Average SCS
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.11
2.01
1.95
1.89
d
c
b
a
1 to 28
29 to 34
35 to 38
39 to 50
1st Lactation Udder Depth Quartile
Catgories with different letters differ (P<0.05)

36

Discussion

- Keep in mind these are phenotypic, not genetic relationships
- Correlation does not equate to causation
- Genetic evaluations already account for milk yield potential, productive life, and SCS
- But, physical conformation matters!
- Classification system quantifies economically important differences well
- This data set should help drive home importance of classification and value to individual traits

37



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U.S. Registered Holsteins FOR MAXIMUM PROFIT

Holstein Association USA, Inc.

WKU SmartHolstein Lab

www.smartholstein.com

Full data results available at:
https://www.holsteinusa.com/typematters

38

A Million Reasons Why Conformation Matters

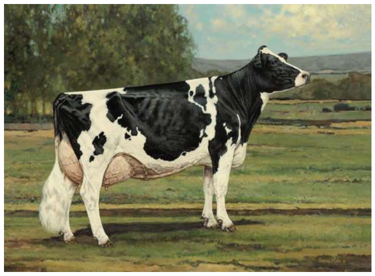
Jeffrey Bewley | Holstein Association USA, Inc. | jbewley@holstein.com

Notes:

PowerPoint Slides on next page

A Million Reasons Why Conformation Matters

Lindsey Worden, Daren Sheffield, Jeffrey Bewley



1

Data

- Holstein Association USA official classification scores were used for linear classification data
- The first classification score for a cow assigned in her first lactation was used for analyses
- Official DHIA records were used for production and culling data
- Only cows born after 1/1/90 were included in analyses
- Only test dates after 1/1/00 were included in test day analyses

2

Data

- Lactations starting between 1/1/00 and 8/27/21 were included in analyses
- For lifetime production analyses only first 6 lactations were included
- Only cows calving for first time before 1/1/16 were included in lifetime analyses
- Only animals with complete 305-day lactations were included in 305-day milk analyses
- All DHIA data was edited to remove biologically unlikely test day results

3

Data

- Only 1st lactation records with age at first calving between 18 to 35 months were included
- Lactation records with milking frequencies >3 were removed
- After edits, 937,603 cows were available for analyses
- 5,496 unique herds were represented in the data set
- Cows were only included in the final analysis if there were at least 5 herdmates in their herd, year, and season of calving

4

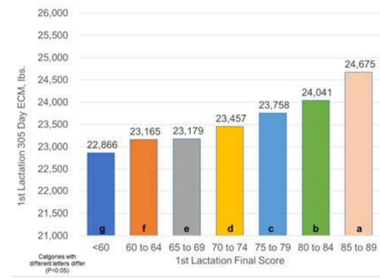
Analyses

- Cows were categorized into quartiles for each trait with approximately the same number of cows categorized into each category
- The CORR Procedure of SAS 9.4 ® was used to calculate correlations between type and production traits
- The FREQ Procedure of SAS 9.4 ® was used for the percent of cows surviving to 6 years old analyses
- The MIXED Procedure of SAS 9.4 ® was used for modeling 1st lactation ECM, SCS, lifetime DIM, and lifetime ECM using a compound symmetry covariance structure. Subject was herd-year-season. Milking frequency was a covariate in the 1st lactation ECM model
- LSMeans are presented with statistical significance presented at p<0.05

5

>1800-pound range

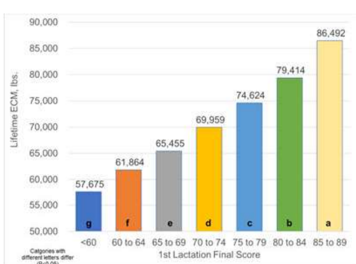
@$20/cwt milk ~$360 milk revenue



6

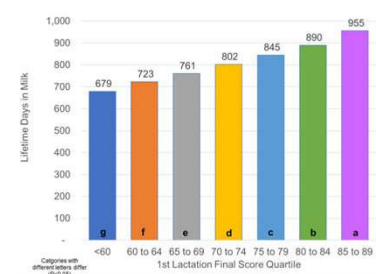
>28,800-pound range

@$20/cwt milk ~$5,700 milk revenue

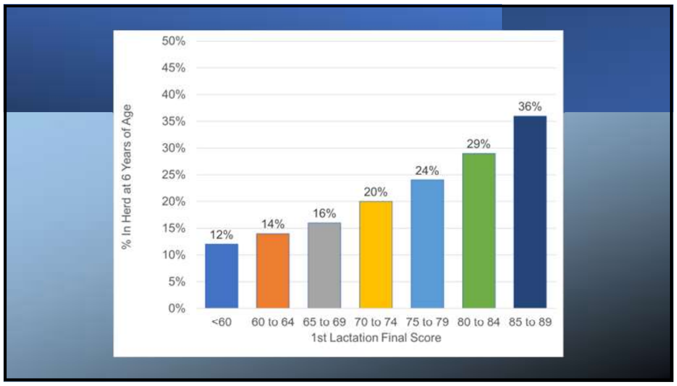


7

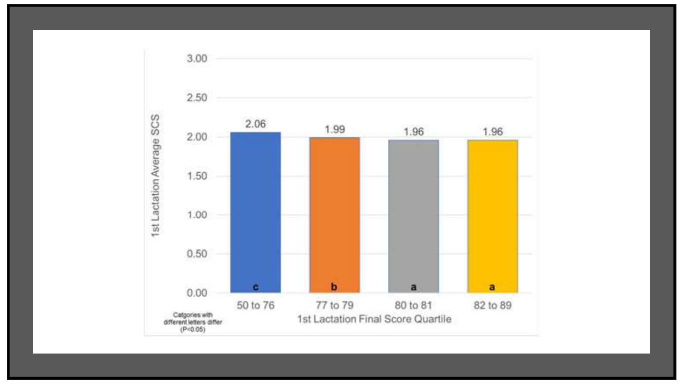
1 full 305-day lactation range



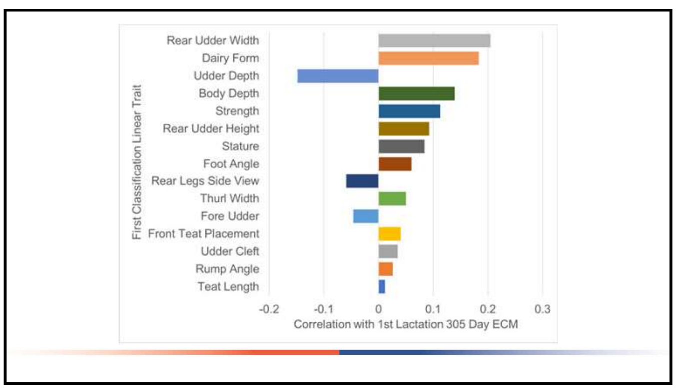
8


% In Herd at 6 Years of Age
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
12%
14%
16%
20%
24%
29%
36%
<60
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85 to 89
1st Lactation Final Score

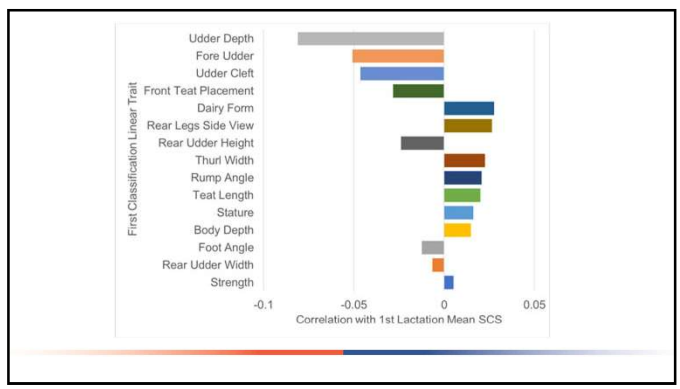
9


1st Lactation Average SCS
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.06
1.99
1.96
1.96
c
b
a
a
50 to 76
77 to 79
80 to 81
82 to 89
1st Lactation Final Score Quartile
Catgories with different letters differ (P<0.05)

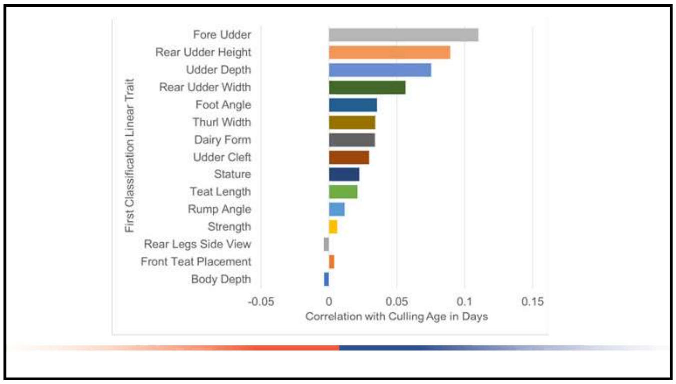
10


First Classification Linear Trait
Rear Udder Width
Dairy Form
Udder Depth
Body Depth
Strength
Rear Udder Height
Stature
Foot Angle
Rear Legs Side View
Thurl Width
Fore Udder
Front Teat Placement
Udder Cleft
Rump Angle
Teat Length
-0.2
-0.1
0
0.1
0.2
0.3
Correlation with 1st Lactation 305 Day ECM

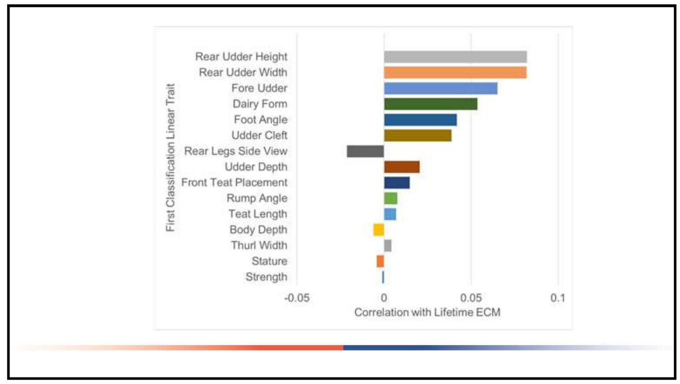
11


First Classification Linear Trait
Udder Depth
Fore Udder
Udder Cleft
Front Teat Placement
Dairy Form
Rear Legs Side View
Rear Udder Height
Thurl Width
Rump Angle
Teat Length
Stature
Body Depth
Foot Angle
Rear Udder Width
Strength
-0.1
-0.05
0
0.05
Correlation with 1st Lactation Mean SCS

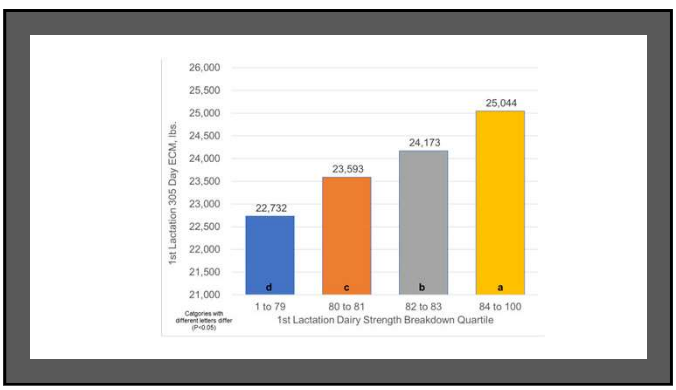
12


First Classification Linear Trait
Fore Udder
Rear Udder Height
Udder Depth
Rear Udder Width
Foot Angle
Thurl Width
Dairy Form
Udder Cleft
Stature
Teat Length
Rump Angle
Strength
Rear Legs Side View
Front Teat Placement
Body Depth
-0.05
0
0.05
0.1
0.15
Correlation with Culling Age in Days

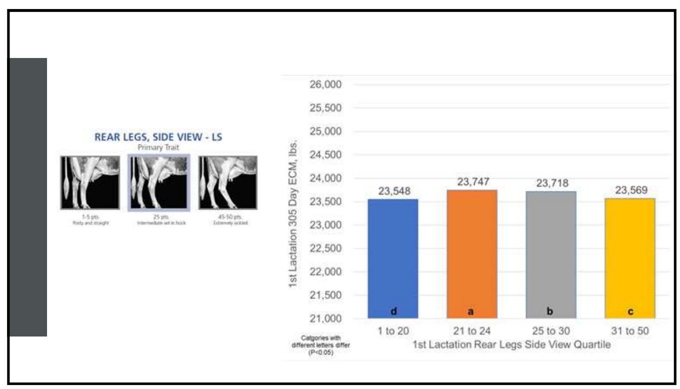
13


First Classification Linear Trait
Rear Udder Height
Rear Udder Width
Fore Udder
Dairy Form
Foot Angle
Udder Cleft
Rear Legs Side View
Udder Depth
Front Teat Placement
Rump Angle
Teat Length
Body Depth
Thurl Width
Stature
Strength
-0.05
0
0.05
0.1
Correlation with Lifetime ECM

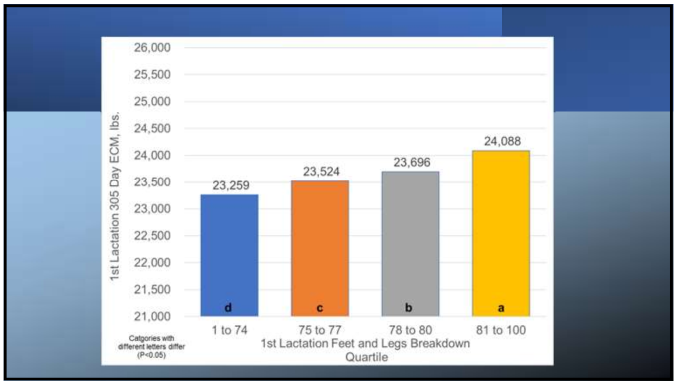
14


1st Lactation 305 Day ECM, lbs.
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
22,732
23,593
24,173
25,044
d
c
b
a
1 to 79
80 to 81
82 to 83
84 to 100
1st Lactation Dairy Strength Breakdown Quartile
Catgories with different letters differ (P<0.05)

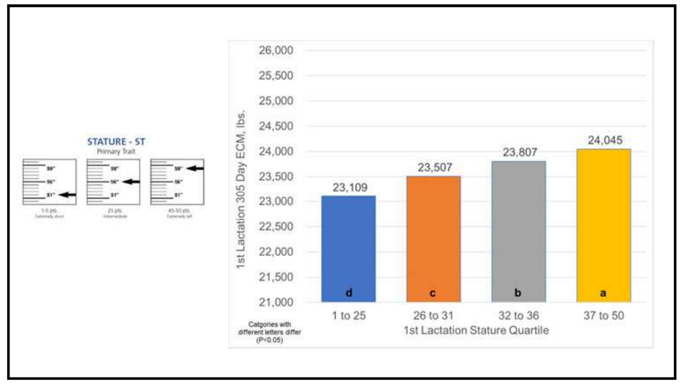
15


REAR LEGS, SIDE VIEW - LS
Primary Trait
1st Lactation 305 Day ECM, lbs.
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
23,548
23,747
23,718
23,569
d
a
b
c
1 to 20
21 to 24
25 to 30
31 to 50
1st Lactation Rear Legs Side View Quartile
Catgories with different letters differ (P<0.05)

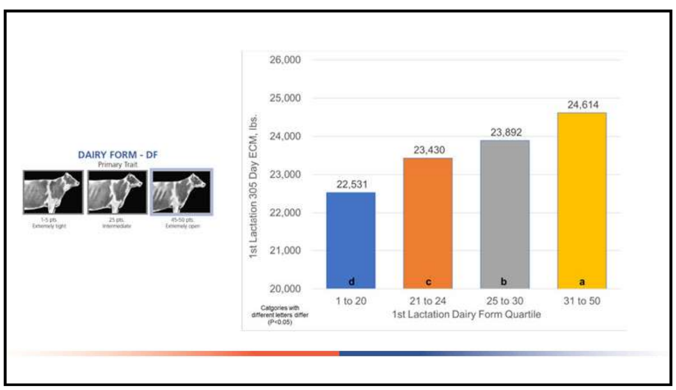
16


26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
1st Lactation 305 Day ECM, lbs.
23,259
23,524
23,696
24,088
d
c
b
a
1 to 74
75 to 77
78 to 80
81 to 100
1st Lactation Feet and Legs Breakdown Quartile
Catgories with different letters differ (P<0.05)

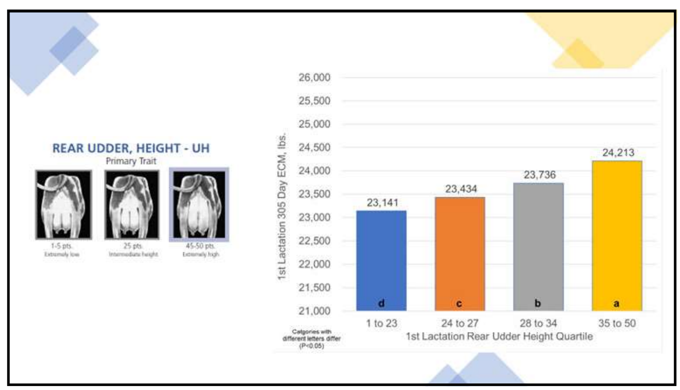
17


STATURE - ST
Primary Trait
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
1st Lactation 305 Day ECM, lbs.
23,109
23,507
23,807
24,045
d
c
b
a
1 to 25
26 to 31
32 to 36
37 to 50
1st Lactation Stature Quartile
Catgories with different letters differ (P<0.05)

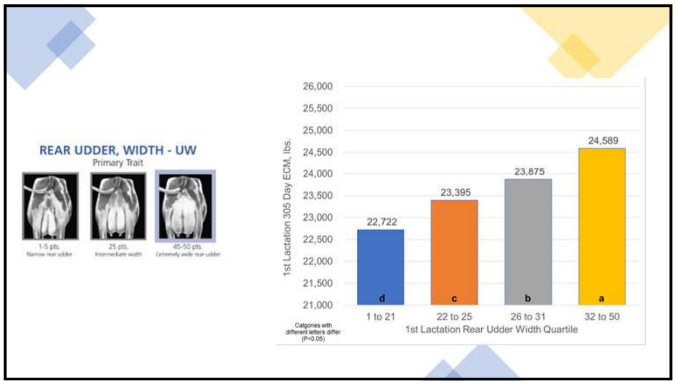
18


DAIRY FORM - DF
Primary Trait
26,000
25,000
24,000
23,000
22,000
21,000
20,000
1st Lactation 305 Day ECM, lbs.
22,531
23,430
23,892
24,614
d
c
b
a
1 to 20
21 to 24
25 to 30
31 to 50
1st Lactation Dairy Form Quartile
Catgories with different letters differ (P<0.05)

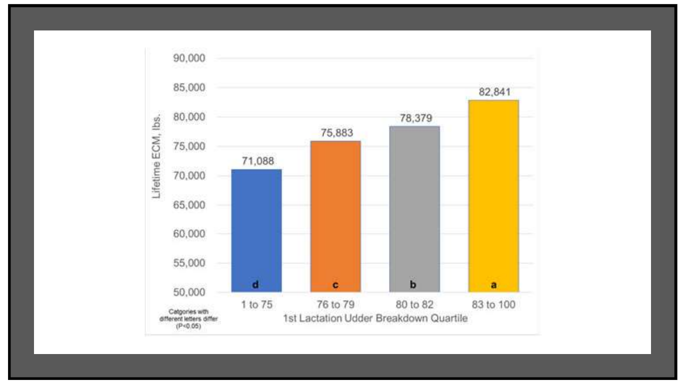
19


REAR UDDER, HEIGHT - UH
Primary Trait
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
1st Lactation 305 Day ECM, lbs.
23,141
23,434
23,736
24,213
d
c
b
a
1 to 23
24 to 27
28 to 34
35 to 50
1st Lactation Rear Udder Height Quartile
Catgories with different letters differ (P<0.05)

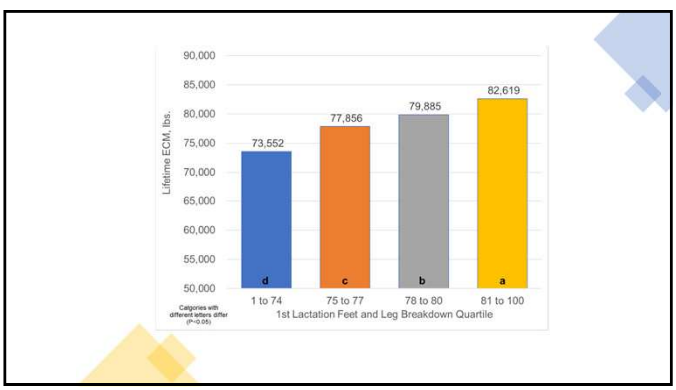
20


REAR UDDER, WIDTH - UW
Primary Trait
1st Lactation 305 Day ECM, lbs.
26,000
25,500
25,000
24,500
24,000
23,500
23,000
22,500
22,000
21,500
21,000
22,722
23,395
23,875
24,589
d
c
b
a
1 to 21
22 to 25
26 to 31
32 to 50
1st Lactation Rear Udder Width Quartile
Catgories with different letters differ (P<0.05)

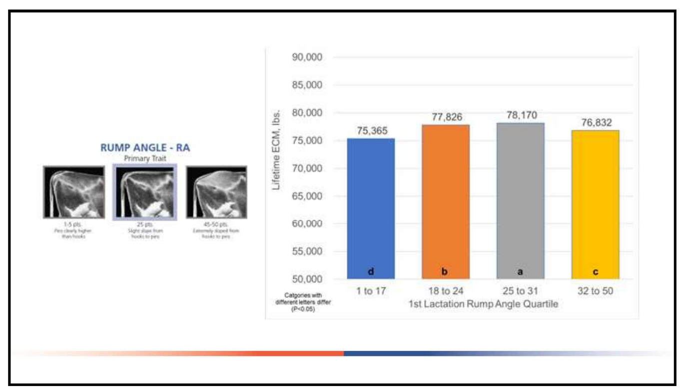
21


Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
71,088
75,883
78,379
82,841
d
c
b
a
1 to 75
76 to 79
80 to 82
83 to 100
1st Lactation Udder Breakdown Quartile
Catgories with different letters differ (P<0.05)

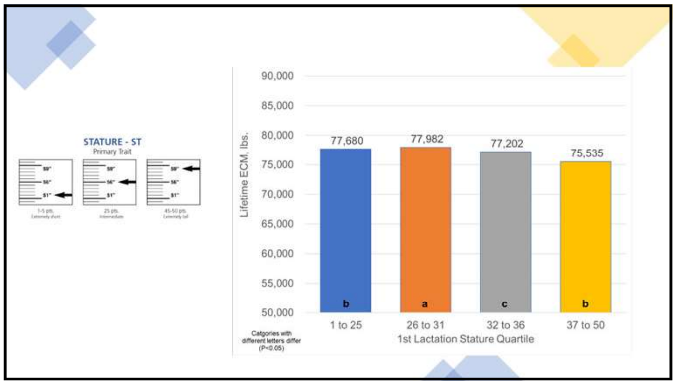
22


Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
73,552
77,856
79,885
82,619
d
c
b
a
1 to 74
75 to 77
78 to 80
81 to 100
1st Lactation Feet and Leg Breakdown Quartile
Catgories with different letters differ (P<0.05)

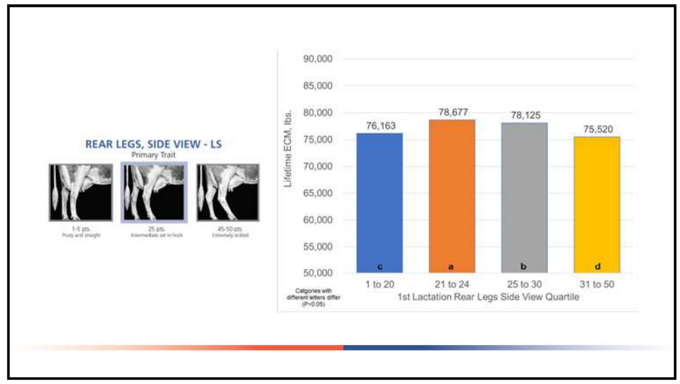
23


RUMP ANGLE - RA
Primary Trait
Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
75,365
77,826
78,170
76,832
d
b
a
c
1 to 17
18 to 24
25 to 31
32 to 50
1st Lactation Rump Angle Quartile
Catgories with different letters differ (P<0.05)

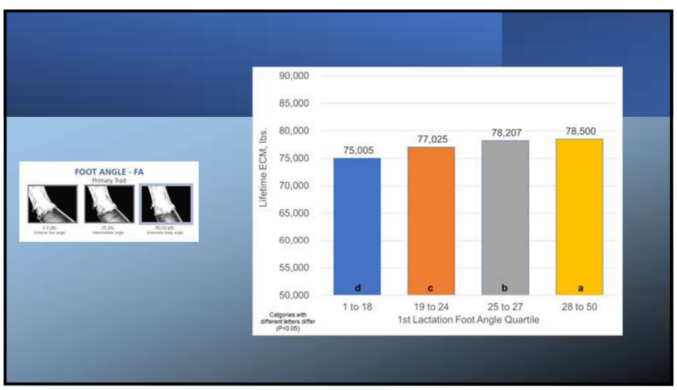
24


STATURE - ST
Primary Trait
Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
77,680
77,982
77,202
75,535
b
a
c
b
1 to 25
26 to 31
32 to 36
37 to 50
1st Lactation Stature Quartile
Catgories with different letters differ (P<0.05)

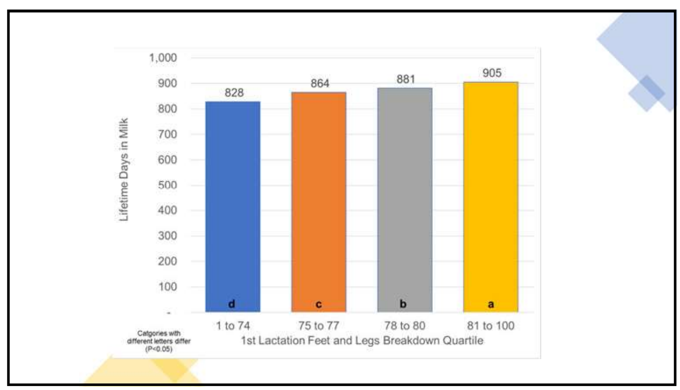
25


REAR LEGS, SIDE VIEW - LS
Primary Trait
Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
76,163
78,677
78,125
75,520
c
a
b
d
1 to 20
21 to 24
25 to 30
31 to 50
1st Lactation Rear Legs Side View Quartile
Catgories with different letters differ (P<0.05)

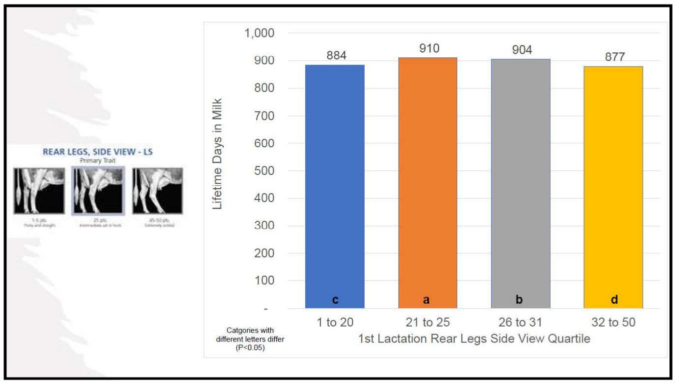
26


FOOT ANGLE - FA
Primary Trait
Lifetime ECM, lbs.
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
75,005
77,025
78,207
78,500
d
c
b
a
1 to 18
19 to 24
25 to 27
28 to 50
1st Lactation Foot Angle Quartile
Catgories with different letters differ (P<0.05)

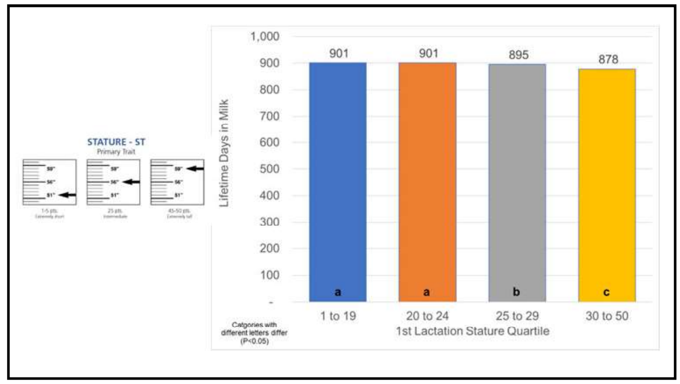
27


Lifetime Days in Milk
1,000
900
800
700
600
500
400
300
200
100
-
828
864
881
905
d
c
b
a
1 to 74
75 to 77
78 to 80
81 to 100
1st Lactation Feet and Legs Breakdown Quartile
Catgories with different letters differ (P<0.05)

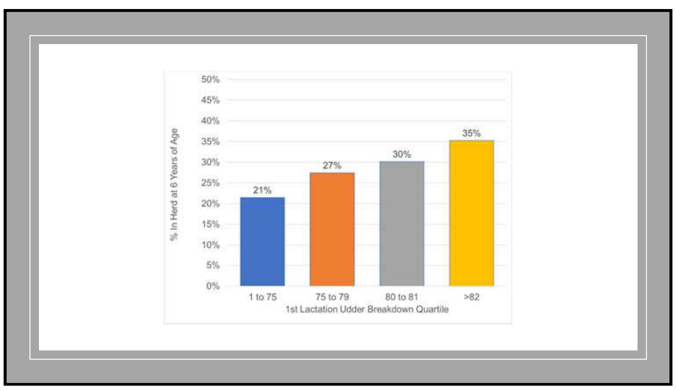
28


REAR LEGS, SIDE VIEW - LS
Primary Trait
1,000
900
800
700
600
500
400
300
200
100
-
Lifetime Days in Milk
884
910
904
877
c
a
b
d
1 to 20
21 to 25
26 to 31
32 to 50
1st Lactation Rear Legs Side View Quartile
Catgories with different letters differ (P<0.05)

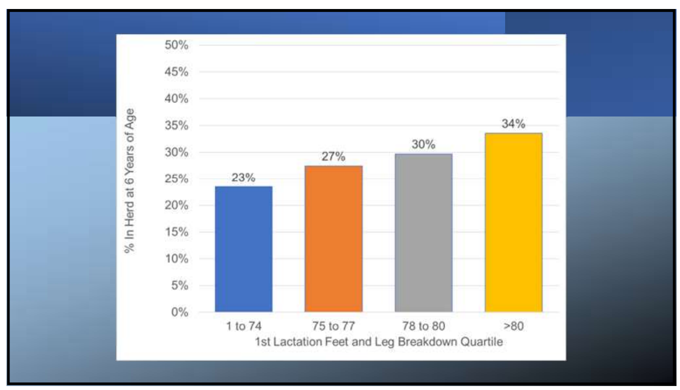
29


STATURE - ST
Primary Trait
1,000
900
800
700
600
500
400
300
200
100
-
Lifetime Days in Milk
901
901
895
878
a
a
b
c
1 to 19
20 to 24
25 to 29
30 to 50
1st Lactation Stature Quartile
Catgories with different letters differ (P<0.05)

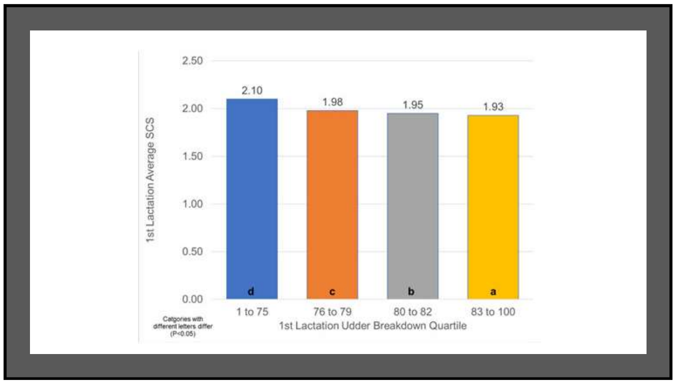
30


50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
% In Herd at 6 Years of Age
21%
27%
30%
35%
1 to 75
75 to 79
80 to 81
>82
1st Lactation Udder Breakdown Quartile

31

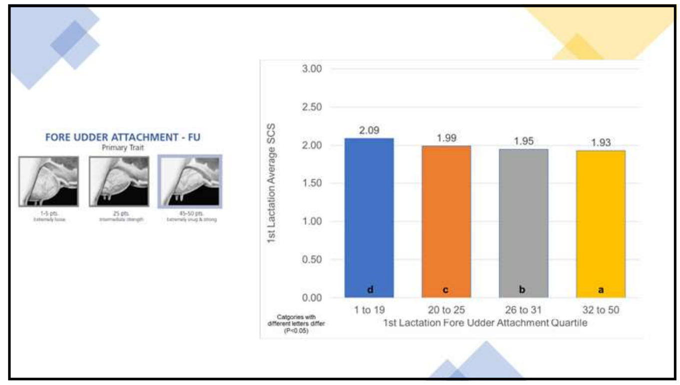

50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
% In Herd at 6 Years of Age
23%
27%
30%
34%
1 to 74
75 to 77
78 to 80
>80
1st Lactation Feet and Leg Breakdown Quartile

32



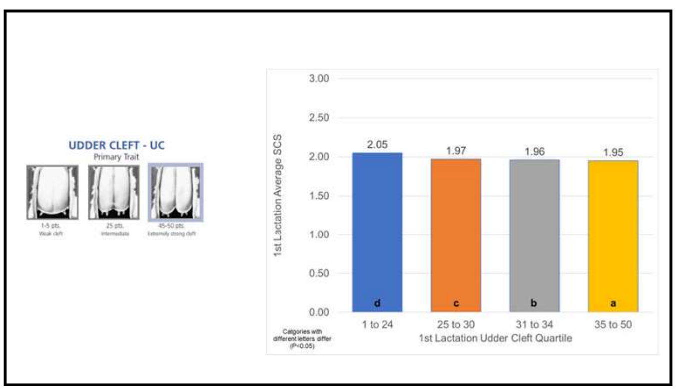
1st Lactation Average SCS
2.50
2.00
1.50
1.00
0.50
0.00
2.10
1.98
1.95
1.93
d
c
b
a
1 to 75
76 to 79
80 to 82
83 to 100
Catgories with different letters differ (P<0.05)
1st Lactation Udder Breakdown Quartile

33



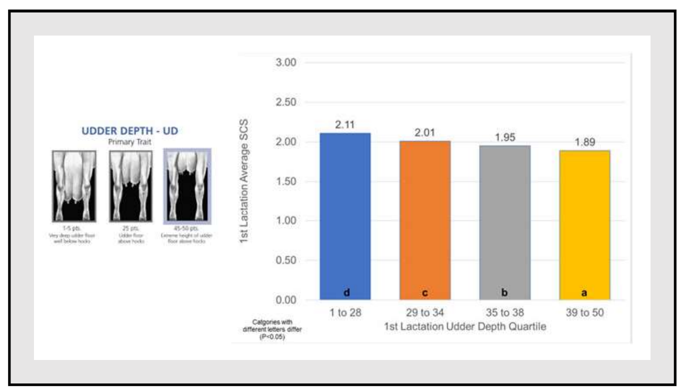
FORE UDDER ATTACHMENT - FU
Primary Trait
1st Lactation Average SCS
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.09
1.99
1.95
1.93
d
c
b
a
1 to 19
20 to 25
26 to 31
32 to 50
Catgories with different letters differ (P<0.05)
1st Lactation Fore Udder Attachment Quartile

34



UDDER CLEFT - UC
Primary Trait
1st Lactation Average SCS
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.05
1.97
1.96
1.95
d
c
b
a
1 to 24
25 to 30
31 to 34
35 to 50
Catgories with different letters differ (P<0.05)
1st Lactation Udder Cleft Quartile

35



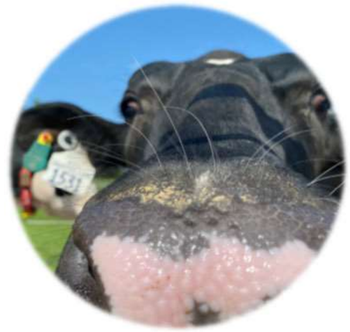
UDDER DEPTH - UD
Primary Trait
1st Lactation Average SCS
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.11
2.01
1.95
1.89
d
c
b
a
1 to 28
29 to 34
35 to 38
39 to 50
Catgories with different letters differ (P<0.05)
1st Lactation Udder Depth Quartile

36

Discussion

- Keep in mind these are phenotypic, not genetic relationships
- Correlation does not equate to causation
- Genetic evaluations already account for milk yield potential, productive life, and SCS
- But, physical conformation matters!
- Classification system quantifies economically important differences well
- This data set should help drive home importance of classification and value to individual traits

37



Jeffrey Bewley, PhD, PAS
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859-699-2998

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WKU SmartHolstein Lab

www.smartholstein.com

Full data results available at:
https://www.holsteinusa.com/typematters

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Calcium Release Technologies (CaRT)

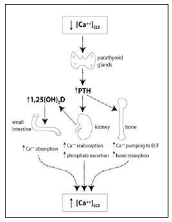
Pat Hoffman | University of Wisconsin-Madison | pchoffma@wisc.edu

Notes:

PowerPoint Slides on next page

Calcium Response Technologies (CaRT)

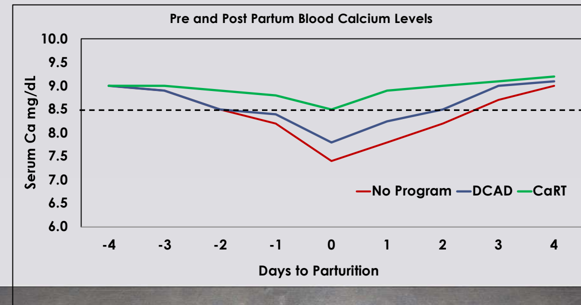
New Innovations to Prevent Hypocalcemia in Dairy Cattle



Patrick C Hoffman, Professor Emeritus, University of Wisconsin-Madison

1

Calcium Response Technology (CaRT)



2

Ca Response Technologies

- Dietary Ca Restriction
- Dietary P Restriction
- Zeolite A

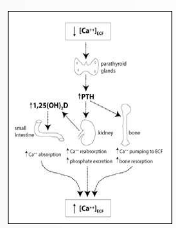
- 5-HTP
- Solanum glaucophyllum

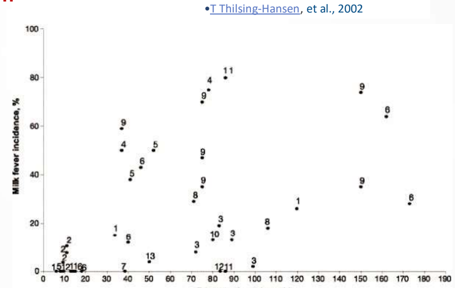
- Difructose Anhydride
- Calcidiol 25 (OH) Vit D_3

3

Calcium Restriction

•T Thilsing-Hansen, et al., 2002

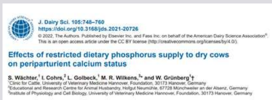




1) Boda and Cole, 1954; 2) Boda, 1956; 3) Gardner and Park, 1973; 4) Beltz et al., 1974; 5) Goings et al., 1974; 6) Wiggers et al., 1975; 7) Westerhuis, 1975; 8) Wittner et al., 1976; 9) Jönsson et al., 1980; 10) Green et al., 1981; 11) Kichura et al., 1982; 12) Braak et al., 1986b; 13) Pickard, 1987-88.

4

Phosphorus Restriction



J. Dairy Sci. 105:748–760
https://doi.org/10.3168/jds.2021-20726
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Effects of restricted dietary phosphorus supply to dry cows on periparturient calcium status

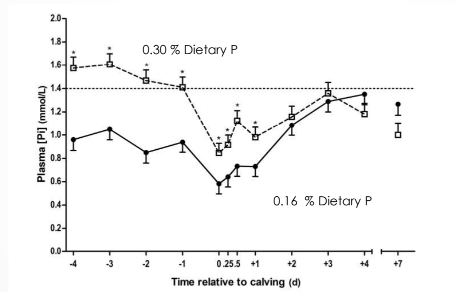
S. Wächter,[1] I. Cohrs,[2] L. Golbeck,[1] M. R. Wilkens,[3]* and W. Grünberg[1]†
[1] Clinic for Cattle, University of Veterinary Medicine Hannover, Foundation, 30173 Hanover, Germany
[2] Educational and Research Centre for Animal Husbandry, Hofgut Neumühle, 67728 Münchweiler an der Alsenz, Germany
[3] Institute of Physiology and Cell Biology, University of Veterinary Medicine Hannover, Foundation, 30173 Hanover, Germany

- 30 prefresh dairy cows
- Fed 0.16 or 0.30 % P
- Controlled feed offerings
- Fed for 28 d prior to calving
- Measurements
  - Blood Ca, P
  - PTH
  - 1-25 (OH_2) Vit D_3
  - Bone mobilization (CrossLaps-CTX)

5

Wachter et.al., JDS-2022

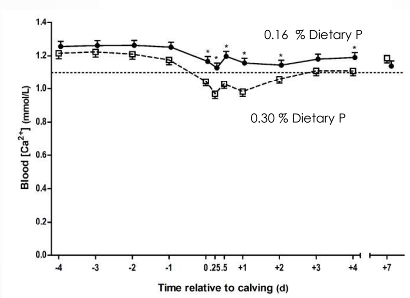
Plasma P



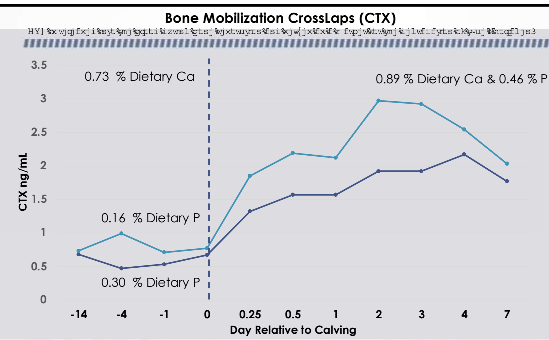
6

Wachter et.al., JDS-2022

Plasma Ca



7



8

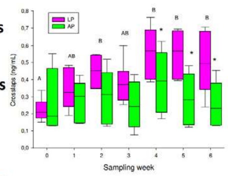
Grunberg et al., 2019

Results

CrossLaps ®

- **Significant increases after 2 weeks of P-depletion**
- **Significantly higher concentrations in LP compared to AP from the 4. week of P-deprivation**

➔ Indication for increased bone resorptive activity with P-deprivation



Different letters: Sampling times differ significantly within treatment
**: Values differ significantly between treatments*

9

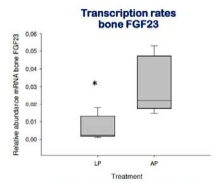
Grunberg et al., 2019

Results

Bone FGF23

- **Relative abundance of mRNA of FGF23 in bone is markedly decreased after 6 weeks of dietary P-deprivation**

Transcription rates bone FGF23



**: Values differ significantly between treatments*

10

Wachter et.al., JDS-2022 (Summary)
Feeding 0.16 % P vs 0.30 % P to prefresh cows……………

- **Decreased blood P**
- **Increased blood Ca**
- **Increased bone mobilization**
- **PTH did not directly explain differences in bone mobilization**
- **1-25 $(OH_2)D_3$ status appeared to be under the influence of P homeostasis precalving and Ca homeostasis postcalving??**
- **Authors speculated that P homeostasis was under the control of FGF23 (not measured) as opposed to PTH**

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FGF23 Fibroblast Growth Factor

Produced in bones cells
Identified in the early 2000s
Is a bone derived hormone
Suppresses phosphate reabsorption (kidney)
Modulates kidney Na and P transport
Suppresses enzymes that activate
1-25 $(OH_2)D_3$
Increases when blood P is high
Decreases when blood P is low

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Zeolite A

- Synthetic Zeolite
- Heavily studied sodium aluminium silicate
  - High ion exchange capacity
- Commercially Available to Feed to Dairy Cows
  - To reduce milk fever
  - To reduce subclinical hypocalcemia
- Introduced as a Ca Binder
  - New research = binding of recycling P
- Fed 14-21 d prefresh

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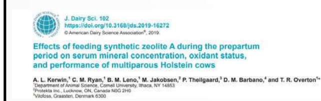
Zeolite A - Kerwin et.al., JDS-2022


J. Dairy Sci. 102
https://doi.org/10.3168/jds.2019-16272
© American Dairy Science Association®, 2019.

Effects of feeding synthetic zeolite A during the prepartum period on serum mineral concentration, oxidant status, and performance of multiparous Holstein cows

A. L. Kerwin,[1] C. M. Ryan,[1] B. M. Leno,[1] M. Jakobsen,[2] P. Theilgaard,[3] D. M. Barbano,[4] and T. R. Overton[1*]
[1]Department of Animal Science, Cornell University, Ithaca, NY 14853
[2]Protekta Inc., Lucknow, ON, Canada N0G 2H0
[3]Vilofoss, Graasten, Denmark 6300

- 55 prefresh Holstein dairy cows

  Fed 0.38 % P or 0.38 % P + Zeolite A

  Ad lib feed offerings

  Fed for 21 d prior to calving

  Measurements
  - Blood Ca, P
  - Clinical Milk Fever
  - Sub-clinical hypocalcemia
  - Milk Production
  - Colostrum Quality

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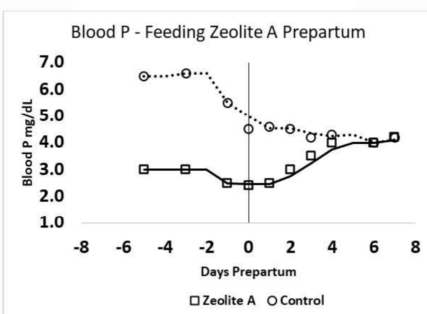
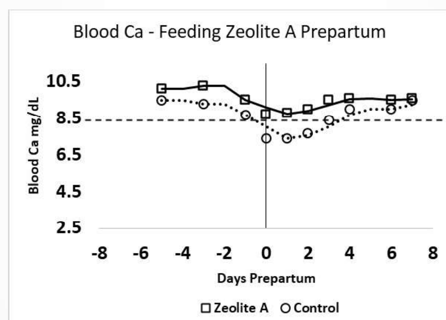
Kerwin et al., 2019



15

Kerwin et al., 2019



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Review of Zeolite A Feeding Trials

Reference	Treatments	Dietary Ca % DM Zeolite	Dietary Ca % DM Control	Dietary P % DM Zeolite	Dietary P % DM Control	Blood Ca Response % of Control Zeolite vs Control	Blood P Response % of Control Zeolite vs Control	Clinical Milk Fever % of Control Zeolite vs Control
Thilsing-Hansen et al., 2001	Zeolite vs Control	0.64	0.45	0.64	0.45	+ 27 %	NR	- 33 %
Kerwin et al., 2019	Zeolite vs Control	0.65	0.68	0.38	0.39	+ 22 %	- 50 %	0%
Frizzarini et al., 2022	Zeolite vs DCAD	NR	NR	NR	NR	+11 %	-47%	NR
	Zeolite vs Control	NR	NR	NR	NR	+17 %	-49%	NR
Crookenden et al., 2020	Zeolite vs Control	NR	NR	NR	NR	+ 13 %	-73 %	NR
Pallesen et al., 2007	Zeolite vs Control	0.61	0.69	0.61	0.69	+ 33%	- 10 %	- 75 %
	Zeolite vs Control	0.61	0.33	0.61	0.69	+ 57 %	- 72 %	-100 %
Grabherr et al., 2008	Zeolite vs Control	0.42	0.38	0.42	0.38	+ 11 %	- 22 %	NR
Saraiva de Oliveira, 2021	Zeolite vs DCAD	0.57	2.53	0.36	0.43	+ 13 %	- 45 %	-51%
Thilsing-Hansen et a., 2002	Zeolite vs Control	0.60	0.60	0.30	0.30	+12 %	- 36 %	0%
Khachouf et al., 2019	Zeolite vs Control	2.79	2.79	0.80	0.80	+ 8 %	0%	NR

NR = not reported

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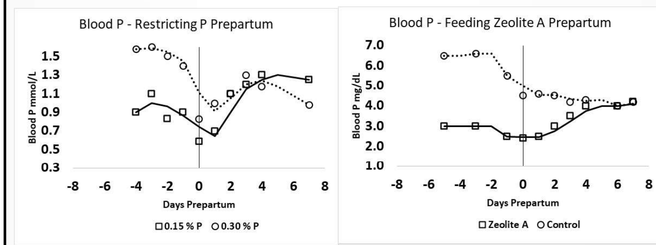
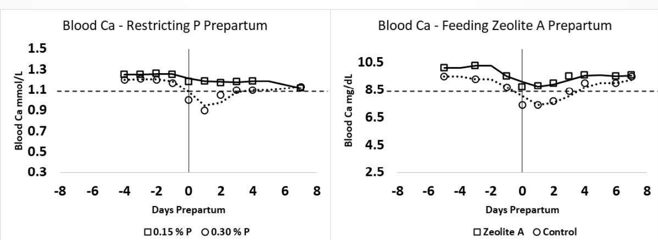
Feeding Zeolite A to Prefresh Cows Mimics Dietary P Restriction



A – Wachter et al., 2022 B – Kerwin et al., 2019

18

Feeding Zeolite A to Prefresh Cows Mimics Dietary P Restriction



A – Wachter et al., 2022 B – Kerwin et al., 2019

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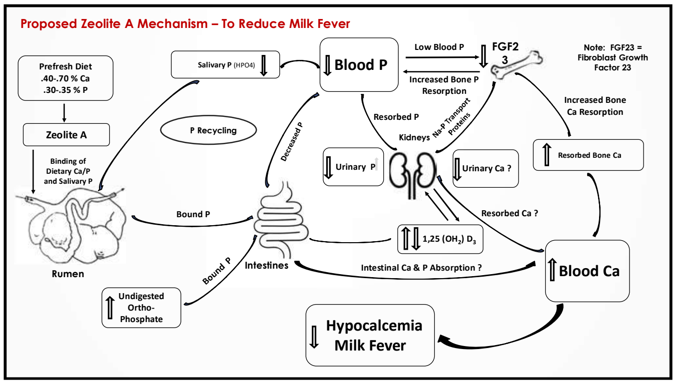
Feeding Zeolite A to Prefresh Dairy Cows to Prevent Milk Fever and Hypocalcemia

- Research observations
  - Decreased milk fever and hypocalcemia
  - Lower blood P observed
  - Greater blood Ca consistently observed
  - Decreased urinary P and Ca excretion
  - Increases 1-25 (OH2) Vit D but Not PTH?
  - Decreases Salivary P
  - Increases Undigested Fecal Ortho PO4
  - Results are nearly identical to dietary P restriction experiments
  - **Feeding Zeolite A appears to reduce milk fever and hypocalcemia by binding P thereby inducing a dietary P restriction**

20


Proposed Zeolite A Mechanism – To Reduce Milk Fever
Prefresh Diet
.40-.70 % Ca
.30-.35 % P
Zeolite A
Binding of Dietary Ca/P and Salivary P
Rumen
Salivary P (HPO4)
P Recycling
Blood P
Low Blood P
FGF2 3
Note: FGF23 = Fibroblast Growth Factor 23
Increased Bone P Resorption
Resorbed P
Kidneys
Na-P Transport Proteins
Increased Bone Ca Resorption
Resorbed Bone Ca
Decreased P
Urinary P
Urinary Ca ?
Bound P
Resorbed Ca ?
1,25 (OH2) D3
Intestines
Intestinal Ca & P Absorption ?
Blood Ca
Bound P
Undigested Ortho-Phosphate
Hypocalcemia
Milk Fever

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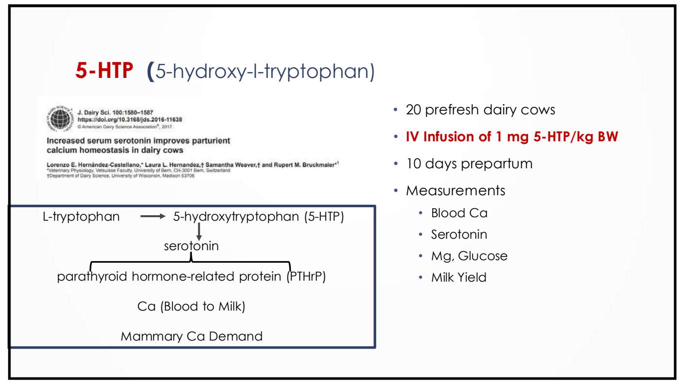
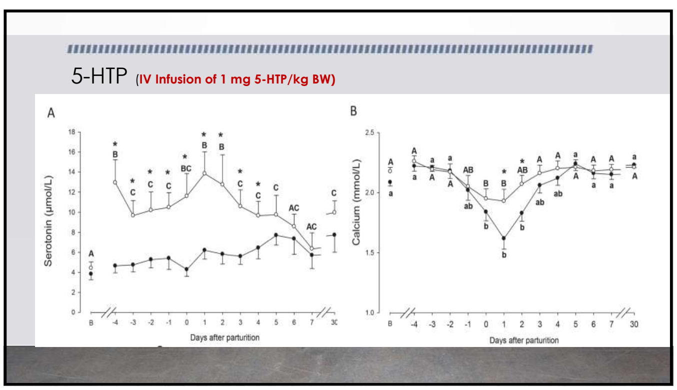
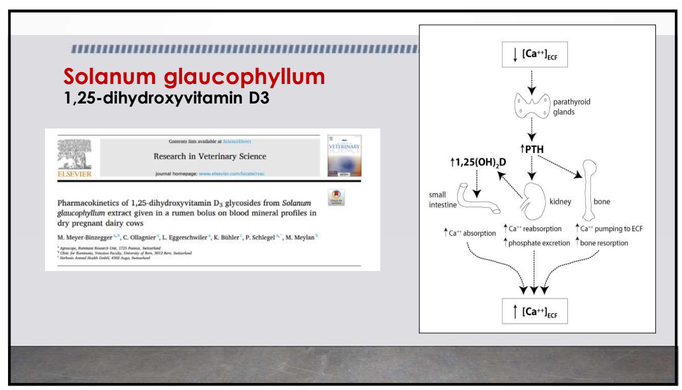

5-HTP (5-hydroxy-l-tryptophan)
Increased serum serotonin improves parturient calcium homeostasis in dairy cows
Lorenzo E. Hernández-Castellano, Laura L. Hernandez, Samantha Weaver, and Rupert M. Bruckmaier
20 prefresh dairy cows
IV Infusion of 1 mg 5-HTP/kg BW
10 days prepartum
Measurements
Blood Ca
Serotonin
Mg, Glucose
Milk Yield
L-tryptophan
5-hydroxytryptophan (5-HTP)
serotonin
parathyroid hormone-related protein (PTHrP)
Ca (Blood to Milk)
Mammary Ca Demand

22


5-HTP (IV Infusion of 1 mg 5-HTP/kg BW)
A
B
Serotonin (µmol/L)
Calcium (mmol/L)
Days after parturition
Days after parturition

23


Solanum glaucophyllum
1,25-dihydroxyvitamin D3
Research in Veterinary Science
Pharmacokinetics of 1,25-dihydroxyvitamin D3 glycosides from Solanum glaucophyllum extract given in a rumen bolus on blood mineral profiles in dry pregnant dairy cows
parathyroid glands
PTH
1,25(OH)2D
small intestine
kidney
bone
Ca++ absorption
Ca++ reabsorption
phosphate excretion
Ca++ pumping to ECF
bone resorption

24

Solanum glaucophyllum – Meyer-Binzegger et al., 2022

- Bolus to Dry Cows
- When to give the bolus?

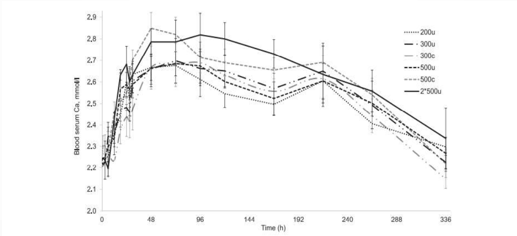


Fig. 2. Pharmacokinetics of calcium in blood serum (least square means ± SE) over time after single oral bolus administration (time effect: $P < 0.001$; treatment effect: $P < 0.001$; time x treatment interaction: $P > 0.10$).

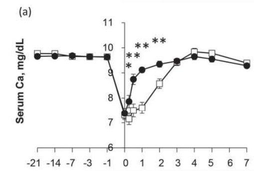
25

- Difructose Anhydride

J. Dairy Sci. 98:8688–8697
http://dx.doi.org/10.3168/jds.2015-9576
© American Dairy Science Association®, 2015.

Supplementation with difructose anhydride III promotes passive calcium absorption in the small intestine immediately after calving in dairy cows

M. Teramura,*†[1] S. Wynn,* M. Reshalaitihan,‡ W. Kyuno,† T. Sato,† M. Ohtani,† C. Kawashima,‡ and M. Hanada‡
*United Graduate School of Agricultural Sciences, Iwate University, Morioka, Iwate, 020-8550, Japan
†Nippon Beet Sugar Manufacturing Co. Ltd., Obihiro, Hokkaido, 080-0831, Japan
‡Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Hokkaido, 080-8555, Japan

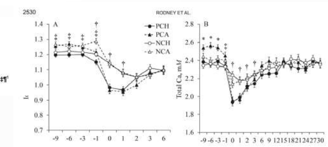


- Calcidiol 25 (OH) Vit D_3

J. Dairy Sci. 101:2519–2543
https://doi.org/10.3168/jds.2017-13737
© American Dairy Science Association®, 2018.

Effects of prepartum dietary cation-anion difference and source of vitamin D in dairy cows: Vitamin D, mineral, and bone metabolism

R. M. Rodney,*† N. Martinez,‡ E. Block,§ L. L. Hernandez,# P. Celi,ǁ C. D. Nelson,‡ J. E. P. Santos,‡¶[1] and I. J. Lean*†
*Faculty of Veterinary Science, The University of Sydney, Camden, NSW 2570, Australia



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Ca Response Technologies - Summary

Technology	CaRT	On-Farm Reality
Dietary Ca Restriction	Yes	Infeasible
Dietary P Restriction	Yes	Difficult to formulate diets low enough in P
Zeolite A	Yes	Commercially available. Induces dietary P restriction – bone mobilization of Ca/P.
5-HTP	Yes	Commercial application in development
Solanum glaucophyllum	Yes	Commercial applications emerging
Difructose Anhydride	No	Increases Ca absorption post-partum
Calcidiol 25 (OH) Vit D_3	No	Improves Vit D status which has other benefits

27

28

Future of Calf Rearing in Pairs and Groups

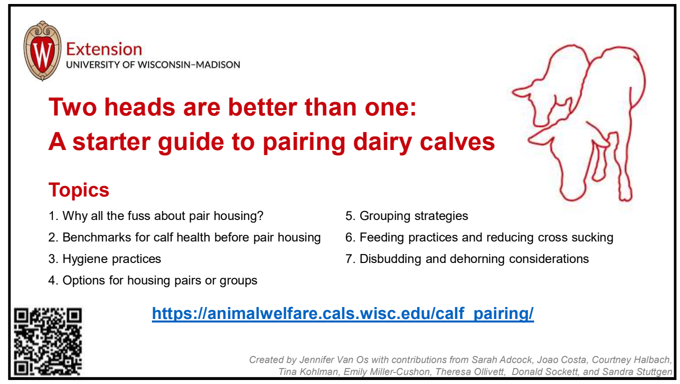
Jennifer Van Os | University of Wisconsin-Madison | jvanos@wisc.edu

Notes:

PowerPoint Slides on next page

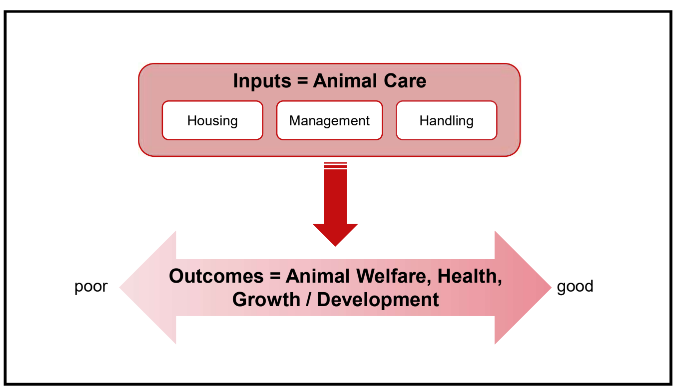
The future of calf rearing in pairs and groups
Jennifer Van Os
Assistant Professor
Extension Specialist in Animal Welfare
Sky Sheng
Western Dairy Management Conference
Wednesday, March 1, 2023
Department of Animal & Dairy Sciences
UNIVERSITY OF WISCONSIN-MADISON

1



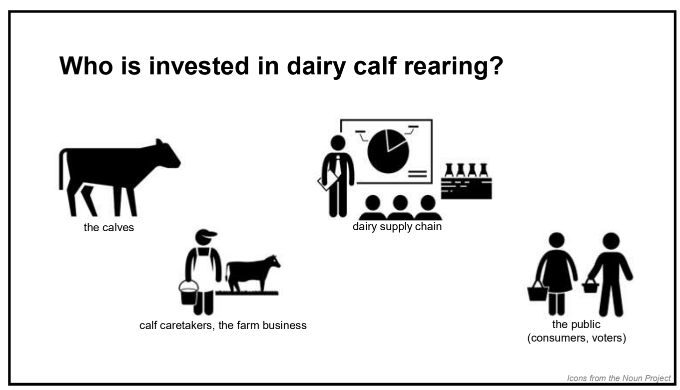
Extension
UNIVERSITY OF WISCONSIN-MADISON
Two heads are better than one:
A starter guide to pairing dairy calves
Topics
1. Why all the fuss about pair housing?
2. Benchmarks for calf health before pair housing
3. Hygiene practices
4. Options for housing pairs or groups
5. Grouping strategies
6. Feeding practices and reducing cross sucking
7. Disbudding and dehorning considerations
https://animalwelfare.cals.wisc.edu/calf_pairing/
Created by Jennifer Van Os with contributions from Sarah Adcock, Joao Costa, Courtney Halbach, Tina Kohlman, Emily Miller-Cushon, Theresa Ollivett, Donald Sockett, and Sandra Stuttgen

2



Inputs = Animal Care
Housing
Management
Handling
poor
Outcomes = Animal Welfare, Health, Growth / Development
good

3

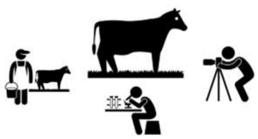


Who is invested in dairy calf rearing?
the calves
dairy supply chain
calf caretakers, the farm business
the public (consumers, voters)
Icons from the Noun Project

4

Animal welfare is a multi-stakeholder issue requiring multi-disciplinary approaches

Biological science:
Understanding the animals



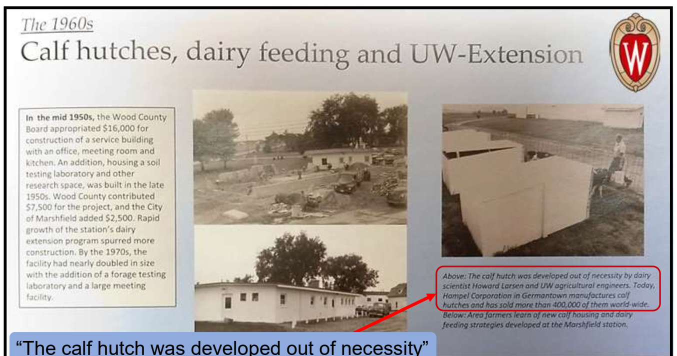
Social science:
Understanding people

Icons from the Noun Project

5

Calf rearing: Past

6



"The calf hutch was developed out of necessity"

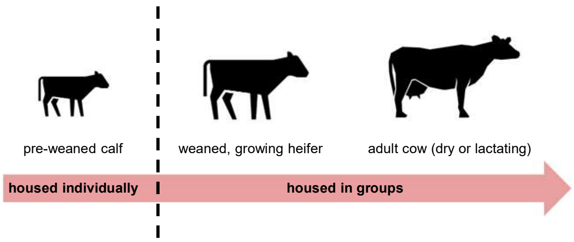
The History of the Marshfield Agricultural Research Station

7

Calf rearing: Present

8

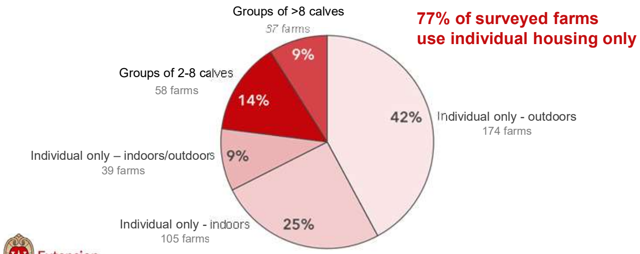
Typical dairy cattle social grouping by life stage



Icons from the Noun Project

9

Individual housing remains the norm in the U.S.



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UNIVERSITY OF WISCONSIN-MADISON

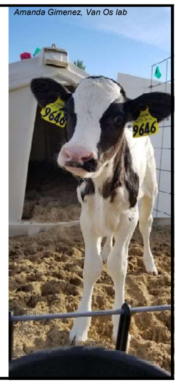
Silva, Van Os et al., in preparation; USDA, 2016

10

Why is individual housing the norm?

- Allows for controlling & monitoring individual calves (feeding, health issues)
- Physical separation can reduce disease risks:
  - ⇩ calf-to-calf contact
  - ⇩ shared aerosol
  - ⇩ contamination of shared feeding equipment or bedding
- Ease of handling individual calves

Amanda Gimenez, Van Os lab



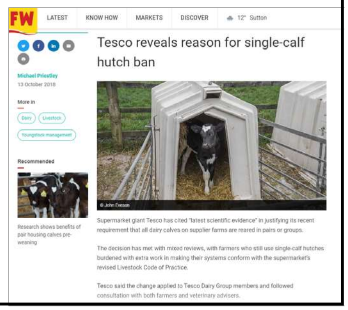
11

Calf rearing: Future

12

What's on the horizon?

There is reason to expect the norm for raising calves will move away from individual housing


FW LATEST KNOW HOW MARKETS DISCOVER 12° Sutton

Tesco reveals reason for single-calf hutch ban

Michael Priestley
13 October 2018

More in
Dairy Livestock
Youngstock management

Recommended
Research shows benefits of pair housing calves pre-weaning

© John Eveson

Supermarket giant Tesco has cited "latest scientific evidence" in justifying its recent requirement that all dairy calves on supplier farms are reared in pairs or groups.

The decision has met with mixed reviews, with farmers who still use single-calf hutches burdened with extra work in making their systems conform with the supermarket's revised Livestock Code of Practice.

Tesco said the change applied to Tesco Dairy Group members and followed consultation with both farmers and veterinary advisers.

https://www.fwi.co.uk/livestock/youngstock-management/tesco-reveals-reason-for-single-calf-hutch-ban

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Benefits of social rearing


benefits for the calves

Emily Miller-Cushon

✓ Addresses calves' motivation and preference for contact
✓ Positive emotional state reflected in "optimistic" test responses

Holm et al., 2002; Faervik et al., 2006, 2007; Ede et al., 2021; Bučková et al., 2019; Lindner et al., 2022; Icon from the Noun Project

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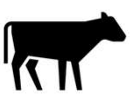
Benefits of social rearing


benefits for the calves

✓ Play behavior
✓ Social development


Van Os lab

Broom & Leaver, 1978; Jensen et al., 1997, 1998, 2015; Veissier et al., 1994, 1997; Holm et al., 2002; Icon from the Noun Project

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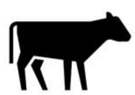
Benefits of social rearing


benefits for the calves

✓ Resilience to stress (weaning)
✓ Cognitive / behavioral flexibility
✓ Adaptability to new things

Jensen et al., 1997; Chua et al., 2002; de Paula Vieira et al., 2010; Duve et al., 2012; Costa et al., 2014; Gaillard et al., 2014; Meagher et al., 2015; Bolt et al., 2017; Whalin et al., 2018; Icon from the Noun Project

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Why does learning ability matter?

We expect cows to learn a lot of new things over their lifetimes:

- ✓ New housing elements (e.g., hutch → bedded pack → stalls; different feeding and drinking sources)
- ✓ New diets and feed items
- ✓ New social groups
- ✓ Milking in parlors (both sides!) or AMS

Photo: http://udderside.blogspot.com/2012/05/graduating-to-milking-herd.html

17

Icons from the Noun Project

Benefits of social rearing

- ✓ Greater solid feed intake
- ✓ Greater weight gains, ADG

benefits for the calves   benefits for the farm business

Costa et al., 2016. Invited review in J. Dairy Sci. 99:2453-2467; Pempek et al., 2016; Wormsbecher et al., 2017; Overvest et al., 2018; Whalin et al., 2018; Knauer et al., 2021; Zhang et al., 2021; Lindner et al., 2022

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To date, no study has shown individually housed calves to outperform those housed in pairs or small groups

	+	=	−
DMI of starter grain	11	8	0
Avg. daily gain	6	7	0
Weaning bodyweight	8	4	0

Dr. Joao Costa

Adapted from Costa et al., 2016. Invited review in J. Dairy Sci. 99:2453-2467; Pempek et al., 2016; Wormsbecher et al., 2017; Overvest et al., 2018; Whalin et al., 2018; Knauer et al., 2021; Zhang et al., 2021; Lindner et al., 2022

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Icons from the Noun Project

Benefits of social rearing

Protection from cold stress
→ more energy for growth and immunity?

benefits for the calves   benefits for the farm business

Reuscher, Van Os, et al. in preparation; Icons from the Noun Project

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Benefits of social rearing

✓ Greater public acceptance

Perttu et al., 2020. J. Dairy Sci. 103:8507-8517; Icons from The Noun Project

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Perttu et al., 2020. J. Dairy Sci. 103:8507-8517; Icon from the Noun Project

n = 1,310 adults at the Minnesota State Fair

	individual	pair	group
approve	31.5%	66.0%	75.8%
neutral	21.5%	19.9%	16.8%
disapprove	47.0%	14.1%	7.4%

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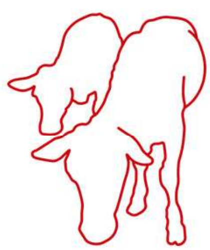
Benefits of pairing calves:

- ✓ Motivated for social contact
- ✓ Play behavior
- ✓ Social development
- ✓ Resilience to stress
- ✓ Cognitive / behavioral flexibility, adaptability to new things
- ✓ Greater solid feed intake
- ✓ Greater weight gains
- ✓ Greater public acceptance
- ✓ (Enhanced protection from cold stress?)

What about potential challenges?



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Potential challenges of pair or group raising

1) How to raise healthy calves?

- Many farms successfully raise healthy calves in social groups
- We surveyed producers using pair or group housing: 72% were satisfied with calf health
- But, some farms may need to adjust management practices before transitioning from individual housing

Silva, Van Os, et al. in preparation

24

Multiple factors contribute to calf morbidity

The same principles for good health apply whether housing calves individually or in groups:

- ✓ preventive care and monitoring
- ✓ colostrum protocol
- ✓ nutrition
- ✓ hygiene, sanitation, biosecurity
- ✓ ventilation
- ✓ space allowance, bedding
- ✓ all-in / all-out moves

Ollivett, 2020. Vet. Clin. Food Anim. 36:385-398; Costa et al., 2016. J. Dairy Sci. 99:2453-2467

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Pair-housed calves can stay healthy

- n = 48 calves (16 individuals, 16 pairs)
- Housed from 0-60 d of age in outdoor plastic hutches
- Winter (December-March) in Wisconsin

Condition	Pair housed	Individually housed
Infected inner ear	1 out of 32	0
Cryptosporidiosis	0	1 out of 16
Pneumonia	1	1
TOTAL	**2 out of 32**	**2 out of 16**

Reuscher, Van Os, et al. in preparation

26

Potential challenges of pair/group raising

2) Proper housing facilities?

One reason given for keeping calves individually is a lack of housing facilities for groups

Medrano-Galarza et al., 2017. J. Dairy Sci. 100:6872-6884

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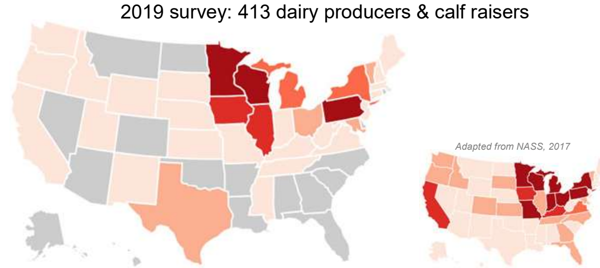
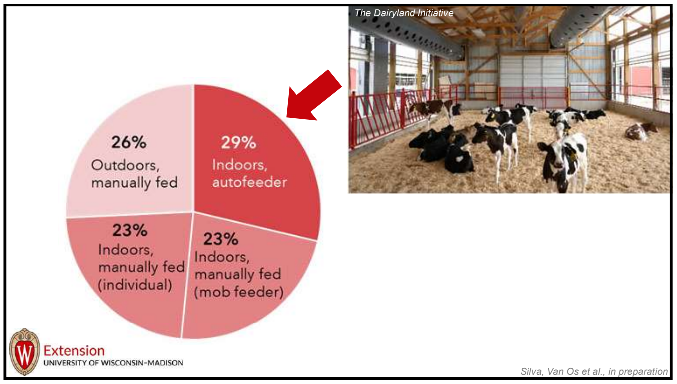
2019 survey: 413 dairy producers & calf raisers



F. Silva, J. Van Os, C. Winder (U Guelph), M. Akins, T. Kohlman, T. Ollivett, H. Schlesser, B. Schley, S. Stuttgen, J. Versweyveld (in preparation)

28


The Dairyland Initiative
26%
Outdoors, manually fed
29%
Indoors, autofeeder
23%
Indoors, manually fed (individual)
23%
Indoors, manually fed (mob feeder)
Extension
UNIVERSITY OF WISCONSIN-MADISON
Silva, Van Os et al., in preparation

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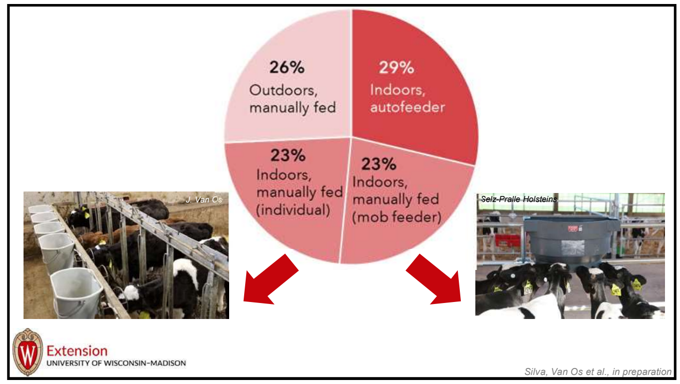
26%
Outdoors, manually fed
29%
Indoors, autofeeder
23%
Indoors, manually fed (individual)
23%
Indoors, manually fed (mob feeder)
J. Van Os
Selz-Pralle Holsteins
Extension
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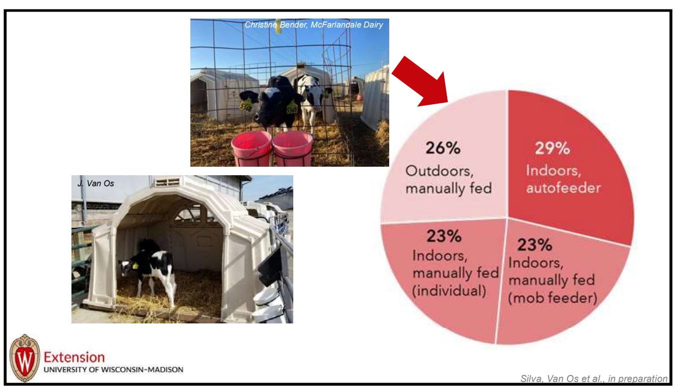
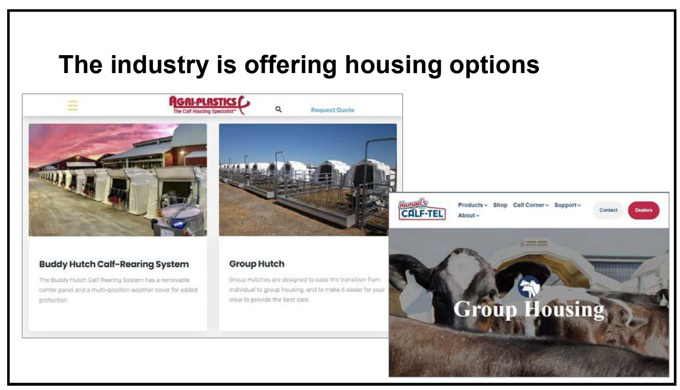
Silva, Van Os et al., in preparation

30


Christine Bender, McFarlandale Dairy
J. Van Os
26%
Outdoors, manually fed
29%
Indoors, autofeeder
23%
Indoors, manually fed (individual)
23%
Indoors, manually fed (mob feeder)
Extension
UNIVERSITY OF WISCONSIN-MADISON
Silva, Van Os et al., in preparation

31


The industry is offering housing options
AGRI-PLASTICS
Request Quote
Buddy Hutch Calf-Rearing System
Group Hutch
CALF-TEL
Group Housing

32

Potential challenges of pair/group raising

3) How to manage unwanted behaviors
(e.g., cross sucking)

In our survey, at least "occasional" cross sucking reported by:

- 85% of producers using pair or group housing
- 70% of producers using individual housing with fence-line contact

Extension
UNIVERSITY OF WISCONSIN–MADISON

Silva, Van Os et al., in preparation

33

Feeding strategies to reduce cross sucking

1. Reduce hunger by feeding a generous milk volume
2. Provide enough opportunity to suckle appropriately

Hammel et al., 1998; de Passillé, 2001, 2010; Jung & Lidfors, 2001; Keil & Langhans, 2001; Loberg & Lidfors, 2001; Lidfors & Isberg, 2003; Veissier et al., 2002; Jensen & Budde, 2006; Salter, Reuscher, Van Os (2021)

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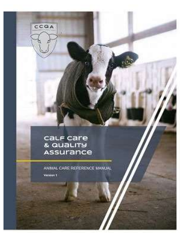
Calf Care and Quality Assurance program



4.4 SOCIAL CONTACT

What is it and Why is it Important?

Cattle are a social species that have a strong urge to live within herds. When calves are separated, there are some detrimental effects that can occur on their development including isolated calves being more fearful and less dominant when mixed into groups later in life. In addition, individually housed calves have a harder time coping with changes in housing and diet and may have cognitive and developmental disadvantages, including poor learning skills and deficient social skills. Collectively this evidence suggests that social contact with peers from an early age is important for the calf.

Beyond these behavioral impacts of social housing, there are some benefits to having socially reared calves including increased body weight gain and increased feed intake. There are some concerns surrounding cross-sucking, aggression, and transmission of disease. However, there are multiple methods to address these challenges, including employing a gradual weaning program, feeding a high plane of milk nutrition, providing appropriate outlets for suckling behavior, using lower stocking density and group sizes, maintaining a stable group of calves, as well as cleaning pens and allowing downtime between subsequent groups.

What Can You Do?

To minimize the effects of social isolation, calves from the same source facilities could be grouped together early in life. Providing visual and/or physical contact with other cattle has been shown to be beneficial to calves. To see the full benefits of social contact, calves need to be housed where they have physical contact with each other. Pair housing, where calves are grouped with one other calf, may be a good compromise between group housing and individual housing in terms of calf welfare and management. It allows producers to incorporate the benefits of social contact while maintaining the intensive management of animals and limit of disease transmission that occurs with individual housing.

Pair housing… may be a good compromise between group housing and individual housing in terms of calf welfare and farm management.

https://www.calfcareqa.org/

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FARM Animal Care program

FARMERS ASSURING RESPONSIBLE MANAGEMENT — FARM™

- Pair/group housing will not become an expectation in version 5.0 (effective 2024)
- Manual will discuss recommended best practice, as in CCQA
- Anticipate it will become an eventual standard in some future version…

https://nationaldairyfarm.com/dairy-farm-standards/animal-care/

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Two (or more) heads are better than one

- Pair or group housing will likely become an industry expectation
- Social contact from an early age is important for calves' development, growth, welfare, and public perception
- There can be challenges, but they are surmountable:
  - Housing options vary in level of infrastructure investment
  - Concerns with health or cross sucking can be managed

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Jennifer Van Os
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www.DairyAnimalWelfare.org

Department of Animal & Dairy Sciences
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Is Your Calf Program Sustainable

Robert James | Down Home Heifer Solutions | jamesre60@gmail.com

Notes:

PowerPoint Slides on next page

Is your calf program sustainable?

- Robert James, Ph.D., PAS
- Professor Emeritus – Va. Tech – Dept. of Dairy Science
- Down Home Heifer Solutions, LLC

1

Sustainable?

- The ability to endure, and to remain diverse and productive indefinitely.
- **"**Five pillars of sustainability" –
  - Dr. Frank Mitloehner – UC – Davis

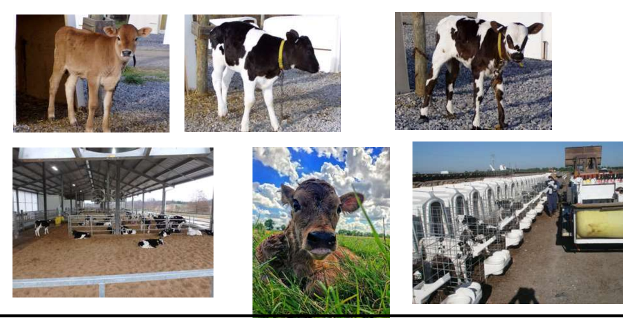
2

Primary goal of all heifer rearing programs

- Raise the highest <u>quality</u> heifer that can maximize profits when she enters the lactating herd.
- No <u>limitations</u> that detract from her ability to produce milk under the farm's management system.
- Optimize <u>profits</u> by obtaining highest <u>quality</u> heifer in lowest possible cost in least amount of time.
- Raise the number of <u>heifers required</u> to meet the goals of the dairy business.

3

Is your **calf** program sustainable?



4

What issues are driving sustainability of the calf enterprise?

- Welfare
- Environment
- Labor
- Food Safety
- Economic viability

5

Calf "welfare"
Calf and consumer perspective

6

Calf rearing is the focus for consumer perceptions of dairy – Univ. of British Columbia

- Animal welfare and consumer willingness to pay for yogurt- Napolitano et al (2008)
- Welfare of calves **transported** by road – Roadknight et al (2021)
- Prolonged cow / calf contact – Meagher et al (2019)
- Citizen views on practices of **zero grazing** and **cow calf separation** – Hotzel (2017)
- Comparison of selected animal observations ….. assess welfare of calves…. Bergman et al (2014)
- Symposium: Considerations for the future of dairy cattle housing: An animal welfare perspective. J. Dairy Sci. 103:5746

7

Impact of animal "welfare" on calf performance and consumer perceptions

- Paired or group-housed calves
  - Earlier starter intake
  - Adapt better to novel situations
  - Less stressful weaning
  - Jennifer Van Os

L. Raatz – Wagner Farms

8

Pair housing – Wagner Farm – Iconto Falls, WI
650 Holsteins

- Social Behavior
  - Prefer having a buddy
  - They stay with their buddy when moved to larger groups
  - Easier transition to weaned calf facility
- Less Antibiotics
  - Eat more, grow faster, therefore less antibiotics
  - Healthier calves
  - Death loss: currently 0% for over a year
- Challenges – still feeding twice daily – learned behavior – labor in feeding and cleaning.

Picture – L. Raatz – Wagner Farm

9

Group Housing – Alternatives

Mob feeders

Acidified Free choice

Autofeeders

10

Group housing

- Requirements for group housing success:
  - Maternity
  - Colostrum management
  - Herd health
  - Facility design – ventilation and drainage.
  - Different managerial skill set
  - Limitation to maximum herd size with different systems?
  - Data availability and use with autofeeder system

11

Another aspect of welfare

Traditional feeding program goals

- Limit feed milk – (<1.25 lb DM/DAY)
- Feed low fat CMR – (<20%)
- Why? – low cost/day and transition to ruminant at earliest age
- Is this normal for mammals?

12

Feeding and housing for calves
von Keyserlingk (2010)

- Milk feeding amounts – Ad lib vs restricted to 10% of body weight vs.
  - Higher BW gains, improved feed conversion, reduced age at first breeding (Diaz, 2001, Shamay, 2005)
  - Less vocalization
  - Fewer unrewarded visits to autofeeder
- Nipple vs bucket feeding – higher concentration of enzymes (de Passille, 1993)
  - Less cross sucking.

13

Impact of "better" nutrition – particularly the <u>first month</u> of life

- Body condition

- Calves fed more milk
  - Reduced duration of scours from Crypto – (Olivett, 2012)
  - Greater leukocyte response to Salmonella – (Ballou, 2018)
  - Less mortality and clinical symptoms when challenged with Bovine Herpes Virus and Mannheimia – (Ballou et al)
- More milk during first and later lactation - Soberon et al, 2013

14

Advantages of body condition in preweaned calf?

15

Why do we raise calve in individual hutches/pens?

- Disease prevention
- Observation
- Tradition?

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Optimizing returns – facilities to promote calf health, labor efficiency and labor effectiveness

- Calf hutch as the "gold standard"???
  - Labor involved in feeding liquid diet, calf starter, bedding, sanitation
  - Impact of weather on labor
  - Impact of weather on calves
  - Retention of labor
  - Minimizing shrink in liquid and dry diet
  - Maintaining quality of liquid and dry diet

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Seeking a win:win outcome

Calf

- More milk earlier in life
- Feed for genetic potential for growth
- Achieve benefits of paired or group housing
- Manage calves to achieve genetic potential
  - Records for proactive calf management
- Raise the number needed – maternity, newborn care, minimize morbidity and mortality

Consumer

18

Transporting calves to calf rearing facilities? Another "welfare" issue?

- Age at shipping?
- Length of "haul" without feed or water?
- US – 28h?
- DCHA- 24 h, then 5 hour stop
- AABP
  http://aabp.org/Resources/AABP_Guidelines/transportationguidelines-2019.pdf
- Biosecurity with calves co-mingled from multiple source farms?

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Canada – February 2020

- Calves may be transported for up to 12 hours if dehydration, starvation and exhaustion are prevented??????
- Once 12 hours is reached, they must be provided with feed, water and rest.
- Calves 8 days and under may only be transported once and are prohibited from going to assembly centres.

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Environment

- Impact of the calf program on the nutrient management plan for the dairy?
- N and P excretion by calves?
- 20 -40 g N/day, 3 – 5g P/day when fed ~ 1.2 – 1.5 kg DM/day (Hill, 2006)
- Climate is large determinant
  - “Wetter” climates must collect nutrient effluent from calf hutch sites.

Carol Highsmith - Library of Congress collection

21

Facilities for calves and nutrient effluent management

22

Labor availability and cost

- 2021 – meat and dairy employers requested 34,000 H-2A and 2B workers
- One in five livestock and dairy workers are foreign born. In Texas, 51% of dairy workers were immigrants

American Immigration Council – July 2022

23

Minimum wage and overtime

- Washington state – 200,000 farm workers
  - >40 hours/week – overtime pay
- California – phased in >26 or <25 employees
  - 9.5 to 8.0 h/day
  - 55 to 40 h/week
- New York
  - Minimum wage - $14.20, overtime 60 h - $21.30

24

What can be done to improve labor efficiency and effectiveness

What can be done to improve labor retention?

25

Calf care tasks

- Maternity – calving, colostrum harvest/storage
- Newborn care – navels, vaccinations, colostrum feeding, transport
- Milk prep / pasteurizer / storage
- Milk replacer prep
- Milk feeding – bucket or bottle, sanitation
- Calf starter feeding
- Health team
- Housing - bedding, maintenance, sanitation

26

Impact of rearing facility on labor effectiveness

27

Labor efficiency and effectiveness

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Labor efficiency and effectiveness

- Efficiency ++++
- Shrink?
- Repetitive actions of adding and removing nipples?

29

Do you have a system?

30

Food safety - Is this an issue for dairy calf programs?

- 55% of dairies fed unpasteurized milk – saleable and unsaleable.***
- Feeding milk from treated cows is "off label use of antibiotics".
- 38% fed medicated milk replacer
- Preweaned calf health
  - 21% diarrhea – 76% treated
  - 12% respiratory – 95% treated
- Primary antimicrobial
  - Tetracyclines
  - Cephalosporins
  - Tremethoprim/sulfa
  - Macrolides/florfenicol

NAHMS DAIRY 2014

31

Financial management – applied to calves!

- Historical = low cost/day
  - Limited milk
  - Early weaning
  - Early calf ranch approach – economy of scale, specialization and protocol development.
  - Is your calf program low cost/day or low cost for value product?
- What about optimizing returns?

32

Cost of raising heifers by stage of growth

	Birth to 200 lb	201 – 700 lb.	701- 850 lb.	851 – Calving
Feed	$172	$342	$105	$443
Labor	95	88	18	92
All other costs	97	310	116	469
Total	$364	$739	$240	$1017
% of Total Costs	15.4%	31.3%	10.2%	43.1%
% of Total Growth	8%	38%	12%	35%

What stage has a greater impact on health? What stage has greatest efficiency of growth? Influence on mammary development? ……….

Karszes, Hill – Dairy Replacement Program: Cost and Analysis, Summer, 2019

33

Low-cost rearing – Is this a sustainable goal?

- DCHA goals
  - Survival
    - >97% - 24 h – 60 days
  - Morbidity
    - Scours - <25%
    - Respiratory < 10%

34

Preweaning morbidity

- Impact of respiratory disease on lifetime performance?
  - Rossini et al (2004) – Treat >2X = reduced herd life and increased AOFC.
  - Bach et al (2010) – Treat >4x =1.87 odds of not completing 1st lactation.

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Optimizing our returns – biology and $$$

- Instead of cost/day – cost / lb(g) of gain
- Biology and $$$ of nutrition
- Nutrient requirements for maintenance and gain

36

Growth rate

- Double birth weight by 56 days?
- 85 lb. birth weight = 1.5 lb. / day
- What is genetic potential for growth?
- Heifers that completed 2nd lactation grew more between 12 to 65 days of age than those that did not. (Bach, 2010)
- Each lb. of preweaning ADG = 850 - 1,130 lb. more milk in 1st lactation (Soberon et al)

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Impact of environment on ADG

Whole Milk Intake Quarts	Environmental Temperature (°F)			
	Allowable gain	68	40	20
4	Energy	.85	.36	Lose weight
	Protein		.83	
	$/lb gain	**$1.81**	**$4.27**	infinite
8	Energy	2.47	2.1	1.9
	Protein		1.9	
	$/lb gain	**$1.25**	**$1.47**	**$1.63**

Calves lose weight at 4 quarts when temperature is less than 30°

Calf continue to grow regardless of temperature at higher feeding rates

Most important during first 30 days of life when limited starter intake

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Cost per pound of gain for 120-lb. calf

Type of milk	2qt. Twice Daily	3 qt. Twice Daily
Whole milk 3.25 PR 3.75 Fat	$2.95	$2.04
Milk Replacer 20%CP, 20% FAT, 12.5% S	$3.23	$2.07
Milk Replacer 24%CP, 22% FAT, 12.5% S	$2.66	$1.79
Milk Replacer 26%CP, 17%FAT, 12.5% S	$2.39	$1.82
Milk Replacer 26%CP, 24% FAT, 12.5% S	$2.48	$1.71
Milk Replacer 28%CP, 20%FAT, 12.5%% S	$2.24	$1.67

Robert Corbett – May /June 2018 – Dairy Herd Management

39

Optimizing returns – raise what you need!

- Cost to rear replacement heifer exceeds their market value.
  - 2019 Dairy Replacement Cost - $2,094 – $2,607 - J. Karzes.
- Selling surplus replacements is not usually profitable. 1/6/2023 USDA / AMS - $1,338
- Biosecurity risk of purchasing replacements.

40

Optimizing returns - cont'd.

- Control involuntary culling rate in milking herd
- Raise what you need.
  - Calf mortality – minimize
  - Optimize potential of what you raise
    - Nutrition
    - Health

41

How do you "manage" your calves?

- to handle or direct with a degree of skill: such as:
- to exercise executive, administrative, and supervisory direction of, manage a business
- Hmmm…. Apply this to the calf enterprise

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Essentials for calf management

- Calf management team – feeders, managers, herd management, DVM, industry partners
- Communication pathways
- **Records – minimal lag and relevant to achieving goals (growth, health, financial.**
- Commitment to improvement.

43

Impact of technology

- Robotic milking – Are these herds managed differently than conventional herds?
- Apply this mindset to managing calves
- Data for calf management?
  - Consumption, drink speed, breakoffs, unrewarded visits, treatments

44

Use of calf feeder data to better manage calf health (calfblog.com) – Cantor et al

45

What does the future hold and are you ready?

- Where is your calf program now?
- Where do you want it to be?
- How will you get there?
- Is your calf program important to your farm?

46

Is your calf program sustainable?

- Plan for the future
- Feeding for success – health and future milk
- Housing system – paired or group housing
- Labor effectiveness and efficiency
- Environmentally compatible.
- Economically sustainable
  - Raise what you need.
  - Control morbidity and mortality
  - Manage your calf program with the same mindset as your cows!

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It’s All in the Milk Flow

Paul Virkler | Cornell University | pdv3@cornell.edu

Notes:

PowerPoint Slides on next page

It's All in the Milk Flow

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Cornell University Animal Health Diagnostic Center
Quality Milk Production Services

1

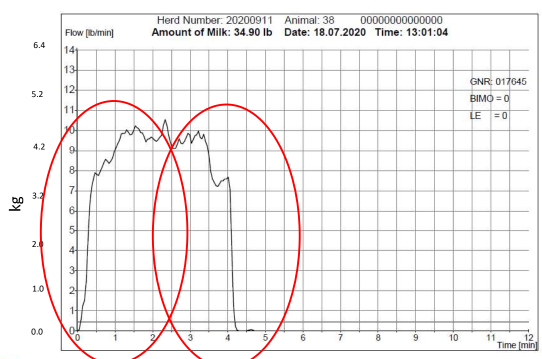
Outline of Talk

- Discussion of influences on the front end of the milk flow curve
- Discussion of consequences of getting it wrong
- Outlining ideas for how we monitor this
- Brief overview of influences on the back end of the milk flow curve

Cornell University Animal Health Diagnostic Center
Quality Milk Production Services

2

The Milk Flow Curve of an Individual Cow



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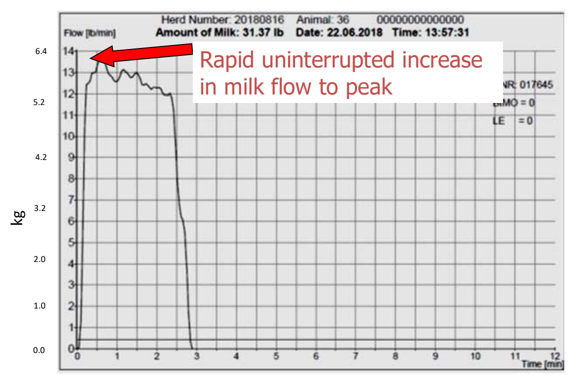
High Flow Rates



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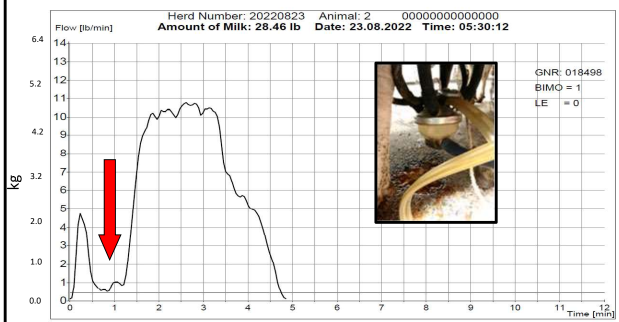
Bimodal Milk Flow or Delayed Milk Ejection



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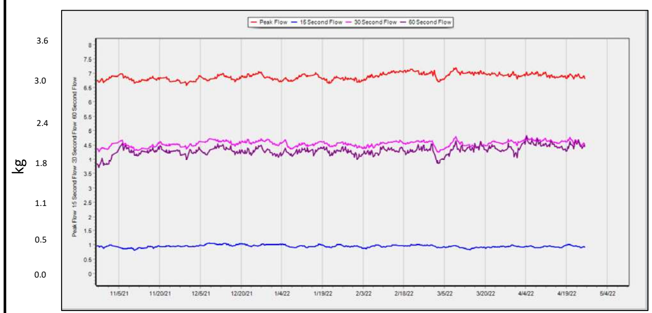
Bimodal Milk Flow or Delayed Milk Ejection



6 months of data

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Milk Letdown Physiology

- “Milk ejection is an inborn reflex, an involuntary act not under the conscious control of the cow.”

  from Milking Machines and Lactation

- Teat stimulation of dairy cows caused oxytocin release and milk ejection at all times during the day.

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Milk Letdown Physiology

Milk Letdown

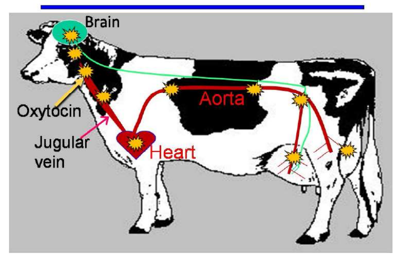

Diagram from www.qualitymilkalliance.com used with permission from Dr. Ron Erskine

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Milk Letdown Physiology

- Milk is present in two primary areas in the udder just prior to milking
  - Cisternal fraction
    - ~20% of milk yield, removed by opening teat canal
  - Alveolar fraction
    - ~80% of milk yield, **need oxytocin**

Bruckmaier and Blum, 1998

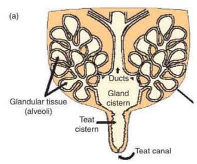

Diagram Adapted from Nickerson SC and Akers RM (2011) Mammary Gland | Anatomy. In: Fuquay JW, Fox PF and McSweeney PLH (eds.), Encyclopedia of Dairy Sciences, Second Edition, vol. 3, pp. 328–337. San Diego: Academic Press.

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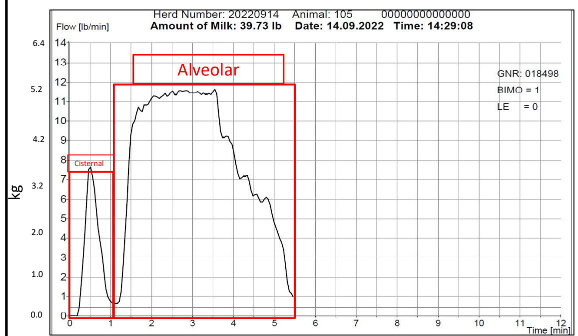
Bimodal Milk Flow



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Bimodal Milk Flow or Delayed Milk Ejection

- Why should we care about bimodal milk flow?
  - Influence on unit on time
  - Kickoffs
  - Reattaches
  - Liner slips
  - Cows leaving the parlor not milked out
  - Loss of milk production!
- These influence parlor efficiency, mastitis risk, and ultimately the bottom line.

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Milk Letdown Physiology

- What causes a failure of milk letdown?
  - Failure to achieve adequate oxytocin levels from stimulation
  - Release of epinephrine (adrenalin)
    - Blocks oxytocin receptors
    - Causes contraction of the teat and cisternal area
  - Milking in unfamiliar surroundings
    - Oxytocin release is blocked and so only cisternal milk is removed

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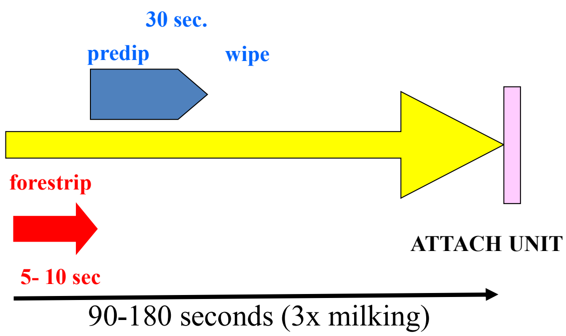
Udder Preparation & milk let-down



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Milking Routine Timing

- Pre-dip Contact Time (>30 seconds)
- Initial Stimulation Time (5-10 seconds or more)
- Lag Time (time from start of stimulation to unit attachment) (90-180 seconds)

Are there issues with the timing if it is performed correctly?

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Milking Routine Timing

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What if we get it wrong?

- Negative influences on:
  - Cow (pain, mastitis)
  - Teat (increased risk of damage)
  - Parlor (increased unit on time, less efficient)
  - Milker (more kick-offs, reattaches, dirtier units)
  - Herd Manager (more mastitis)
  - Owner (less milk, more mastitis)

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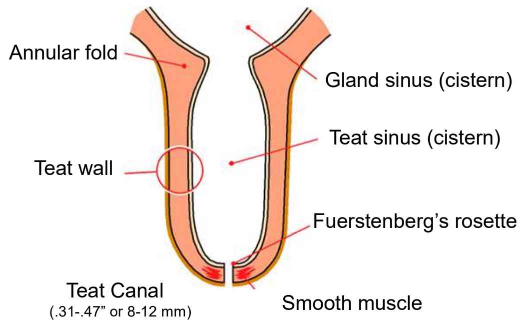
Teat Anatomy



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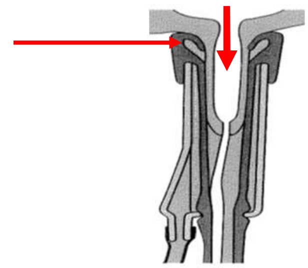
Forces on fluids within the teat during pulsation cycles

b phase (open phase)



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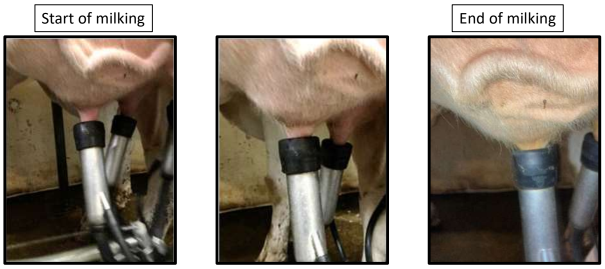
Liner Movement



Notice the movement of the liner toward the teat base as the cow milks

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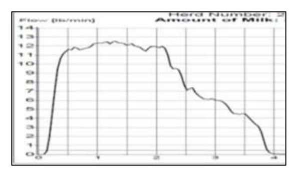
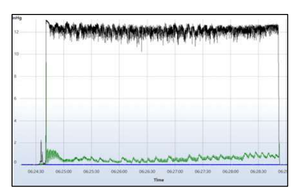
Good Letdown





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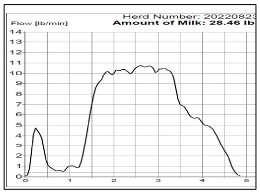
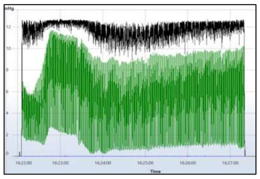
Poor Letdown



Milk Flow



Claw vacuum (black)

Mouthpiece chamber vacuum (green)

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Influence on Teat Ends

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Short and Medium-term Effects

- Why do they matter?
  - Prolonged closure of teat canal after milking
    - Traditional thought = 30-60 minutes
    - Work from Europe (Neijenhuis, F., 2001) shows it is much longer under certain conditions
    - Our work (Wieland, M., 2018) also showed this for 3x milked cows
- What does this mean for entry of environmental mastitis causing organisms?

Neijenhuis, F., G. H. Klungel, and H. Hogeveen. 2001. Recovery of cow teats after milking as determined by ultrasonographic scanning. Journal of Dairy Science 84(12):2599-2606. NMC. 1999. Laboratory Handbook on Bovine Mastitis. Rev. ed. National Mastitis Council, Madison, WI.
Wieland, M., Virkler, P.D., Borkowski, A.H., Älveby, N., Wood, P, Nydam, D.V.: 2019. An observational study investigating the association of ultrasonographically assessed machine milking induced changes in teat condition and teat-end shape in dairy cows. Animal 13(2):341-348. DOI: 10.1017/S1751731118001246.

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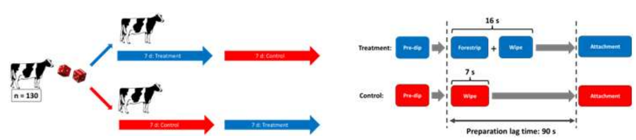
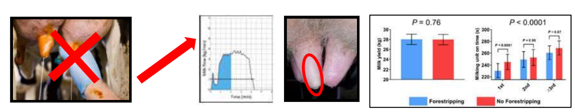
Delayed milk ejection – Risk factors





Wieland, M., Virkler, P.D., Weld, A., Melvin, J.M., Wettstein, M.R., Oswald, M.F., Geary, C.M., Watters, R.D., Lynch, R. and Nydam, D.V.: 2020. The effect of 2 different premilking stimulation regimens, with and without manual forestripping, on teat tissue condition and milking performance in Holstein dairy cows milked 3 times daily. J Dairy Sci. 103(10):9548-9560. DOI: 10.3168/jds.2020-18551.

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Milk Production

Minute Delay =

7 Lbs Tossed Away

Dr. Ron Erskine at recent NMC Regional Meeting Short Course based on their published research about how delayed milk ejection influences milk production.

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Milking Routine Timing

- **<u>Your Action Item</u>**:
  - Go home and time your routine in the 3 critical areas that I outlined
- If it is not correct, then work on ways to correct it
- Without a good routine, you will have a challenge to milk cows quickly, gently, and completely.

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Monitoring The Front End of the Curve on Your Farm

- If you have parlor data use:
  - Pounds of milk in the first two minutes (2 min milk)
  - Goal is >15 lbs (6.8 kgs) for 3x milking
  - Goal is >18 lbs (8.2 kgs) for 2x milking
- If you do not have parlor data then:
  - Recheck the timing of your routine in the 3 critical areas on a regular basis and at unannounced times for all milkers

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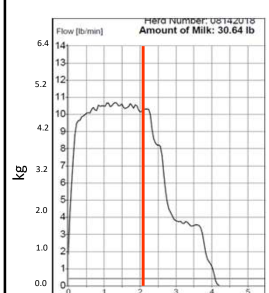
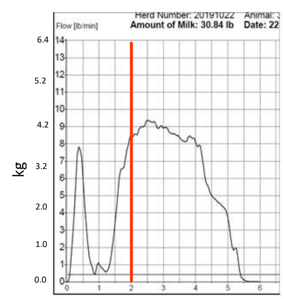
Milk in First Two Minutes



Milk in first two minutes = 18 lbs (8.2 kgs)



Milk in first two minutes = 7.3 lbs (3.3 kgs)

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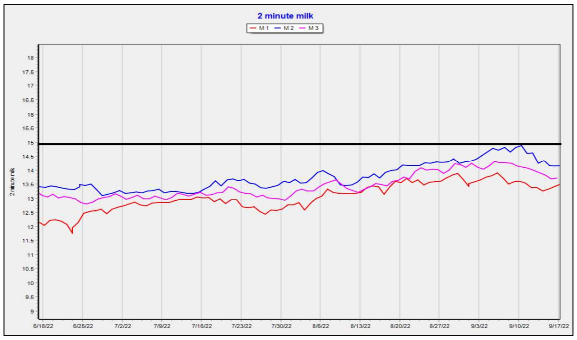
Milk in First Two Minutes



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Other Influences on the Front End of the Curve

- Vacuum levels
- Pulsation settings

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Inappropriate Claw Vacuum Settings

- Has the average claw vacuum at peak flow for a 5 to 20 second interval been accurately measured on at least 10 cows?
- Is it appropriate for your herd?
  - Goals of your dairy
  - Liners
  - Risk of over milking (milking routine, ATO settings, unit alignment, etc)

48 kPa vs 42.5 kPa

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Inappropriate Claw Vacuum Settings

- 1000 cow herd with a double 20 parallel parlor
- Increasing clinical mastitis and bulk tank somatic cell count (SCC)
- Hardness at teat end = 50% abnormal
- Average claw vacuum was 13.3”Hg (45.1 kPa)
- Liner manufacturer wants 11.5”Hg (39.0 kPa)

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Inappropriate Pulsation Settings

- Have the pulsation parameters been accurately measured?
- Are they appropriate for your herd?

	Previous set-up	New claws, shells, and liners	After adjustments
Claw vacuum ("Hg(kPa))	12.2 (41.4)	12.1 (41)	11.8 (40)
Pulsator rate	60	60	60
Pulsator ratio	60:40	65:35	60:40
b phase (ms)	450	496	442
d phase (ms)	235	186	226

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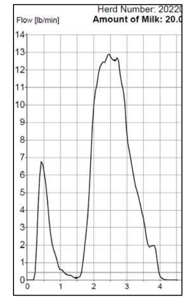
Summary of the Major Influences on the Front End of the Milk Flow Curve

- **Milking Routine**
  - **Stimulation**
  - **Lag Time from Stimulation to Unit Attachment**
- Also think about:
  - Claw vacuum levels
  - Pulsation settings



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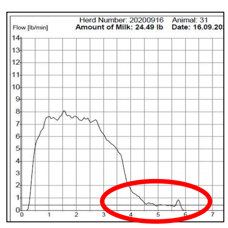
Major Influences on the Back End of the Milk Flow Curve

- You can have a great front end of the curve but a poor back end. Think about:
  - Unit alignment
  - Automatic take-off settings
  - Use of manual mode



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Poor Unit Alignment

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Unit Alignment Scoring

- Poor unit alignment
  - Increases the risk for liner slips
  - Influences milking speed of individual quarters
  - Increases the risk of teat damage and abnormal cow behavior
  - Can add confusion to appropriate Automatic Take-Off settings
  - Decreases parlor efficiency
    - Prolonged unit on time
    - More chance of reattach

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Why Adjust ATO settings?

- Reduce the risk of teat damage
- Improve animal welfare
- Reduce unit on time
- Increase parlor efficiency

What happens to milk production?

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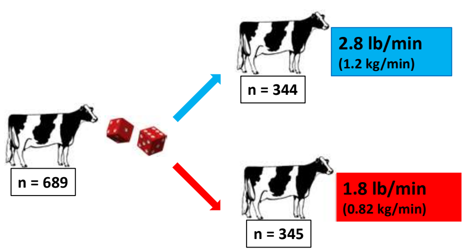
A randomized trial to study the effect of automatic cluster remover settings on milking performance, udder health, and teat condition



Wieland, M., Nydam, D.V., Heuwieser, W., Morrill, K.M., Ferlito, L., Watters, R.D., and Virkler, P.D.: 2020. A randomized trial to study the effect of automatic cluster remover settings on milking performance, teat condition, and udder health. J Dairy Sci. 103(4):3668-3682. DOI:10.3168/jds.2019-17342.

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Summary

2.8 lb/min | 1.8 lb/min

- No difference in milk
- 27 seconds less unit on time with 2.8 lb/min
- No difference in components
- Short term teat scores better with 2.8 lb/min
- No difference in mastitis

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Automatic Take-Off Settings

- Need to take into account complete picture of milking routine, teat scoring, goals of dairy, milking equipment, strip yields, etc

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Monitoring the Back End of the Milk Flow Curve

- If you have parlor data then use:
  - Unit on time
  - Time in low flow
- If you do not have parlor data then:
  - Time the unit on time and observe the claw and cow behavior at the end of milking

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Putting it All Together

Pounds (kgs) of milk/stall/hour

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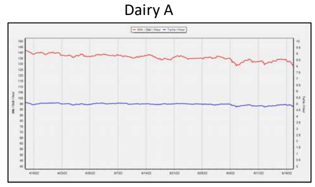
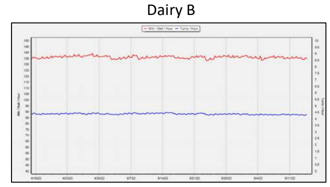
Putting it All Together

Dairy A



Dairy B



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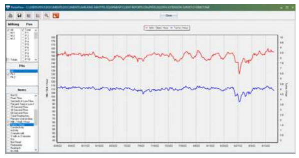
Putting it All Together

Dairy A

Dairy B



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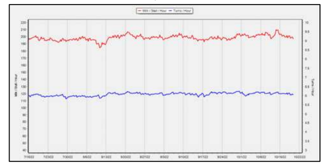
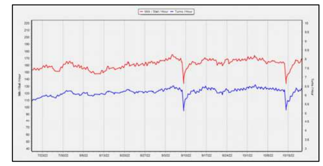
Putting it All Together-Rotary

Dairy A



Dairy D



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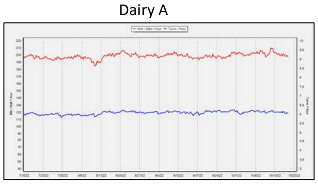
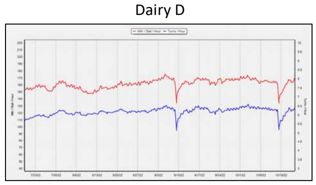
Putting it All Together-Rotary

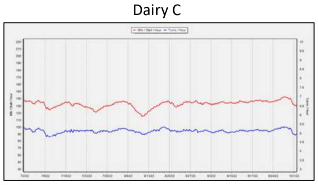
Dairy A



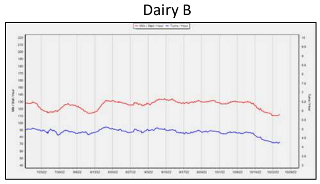
Dairy D



Dairy C



Dairy B



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Summary of Front End

- <u>**Time your milk routine**</u>
- Monitor with 2 minute milk or timings
- Check claw vacuum levels
- Check pulsation

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Summary of Back End

- Look at unit alignment in your parlor
- Check what your automatic take-offs are currently set at:
  - Adjust if complete picture warrants this
- Monitor with:
  - unit on time
  - time in low flow
  - observing claws at end of milking

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Questions?

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Minimizing the Impacts of Wildfire Smoke on Cattle

Amy Skibiel | University of Idaho | askibiel@uidaho.edu

Notes:

PowerPoint Slides on next page

Impacts of wildfire smoke on dairy cattle and opportunities to minimize harm

Amy L. Skibiel, PhD

Pedram Rezamand, PhD, Ashly Anderson, MS, Alexandra Pace

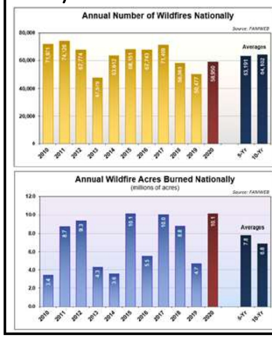
University of Idaho

Department of Animal, Veterinary and Food Sciences

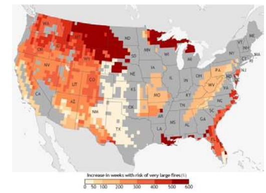
University of Idaho

1

Why are wildfires a concern?



- Wildfires becoming more frequent, severe
- In 2021 - 58,985 fires, 7.1 million acres burned
- In 2022 - 59,441 fires, 7.2 million acres burned
- 74% to 118% increase in wildfire area burned by next century
- Land/structures burned and air toxics released

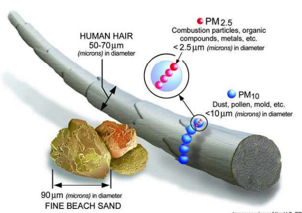


(NOAA, based on data from Barbera *et al*, 2015.)

2

Particulate matter (PM)

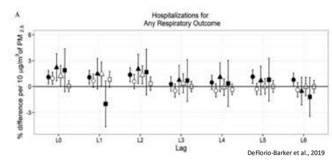
- PM_{10} – particles between 2.5 – 10 µm
- $PM_{2.5}$ - particles smaller than 2.5 µm in diameter
- PM inhaled into lungs, deposit in airways
- $PM_{2.5}$ particles are especially harmful
- $PM_{2.5}$ can enter bloodstream
- U.S. EPA - $PM_{2.5}$ emissions as a criteria pollutant



3

Effects of wildfire PM in humans

- Pulmonary effects
  - ↑ Lung disease/damage
  - ↓ Lung function
  - ↑ Pulmonary hospitalizations
- Cardiovascular effects
  - ↑ Cardiovascular hospitalizations
  - ↓ Cardiovascular health
- Death
  - ↑ Premature mortality
  - ↑ Positive association between mortality and smoke-affected days



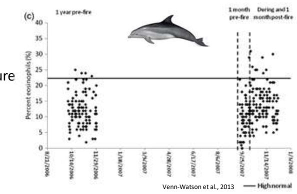
Effects largely attributable to inflammation and oxidative stress

Johnston et al., 2012; Reid et al., 2016; DeFlorio-Barker et al., 2019

4

Effects of PM in animals

- Captive bottle nose dolphins - wildfire PM changes blood composition
- Orangutans – wildfire PM decrease energy expenditure & negative energy balance
- PM_{10} increase risk of pulmonary lesions in pigs



Venn-Watson et al., 2013

Venn-Watson et al., 2013; Michiels et al. 2015; Erb et al., 2018

5

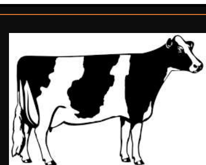
Bovine pulmonary system

- Fewer pulmonary capillaries per alveolar section
- Lower lung compliance and greater resistance
- Longer trachea and bronchi
- Lower lysozyme levels
- Fewer alveolar macrophages

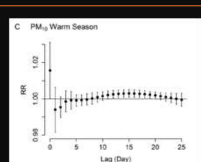
Mariassy et al., 1975; Veit & Farrell 1978; Kirschvink, 2008; Terry and Traystman, 2016

6

Effects of PM in cattle



- PM exposure ↑ dairy cattle mortality
- Air pollution ↑ dairy calf mortality
- PM associated with elevated lung neutrophil and epithelial cell count and pneumonia in dairy calves
- Ambient $PM_{2.5}$ and THI ↓ milk yield and ↑ SCC
- Our preliminary study – Wildfire-derived $PM_{2.5}$ associated with general illness in cows and mortality in calves

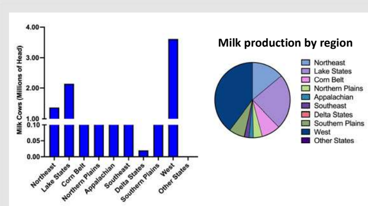


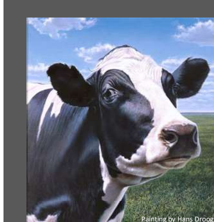
Cox et al., 2016

Cox et al., 2016; Egberts et al., 2019; Anderson et al., 2020; van Leenen et al., 2021; Beaupied et al., 2021

7

Dairy industry in the western U.S.

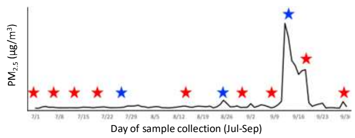




8

Dairy cows - Methods

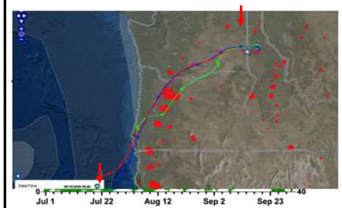
- Primiparous (*n*=7) and multiparous (*n*=6) Holstein cows through wildfire season (Jul – Sep 2020)
- UI Dairy Center - cows housed in open barn with compost-bedded free-stalls
- All cows calved in early July
- Collected blood samples, milk samples
- Daily milk yield
- Hourly $PM_{2.5}$, temperature, and humidity data from ID Dept. Environ. Quality monitoring station
- 7-day wildfire smoke event – Sep 12-18

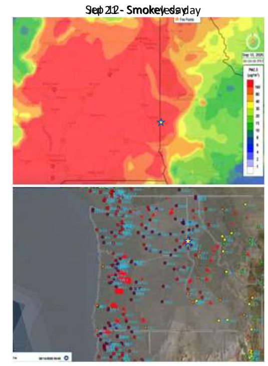


Anderson et al., 2022

9

Wildfire $PM_{2.5}$ mapping

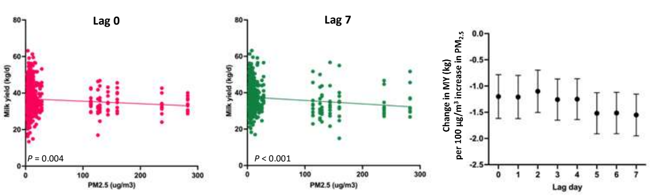




Anderson et al., 2022

10

Milk yield is lower with high $PM_{2.5}$



Milk protein 0.14% lower with every 100 μg/m³ increase in $PM_{2.5}$ on day of exposure (lag 0)

Anderson et al., 2022

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$PM_{2.5}$ and THI affect metabolism

Lag 0

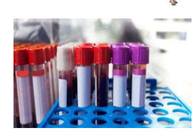
↓ Blood urea nitrogen (BUN)

– Glucose

– β-hydroxybutyrate (BHB)

↑ Non-esterified fatty acids (NEFA)

↓ Body condition score (BCS)

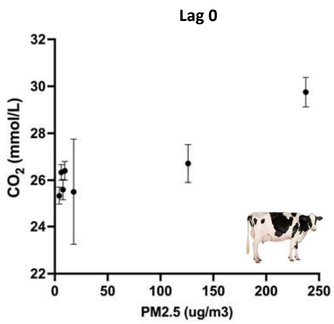


Anderson et al., 2022

12

Effects of PM on blood CO_2

- CO_2 increase with $PM_{2.5}$
- High THI and PM together increase respiration rate



Anderson et al., 2022

13

$PM_{2.5}$ and THI alter blood hematology

Lag 3

↓ Red blood cell count (RBC)

↓ Hemoglobin

↑ Eosinophil count

↑ Basophil count

PM & THI together ↓ neutrophil count with 5 & 7 day lags

Anderson et al., 2022

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Summary

- MY decreases when wildfire-derived $PM_{2.5}$ is high, independent of THI
  - ↓1.2-1.5 kg/d/ cow (2.7-3.3 lbs/d/cow)
- Immediate effects of $PM_{2.5}$/THI on metabolism
  - Lower BUN
  - Higher NEFA
- Increased blood CO_2 with greater $PM_{2.5}$
- Increased respiration rate with combined high $PM_{2.5}$ and THI
- Delayed effects of $PM_{2.5}$/THI on blood hematology
  - Lower RBC counts and hemoglobin
  - Higher eosinophils
  - Lower neutrophils

Wildfire smoke impacts production, metabolism, and immune function in dairy cows

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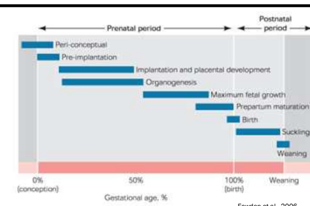
Developmental Effects

- Bovine neonatal immunity
  - Immunonaïve, passive immunity from colostrum
  - Post-natal developmental period important for future production
- Compromised respiratory health at a young age decreases performance
  - ↓ Milk production at 1st lactation
  - ↓ Weight gain
- Infant Rhesus macaques exposed to wildfire smoke
  - ↓ Lung immune function
  - ↓ Lung capacity
  - In adulthood ↓ lung volume/inspiratory capacity
- Calves exposed to non-wildfire PM in dust
  - ↑ Neutrophils in lungs
  - ↑Pneumonia



Fowden et al., 2006

Fowden et al., 2006; Black et al., 2017; Miller, 2019; Bassein et al., 2019; van Leenen et al., 2021

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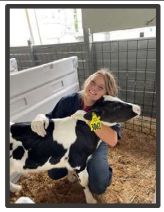
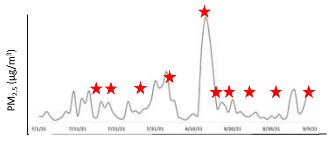
Dairy calf - Methods

- 15 heifer calves from July – September 2021
- Calves housed in barn in individual hutches
- All calves born in early July
- Collected blood samples, health data
- Hourly $PM_{2.5}$, temperature, and humidity data from ID Dept. Environ. Quality monitoring station
- Multiple wildfire smoke events

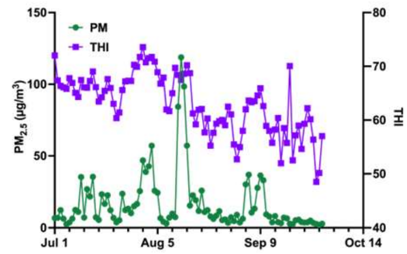




Pace et al., 2022

17

Wildfire $PM_{2.5}$ and THI summer 2021



Pace et al., 2022

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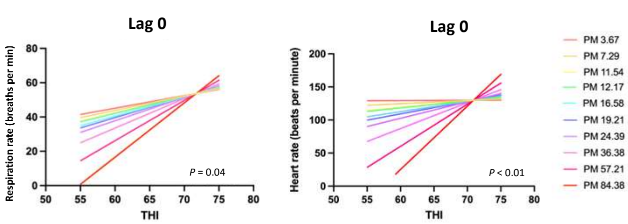
$PM_{2.5}$ and THI ↑ calf respiration and heart rates



Pace et al., 2022

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$PM_{2.5}$ and THI alter calf blood hematology

Lag 3

↓ White blood cell count (WBC)

↓ Neutrophil count

↓ Eosinophil count

↓ Hemoglobin

PM & THI together ↓ lymphocyte count with 2-day lag

Pace et al., 2022

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PM$_{2.5}$ and THI impacts calf health scores

- Scoring system
  - *Nasal score* (0 to 3; 0 = normal discharge; 1 = small amount of cloudy discharge, 2 = bilateral cloudy/mucus discharge, 3 = copious bilateral discharge)
  - *Eye score* (0 to 3; 0 = normal discharge; 1 = small amount of discharge, 2 = moderate amount of bilateral discharge, 3 = heavy discharge)
  - *Fecal score* (0 to 3; 0 = normal, 1 = semi-formed and pasty, 2 = loose, but stays on top of bedding, 3 = watery, sifts
  - *Cough score* (0 = None, 1 = induced single cough, 2 = induced repeated coughs, 3 = repeated spontaneous coughs)
- Results
  - 3-4 d lag, increased THI and PM$_{2.5}$ increase eye score
  - 3 d lag, increased THI and PM$_{2.5}$ increase cough score

Pace et al., 2022

McGuirk 2008

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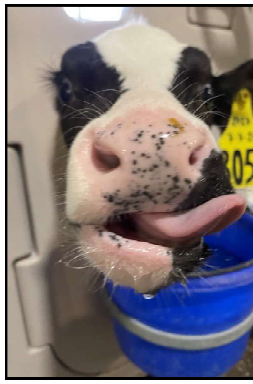

Summary & Conclusions: PM$_{2.5}$ effects on calves

- Total WBC count and specific WBC populations reduced with combination of high THI and PM$_{2.5}$
  - Lower hemoglobin
  - Lower white blood cells
- Elevated respiration and heart rates with increases in both THI and PM$_{2.5}$
- Increase eye discharge and cough with greater THI and PM$_{2.5}$

Wildfire smoke impacts calf immune status and health

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Conclusions and Future Directions

- Important to understand how wildfire smoke events affect cattle health and performance
- In western U.S. addressing heat stress only will not obviate reduced milk production in summer
- Management strategies/interventions to improve productivity?

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Tips for protecting livestock

- Monitor animals
- Limit exercise during periods of smoke
- Make sure animals have adequate water
- Keep animals indoors
- Allow animals time to heal
- Good barn and field maintenance
- Have an evacuation plan
- Check out https://livestockwildfirehub.org

AVMA https://www.avma.org/resources/pet-owners/emergencycare/wildfire-smoke-and-animals
Ranches, 2020 https://extension.oregonstate.edu/animals-livestock/beef/how-protect-pets-livestock-wildfire-smoke

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• Funding – USDA NIFA AFRI, CALS & AVFS at UI
• Farm management – Josh Peak, Logan Harper
• Palouse Research, Extension and Education Center
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• Dr. Patricia Villamediana
• Dr. Denise Konetchy
• Dr. Bruna Calvo Agustinho
• Mallery Larson
• Skibiel lab undergraduates
University of Idaho
College of Agricultural and Life Sciences
USDA

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Pest Bird Management

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Notes:

Paper on next page

Pest Bird Management: How to Stop the Flock

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Introduction

Pest birds cause a significant amount of damage on dairies across the United States every year. These losses range from crop damage to the loss of cattle feed from bird depredation. The economic losses from bird depredation of feed has been self-reported by dairy farmers from coast to coast in the United States. A survey of dairy farmers in New York, Pennsylvania, and Wisconsin suggests dairies reporting 10,000 or more birds per day lost $64,000 of feed annually (Shwiff et al., 2012). An additional survey of dairy farmers in Washington State reported feed losses that equated to $55 per cow per year (Elser et al., 2019). Besides the loss of feed, pest birds also pose a health risk to cattle.

Most pest bird species are carriers of potentially pathogenic bacteria including *Salmonella spp*., *Escherichia coli spp*., *Campylobacter spp.*, and *Mycobacterium avium paratuberculosis*. They can transfer bacteria from farm to farm on their feet or through their fecal matter. A probable connection between the presence of pest birds and cattle health was identified in both of the previously mentioned surveys. Results from the surveys indicated that farmers in Washington State, New York, Pennsylvania, and Wisconsin whom reported more than 10,000 pest birds per day on their dairy were more likely to have Johne's disease or *Salmonella* present on the farm (Elser et al., 2019; Shwiff et al., 2012). Pest birds may contribute to disease transmission on dairies. The methods available for pest bird deterrence vastly range in price and effectiveness. Shooting is the most commonly used deterrence method, but farmers self-reported it as only "somewhat effective". The use of netting over entry points in the barn can be effective but expensive. Cannons or predator calls are effective at first, but then pest birds habituate to them. Although pest birds pose a threat to farm viability, research on this issue is limited.

Over the past seven years, our research team investigated pest bird movement on dairies, feed nutrient loss from bird depredation, bacteria present in bird fecal matter, effects of pest bird presence on dairy cattle behavior, and the effectiveness of lasers and native raptors as bird deterrence methods.

Pest Bird Movement

Wild birds have little need to inhabit dairy barns during the warmer months of the year because nature provides their housing and nutritional needs. However, shelter and food become scarce during the winter months. Dairy barns provide a suitable environment for birds during winter, especially with a plentiful food supply. This is one reason why wild birds begin establishing a night roost in dairy barns at the end of the fall season. Our team monitored bird night roosting behavior and bird count data on 12 Washington State and Idaho dairies during the fall and winter months. Across all farms, European starlings (*Sturnus vulgaris)* were the most commonly recorded bird species, with a few sparrows and pigeons also observed. As environmental temperatures decreased, the number of birds present on the dairies increased (Lichtenwalter et al., under review). This study documented the movement pattern we expected for pest birds on dairies.

Feed Quality

Feed loss from pest bird depredation and spoilage is the most common type of pest bird damage reported by dairy farmers. Besides the loss of feed quantity, pest birds also influence feed quality. In theory, the total mixed ration (TMR) is formulated so that the cow receives balanced nutrients in every bite. We determined how pest bird depredation of the feed affected feed quality for 19 lactating cow pens on five dairies. Fresh feed samples were collected upon delivery to the feed bunks. We then allowed the pest birds (primarily European starlings) to consume feed for 30 minutes while the cows were being milked. Feed samples were collected from the areas of the feed bunk that were most densely populated by pest birds. Changes in feed quality differed by farm, depending on the lactating cow diets. For example, farms that fed corn silage noticed a significant decrease in net energy for lactation, but farms that fed haylage did not notice a drop in net energy for lactation (Caskin et al., under review).

Bacteria Transmission

Understanding the prevalence rate of pathogenic bacteria in pest bird fecal samples found on dairies allows us to analyze potential relationships between pest bird presence and cow health. We collected 88 fresh fecal droppings from European starlings on five dairies. All samples were evaluated for *Salmonella spp*., *Escherichia coli spp*., and *Campylobacter spp*. Over 38% of samples contained *Escherichia coli spp*. and 1% contained *Campylobacter jejuni*. *Salmonella* was not detected in our samples (Caskin et al., under review). These results differ from similar studies in other regions of the United States. It is apparent that regional differences in bacteria prevalence in bird fecal matter exists, and direct connections between pest birds and cattle health cannot be easily established.

Cow Behavior

Several studies investigated pest bird damage to feed and potential disease transmission, but no known studies determined whether pest bird presence influences cow behavior. We conducted two studies that observed cow behavior at the feed bunk when pest birds were present. The first study included 16 pens from five dairies. Cow behavior was recorded one hour prior to feed delivery and three hours post-feed delivery. Bovine-bovine interactions as well as bovine-avian interactions were observed. As the proportion of occupied headgates at the feed bunk increased, the number of occurrences of bovine-avian aggression increased. Bird aversion towards cattle also increased as the proportion of occupied headgates at the feed bunk increased (Caskin et al., under review). Interestingly, pest birds preferred to occupy the ends of the feed bunk in lieu of the middle of the feed bunk in freestall barns. These locations may have been preferred because they were closer to the barn exits.

The second study recorded the number of pest birds that established a night roost within the freestall barns at one dairy during the winter. These bird estimates were analyzed against cow behavior data collected for 214 lactating cows during the bird observation periods. Cow inactivity or high activity were not affected by pest bird presence. However, changes in time spent ruminating, eating, and being active were related to pest bird presence (Lichtenwalter et al., under review). As the number of birds increased, the average number of minutes cows spent eating or ruminating per hour decreased. These results suggest that pest birds may negatively impact cow behavior, in addition to impacting cow feed quality, which could lead to potential metabolic health concerns.

Deterrence Methods

We have anecdotal evidence that having resident raptors present on a dairy is one of the most effective long-term pest bird deterrence methods. This method is also environmentally-friendly and socially-acceptable. Attraction techniques such as installing nestboxes or perches can encourage a raptor to visit a dairy, and hopefully choose that dairy as a nesting site. We installed 40 American kestrel nestboxes on seven dairies in Washington State and are monitoring nestbox occupancy over the next several years. Another deterrence method we are testing is the use of lasers in freestall barns. Our goal is to determine whether these lasers will deter birds from establishing night roosts in the rafters of the barns. By the end of our project, we intend to have valuable information on these two bird deterrence methods to help farmers decide which methods are the most economical and successful for their dairies.

To-do List

Based on the past seven years of data and observations, we have a list of recommendations that will help dairy farmers minimize pest bird damage. Here are the top four:

- ✓ Estimate the number of birds on your farm, especially during consistently cold weather
- ✓ Do not underestimate the amount of pest bird damage on your farm
- ✓ Implement deterrence methods during warmer weather, make your dairy less “comfy”
- ✓ Consider using more than one deterrence method

References

Elser, J., A. Adams-Progar, K. Steensma, T. Caskin, S. Kerr, and S. Shwiff. 2019. Economic impacts of birds on dairies: Evidence from a survey of Washington dairy operators. PLoS ONE 14(9): e0222398.

Caskin, T., K. Steensma, S. Shwiff, H. Cameron, E. Impala, C. Lichtenwalter, and A. Adams Progar. Bovine-avian interactions on dairies: Wild bird influence on pathogen prevalence, feed quality, and cow behaviour. Under Review.

Lichtenwalter, C., K. Steensma, B. Garries, M. Marcondes, K. Taylor, C. McConnel, and A. Adams Progar. Seasonality of pest bird presence on dairies. Under Review.

Shwiff, S. A., J. C. Carlson, J. H. Glass, J. Suckow, M. S. Lowney, K. M. Moxcey, B. Larson, and G. M. Linz. 2012. Producer survey of bird-livestock interactions in commercial dairies. J. Dairy Sci. 95: 6820-6829.

Practical Disease Control in Dairy Herds

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Notes:

PowerPoint Slides on next page

Practical disease control in dairy herds- Making sure all three legs of the stool are standing

Chris Chase
Department of Veterinary and Biomedical Sciences
South Dakota State University
Brookings SD

1

Bovine Immunology Book

https://bovineimmunity.hipra.com

2

Credits

- Slides
  - Kuby Immunology
  - Immunobiology, 8th edition
  - David Topham, University of Rochester
- Movies/Animations
  - Immunobiology, 8th edition

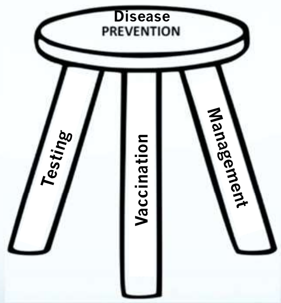
3

Topics

- Overview-Disease Prevention
- What? Types of vaccines and pathogens/immunogens
- When? do we vaccinate- age and stressors
- How?- Route and Good Nutritional Plane

4

Disease Control Programs 3-Legged Stool



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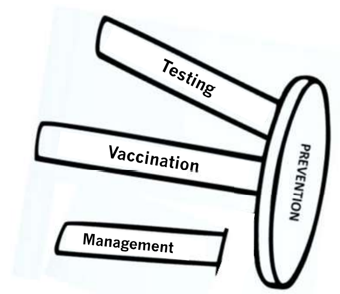
Disease Control Programs 3-Legged Stool



Must have all 3

6

Homeostasis & the Immune System

- **Homeostasis** is the process by which a the animal maintains a stable, healthy internal environment.
- The **immune system** is part of the overall process of maintaining homeostasis.
- The immune system identifies and attacks harmful invasive biological entities called **pathogens**.

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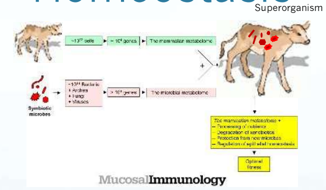
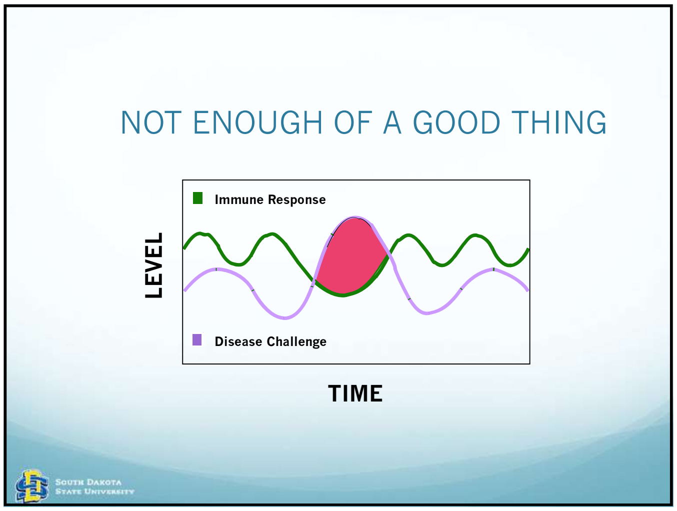
Homeostasis

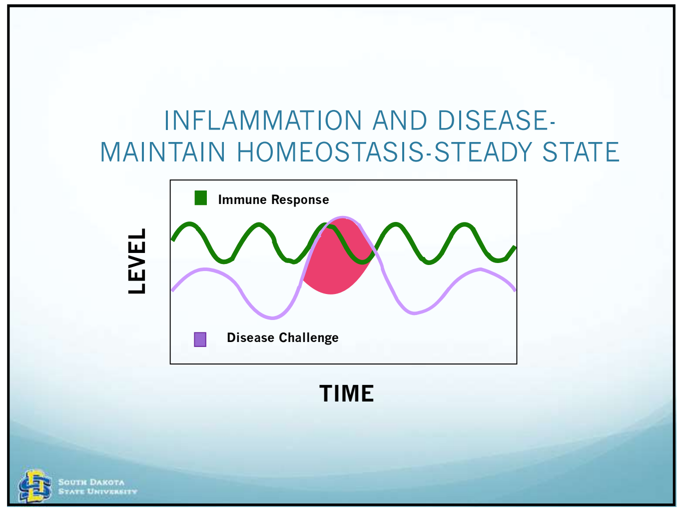


Mucosal Immunology (2010) 3, 450-460

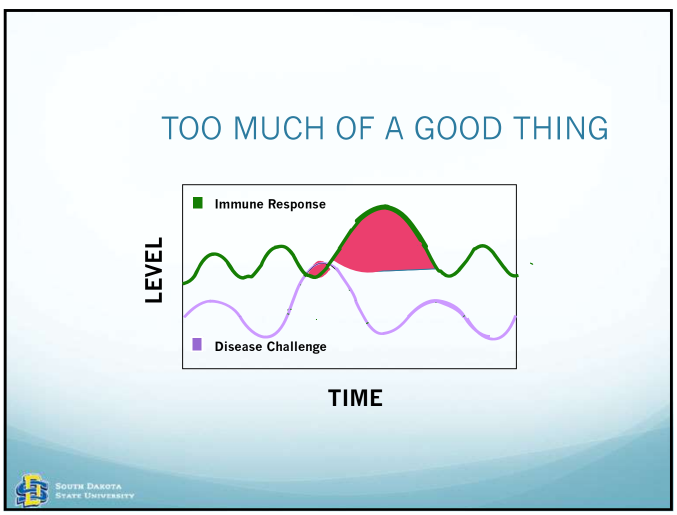
8


NOT ENOUGH OF A GOOD THING
Immune Response
LEVEL
Disease Challenge
TIME
South Dakota State University

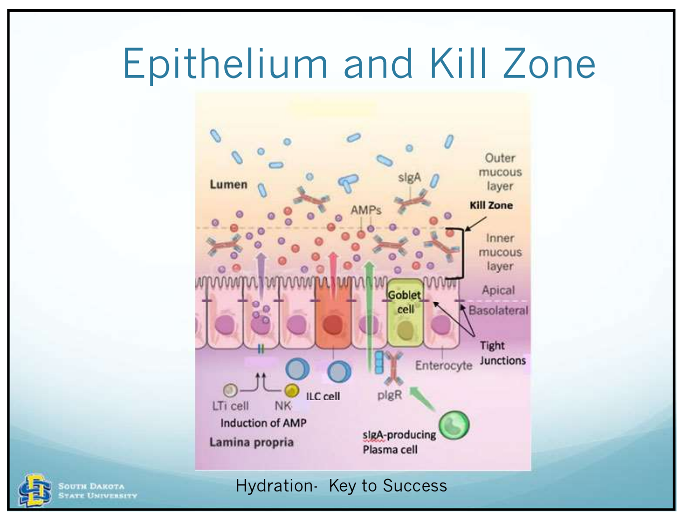
9


INFLAMMATION AND DISEASE-
MAINTAIN HOMEOSTASIS-STEADY STATE
Immune Response
LEVEL
Disease Challenge
TIME
South Dakota State University

10


TOO MUCH OF A GOOD THING
Immune Response
LEVEL
Disease Challenge
TIME
South Dakota State University

11


Epithelium and Kill Zone
Lumen
sIgA
Outer mucous layer
AMPs
Kill Zone
Inner mucous layer
Apical
Goblet cell
Basolateral
Tight Junctions
Enterocyte
LTi cell
NK
ILC cell
pIgR
Induction of AMP
Lamina propria
sIgA-producing Plasma cell
Hydration- Key to Success
South Dakota State University

12

Microbes and Regulating Body Systems

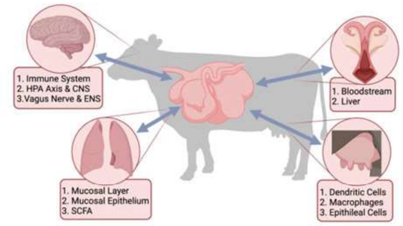


Figure 1. Proposed links between the gastrointestinal tract microbiota and different organ systems through the microbiome-gut-organ axes, including the microbiome-gut-brain axis (MGOA), the microbiome-gut-lung axis, the microbiome-gut-reproductive axis, and the microbiome-gut-mammary axis. Included are pathways, cells, and metabolites important for the bi-directional communication of the MGOA.

Clemmons, B.A., Voy, B.H., Myer, P.R., 2019. Altering the Gut Microbiome of Cattle: Considerations of Host-Microbiome Interactions for Persistent Microbiome Manipulation. Microbial Ecol 77, 523–536. https://doi.org/10.1007/s00248-018-1234-9

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Development of the Gut Microbiome

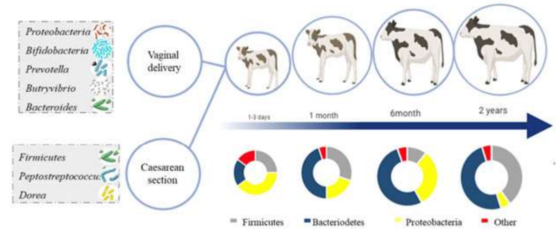

Figure 1. Dynamics of bacterial communities across different ages [24,32].

Khalil, A., Batool, A., Arif, S., 2022. Healthy Cattle Microbiome and Dysbiosis in Diseased Phenotypes. Ruminants 2, 134–156. https://doi.org/10.3390/ruminants2010009

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14

Microbiome- Different Organ Systems

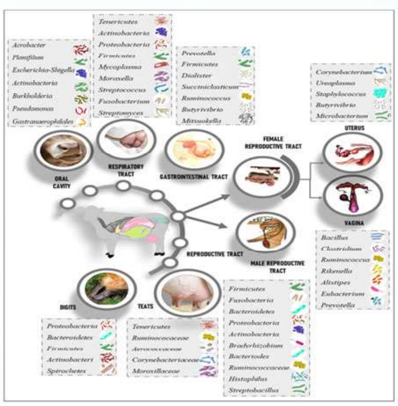

Figure 2. Variation in healthy cattle microbiome at different organs. Predominant bacteria in skin, reproductive organs, oral cavity, gastrointestinal tract, and respiratory tract are shown [10,13,35,40,51,55–57,60,62].

Khalil, A., Batool, A., Arif, S., 2022. Healthy Cattle Microbiome and Dysbiosis in Diseased Phenotypes. Ruminants 2, 134–156. https://doi.org/10.3390/ruminants2010009

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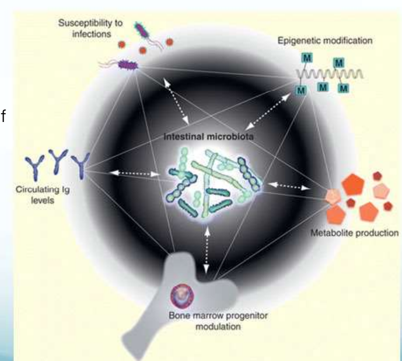
15

Microbiota and Immune Development

Global Effect of Microbiota



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Reynolds, L. A., & Finlay, B. B. (2013).. *Expert Review of Clinical Immunology*, 9(11), 1019–1030.

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Take Aways

- Microbiome needs to be managed and not upset- diet, dehydration, intakes
- Pre- and Probiotics- where do they fit in?

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Take Home: A Healthy Gut is a Necessity- What About Probiotic and Prebiotics?

- Bacterial cultures, Yeast, cell wall products are good for gut health
- Problem: how do we measure it
- Do we need them all the time? No- times of stress

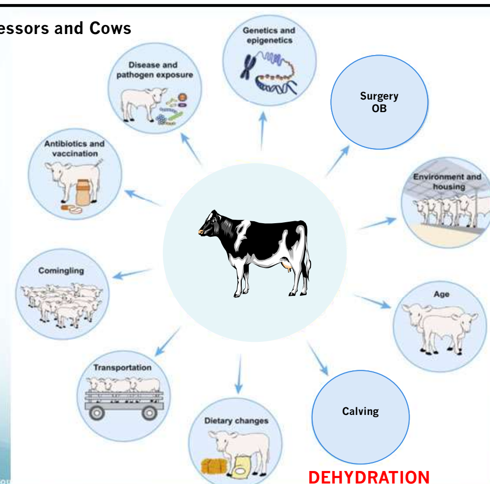
18

Stress

- Stress is anything that reduces immune response capability
- Adaptation to intensive production is stressful
  - Anything that improves adaptation will reduce costs and improve production
- The reason that this condition is seen more in intensive operations rather than extensive

19

Stressors and Cows



Adapted from Trends Microbiol. May 2019. doi:10.1016/j.tim.2019.04.005.

20

Stress and Dysbiosis

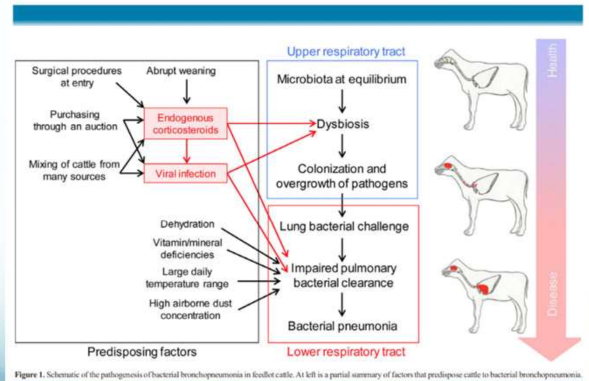


Figure 1. Schematic of the pathogenesis of bacterial bronchopneumonia in feedlot cattle. At left is a partial summary of factors that predispose cattle to bacterial bronchopneumonia.

Timsit E, Holman DB, Hallewell J, et al. The nasopharyngeal microbiota in feedlot cattle and its role in respiratory health. Animal Frontiers 2016;6:44–50.

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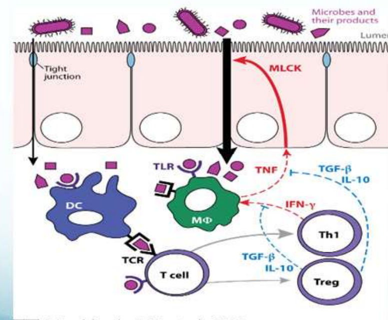
Inflammatory Response-Epithelial Cells



Marchiando AM, et al. 2010.
Annu. Rev. Pathol. Mech. Dis. 5:119–44

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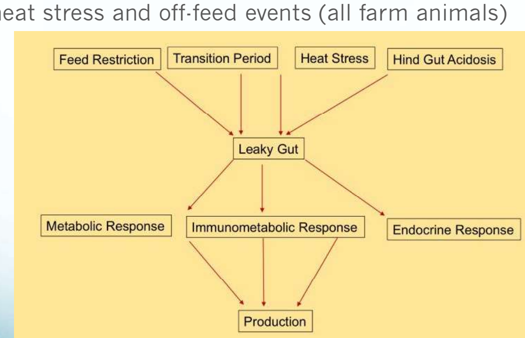
22

Leaky Gut

- Leaky gut explains the negative consequences of heat stress and off-feed events (all farm animals)



Baumgard L, International Symposium on Dairy Cattle Nutrition, Wageningen NL October 26, 2017

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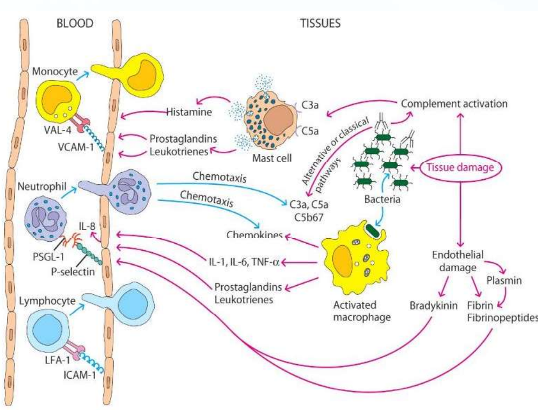
Inflammatory Response



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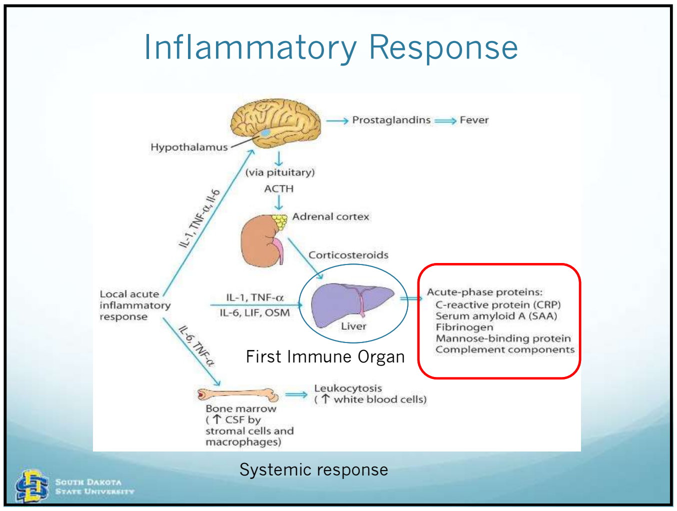
Inflammatory Response
Prostaglandins
Fever
Hypothalamus
(via pituitary)
ACTH
Adrenal cortex
IL-1, TNF-α, IL-6
Corticosteroids
Local acute inflammatory response
IL-1, TNF-α
IL-6, LIF, OSM
Liver
Acute-phase proteins:
C-reactive protein (CRP)
Serum amyloid A (SAA)
Fibrinogen
Mannose-binding protein
Complement components
First Immune Organ
IL-6, TNF-α
Leukocytosis
(↑ white blood cells)
Bone marrow
(↑ CSF by stromal cells and macrophages)
Systemic response
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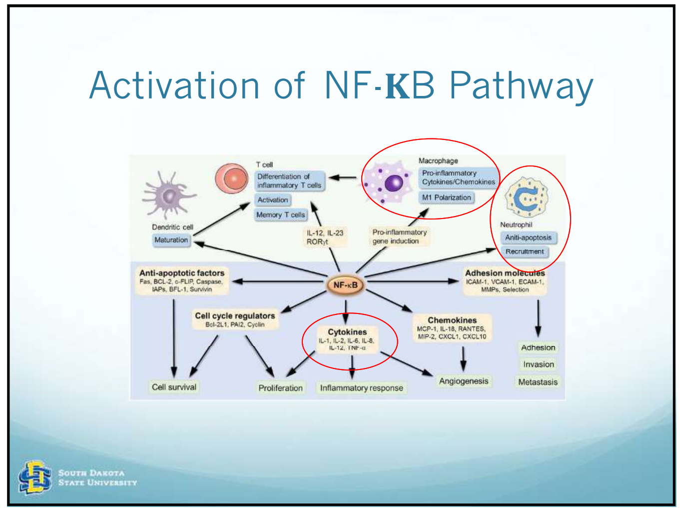
Activation of NF-ΚB Pathway
T cell
Differentiation of inflammatory T cells
Activation
Memory T cells
Macrophage
Pro-inflammatory Cytokines/Chemokines
M1 Polarization
Dendritic cell
Maturation
IL-12, IL-23 RORγt
Pro-inflammatory gene induction
Neutrophil
Aniti-apoptosis
Recruitment
Anti-apoptotic factors
Fas, BCL-2, c-FLIP, Caspase, IAPs, BFL-1, Survivin
NF-κB
Adhesion molecules
ICAM-1, VCAM-1, ECAM-1, MMPs, Selection
Cell cycle regulators
Bcl-2L1, PAI2, Cyclin
Cytokines
IL-1, IL-2, IL-6, IL-8, IL-12, TNF-α
Chemokines
MCP-1, IL-18, RANTES, MIP-2, CXCL1, CXCL10
Adhesion
Invasion
Metastasis
Cell survival
Proliferation
Inflammatory response
Angiogenesis
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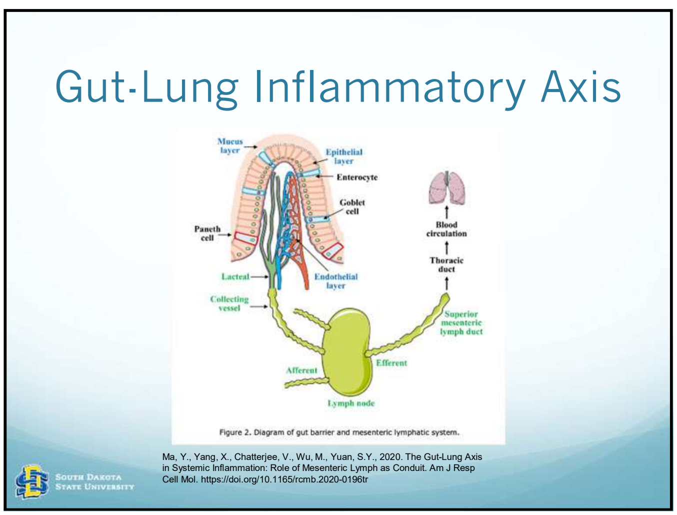
Gut-Lung Inflammatory Axis
Mucus layer
Epithelial layer
Enterocyte
Goblet cell
Paneth cell
Lacteal
Endothelial layer
Collecting vessel
Blood circulation
Thoracic duct
Superior mesenteric lymph duct
Efferent
Afferent
Lymph node
Figure 2. Diagram of gut barrier and mesenteric lymphatic system.
Ma, Y., Yang, X., Chatterjee, V., Wu, M., Yuan, S.Y., 2020. The Gut-Lung Axis in Systemic Inflammation: Role of Mesenteric Lymph as Conduit. Am J Resp Cell Mol. https://doi.org/10.1165/rcmb.2020-0196tr
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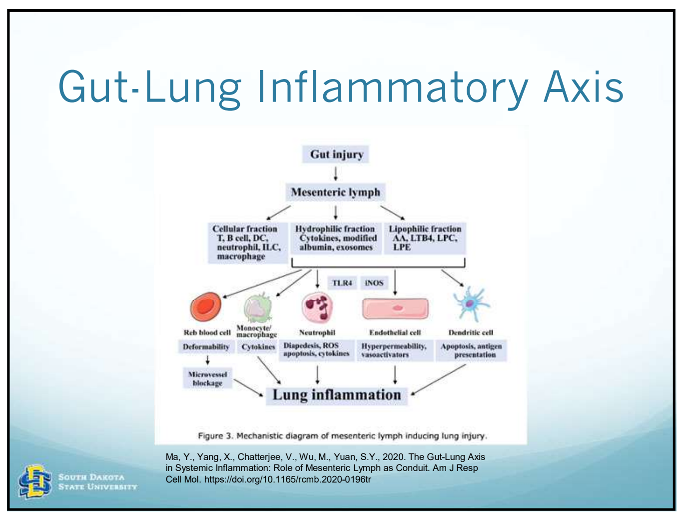
Gut-Lung Inflammatory Axis
Gut injury
Mesenteric lymph
Cellular fraction T, B cell, DC, neutrophil, ILC, macrophage
Hydrophilic fraction Cytokines, modified albumin, exosomes
Lipophilic fraction AA, LTB4, LPC, LPE
TLR4
iNOS
Reb blood cell
Monocyte/ macrophage
Neutrophil
Endothelial cell
Dendritic cell
Deformability
Cytokines
Diapedesis, ROS apoptosis, cytokines
Hyperpermeability, vasoactivators
Apoptosis, antigen presentation
Microvessel blockage
Lung inflammation
Figure 3. Mechanistic diagram of mesenteric lymph inducing lung injury.
Ma, Y., Yang, X., Chatterjee, V., Wu, M., Yuan, S.Y., 2020. The Gut-Lung Axis in Systemic Inflammation: Role of Mesenteric Lymph as Conduit. Am J Resp Cell Mol. https://doi.org/10.1165/rcmb.2020-0196tr
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Inflammatory Cytokines

- Increase Sickness Behavior-listlessness
- Decrease feed intake- Inappetence-
- Increase body temperature sweats
- Decreased feed conversion
- Decrease gain
- Decrease milk production
- Increased Mastitis
- Increased Metritis
- Increased BRD

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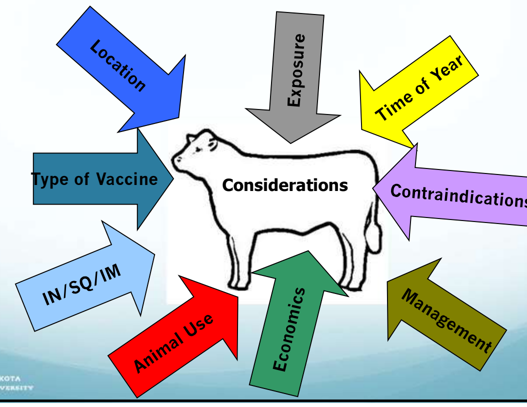
How do I Design a Vaccine Control Program?



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Goal of Vaccination is to Immunize

(Immunization versus Vaccination)

Vaccination: The act of administering a vaccine.

Immunization: An appropriate immune response following vaccine administration that provides protection from disease.

•There is a big difference between these two acts.
•Controlling environmental, pathogen and host factors will influence how many vaccinates truly become immunized.

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100% Guarantee- Biologically Impossible

- In most cases we hope that 70-80% respond and are protected
- In any herd, cattle or human, 100% of the vaccinates will not be protected
- With most viruses that is good enough.
- Herd Immunity

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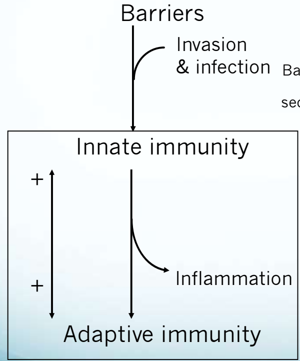
Immune Responses



•1st Line of Defense

•Barriers

Skin & Mucous membranes and secretions

Barrier, rapidly regenerating surfaces, peristaltic movement, lysozyme, sebaceous/mucous secretions, stomach acid, commensal organisms

2nd Line of Defense

Humoral and Cellular Components

Cellular, cytokine and protein defenses

Interferons, defensins, chemokines, cytokines (pro-inflammatory and T stimulatory), complement proteins, TLRs, phagocytosis, NK cells

3rd Line of Defense

Humoral and Cellular Components

Cellular and humoral defenses

Antibodies, cytokines, chemokines, T helper cells, cytotoxic T cells

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Herd Immunity

- How do you achieve Herd Immunity?
  - Vaccination
  - Exposure

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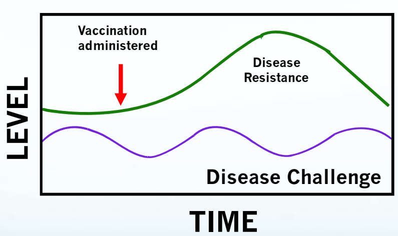
DISEASE AND RESISTANCE



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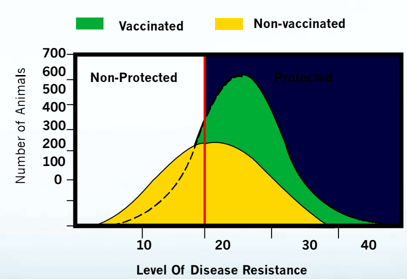
POPULATION DISTRIBUTION



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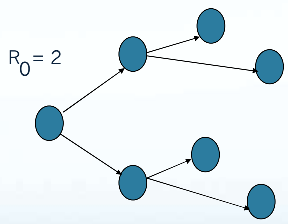
Basic reproduction number



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Herd Immunity Thresholds for Selected Bovine Vaccine-Preventable Diseases

Disease	R_o	Herd Immunity needed to prevent
BVDV PI	□^	>95%
BRSV-naive	36.5*	>95%
BHV-1-naive	3.2#^^	75-86%
BVDV-Transient	0.25^-3.4##	70-80%
BRSV-endemic	1.14*	50-60%
BHV-1-latency	0.5^^	0%
COVID19	2-3	60-66%

*M.C.M. de Jong, W.H.M. Van der Poel, J.A. Kramps, A. Brand, J.T. Van Oirschot. 1996. Persistence and recurrent outbreaks of bovine respiratory syncytial virus on dairy farms, Am. J. Vet. Res. 57, 628-633.
#Bosch, J.C., Jong, M.C.M.D., Franken, P., Frankena, K., Hage, J.J., Kaashoek, M.J., Maris-Veldhuis, M.A., Noordhuizen, J.P.T.M., Poel, W.H.M.V. der, Verhoeff , J., Weerdmeester, K., Zimmer, G.M., Oirschot, J.T.V., 1998. An inactivated gE-negative marker vaccine and an experimental gD-subunit vaccine reduce the incidence of bovine herpesvirus 1 infections in the field. Vaccine 16, 265–271.
##Moerman, A., Straver, P.J., de Jong, M.C.M., Quak, J., Baanvinger, T., vanOirschot, J.T., 1993. A long-term epidemiologic-study of bovine viral diarrhea infections in a large herd of dairy-cattle. Veterinary Record 132, 622-626.
^Sarrazin, S.,Dewulf, J., Mathijs, E., Laureyns, J., Mostin, L., Cay, A.B.,2014. Virulence comparison and quantification of horizontal bovine viral diarrhoea virus transmission following experimental infection in calves. The Veterinary Journal 202, 244-249.
^^Brock, J., Lange, M., Guelbenzu-Gonzalo, M., Meunier, N., Vaz, A.M., Tratalos, J.A., Dittrich, P., Gunn, M., More, S.J., Graham, D., Thulke, H.-H., 2020. Epidemiology of age-dependent prevalence of Bovine Herpes Virus Type 1 (BoHV-1) in dairy herds with and without vaccination. Vet Res 51, 124

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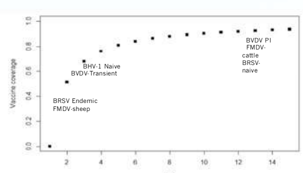
R_0- and Vaccination



Relationships between the vaccine coverage within the population (proportion of the population to be immunized) and the R_0 value (particular case of vaccine conferring a "perfect" protection)

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What?

Types of vaccines and pathogens/immunogens

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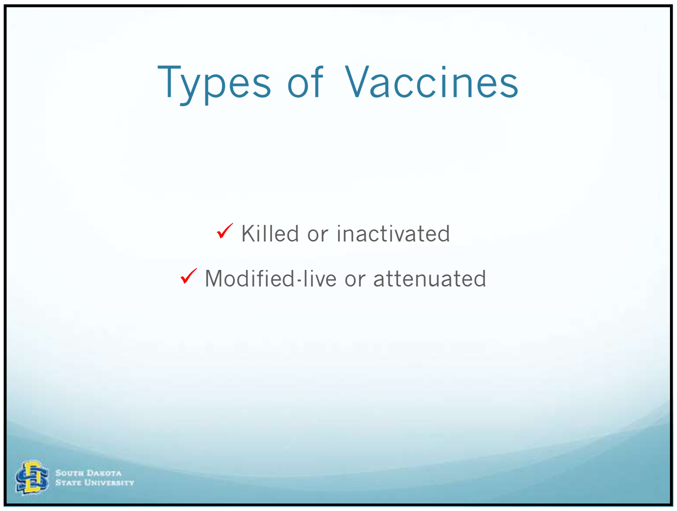
Types of Vaccines
✓ Killed or inactivated
✓ Modified-live or attenuated

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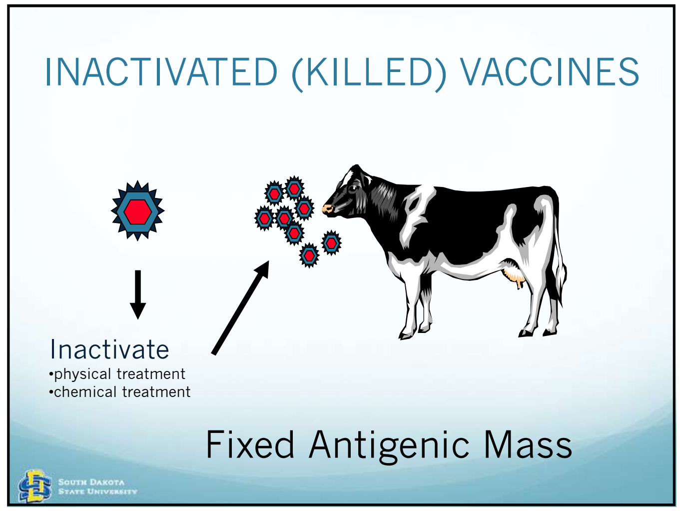
INACTIVATED (KILLED) VACCINES
Inactivate
•physical treatment
•chemical treatment
Fixed Antigenic Mass

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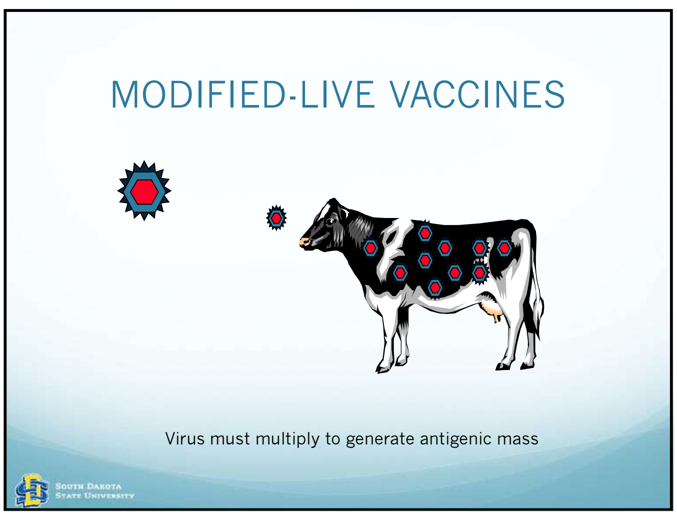
MODIFIED-LIVE VACCINES
Virus must multiply to generate antigenic mass

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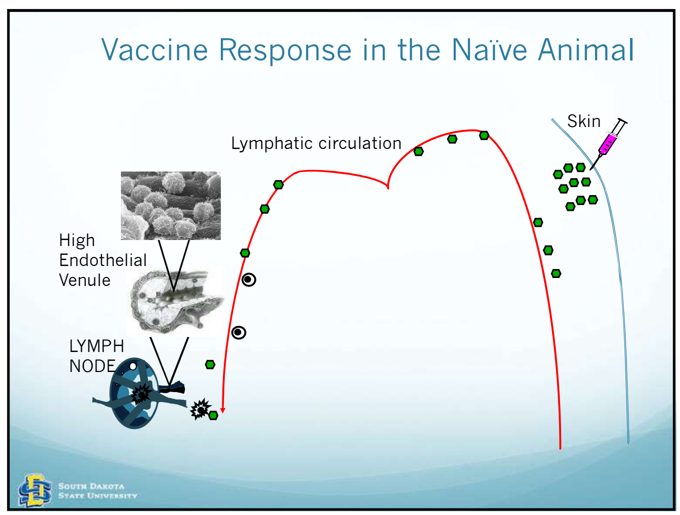
Vaccine Response in the Naïve Animal
Skin
Lymphatic circulation
High Endothelial Venule
LYMPH NODE

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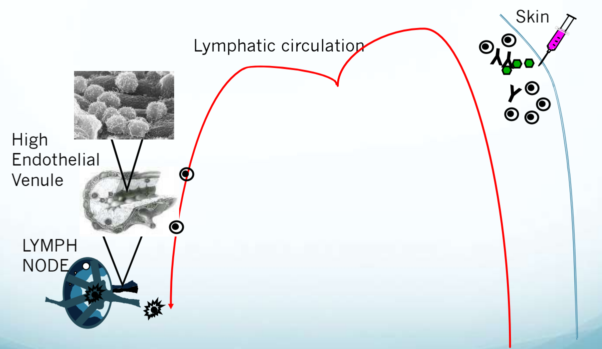
Vaccine Response in the Well-Protected Animal



Active Immune Interference- Never goes Away-Immune system doesn't know difference between vaccine and field virus

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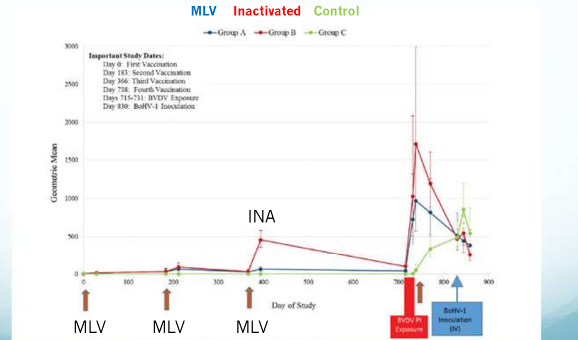
BVDV 1 Titers



Walz PH, Givens MD, Rodning SP, Riddell KP, Brodersen BW, Scruggs D, et al. Evaluation of reproductive protection against bovine viral diarrhea virus and bovine herpesvirus-1 afforded by annual revaccination with modified-live viral or combination modified-live/killed viral vaccines after primary vaccination with modified-live viral vaccine. Vaccine 2017;35:1046–54. https://doi.org/10.1016/j.vaccine.2017.01.006.

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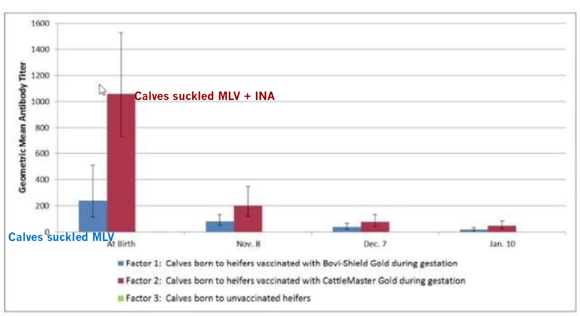
Transfer of Immunity to Calves



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What to Vaccinate with?

- In general, viral vaccine responses are better
- Many bacteria are endemic (*Histophilus somni, Mannheimia. hemolytica, Pasteurella. multicida, Moraxella spp., Mycoplasma bovis, Salmonella typhimurium, Clostridium perfringens)*

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What About Bacterins in Cattle?

- Site specific- Only if you have problem- many of these management related (nutrition, sanitation, environment)- efficacy is variable
- Clostridials
- Respiratory Pathogens
- Leptospira
- Salmonella
- Mastitis Vaccines

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What About Bacterins in Cattle?- Endotoxin Stacking

- Endotoxin Stacking and Vaccines (ranked most reactive to least reactive)
  - E.coli Mastitis vaccines
  - Pinkeye (Moraxella bovis)- Whole cell LOS very reactive
  - Histophilus somnus Whole cell LOS very reactive
  - Salmonella-Whole cell LPS
  - Scour vaccines E.coli-Whole cell LPS
  - Mannheimia hemolytica- Whole cell LPS
  - Pasteurella multicida
- Subunit vaccines- no issues, leukotoxin, fimbriae, OMP
- Leptospira DOES NOT contribute to ENDOTOXIN STACKING- leptospiral LPS does not have potent endotoxigenic properties
- If need to use more than one- administer on other side of the neck

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When?

Do we vaccinate- age and stressors

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What is your recommended viral vaccine protocol from birth to mature heifer?

- 1-3 days old: Intranasal vaccine with IBR-BRSV
- 8-12 weeks old: Intranasal vaccine with BRSV or MLV IBR-BVD-PI3-BRSV Heifers-LEPTO 5
- 4-5 months old: MLV IBR-BVD-PI3-BRSV-Heifers-LEPTO 5
- 7-9 months old: MLV IBR-BVD-PI3-BRSV-Heifers-LEPTO 5, must be 60 days prior to first breeding

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How?

Route, Booster Timing, and Good Nutritional Plane

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Intranasal vs Parenteral

- In face of maternal immunity- adjuvanted parenteral
- Mucosal immunity- Adjuvanted IgA
- Colostral Antibody- It Is not IgA- It's IgG-that comes from the serum- parenteral vaccines
- Reproductive viral vaccines- parenteral- prevent IBR and BVDV viremia

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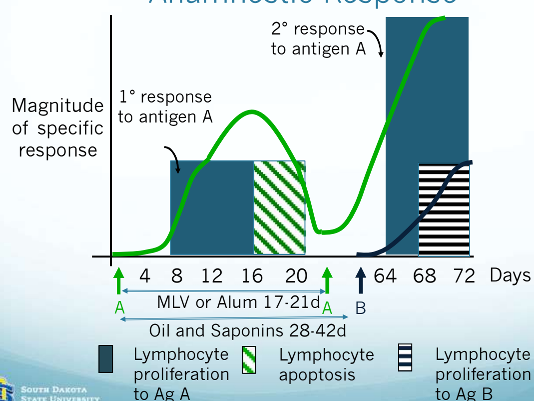
Timing and the Adaptive Immune Response- Anamnestic Response



What is the Best Time Interval for Boostering?

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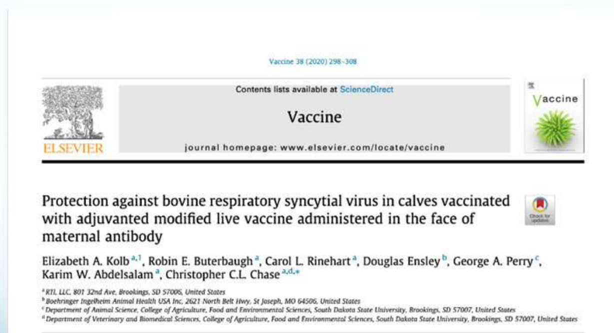
Vaccine 38 (2020) 298–308

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

ELSEVIER

Protection against bovine respiratory syncytial virus in calves vaccinated with adjuvanted modified live vaccine administered in the face of maternal antibody

Elizabeth A. Kolb [a,1], Robin E. Buterbaugh [a], Carol L. Rinehart [a], Douglas Ensley [b], George A. Perry [c], Karim W. Abdelsalam [a], Christopher C.L. Chase [a,d,*]

[a] RTI, LLC, 801 32nd Ave, Brookings, SD 57006, United States
[b] Boehringer Ingelheim Animal Health USA Inc, 2621 North Belt Hwy, St Joseph, MO 64506, United States
[c] Department of Animal Science, College of Agriculture, Food and Environmental Sciences, South Dakota State University, Brookings, SD 57007, United States
[d] Department of Veterinary and Biomedical Sciences, College of Agriculture, Food and Environmental Sciences, South Dakota State University, Brookings, SD 57007, United States

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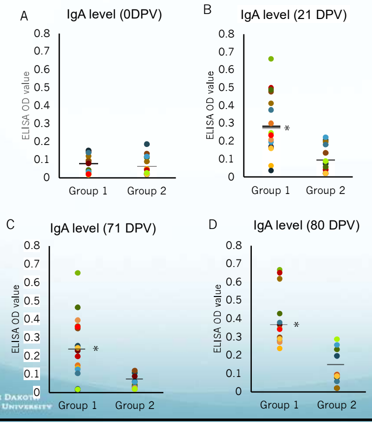
Nasal BRSV IgA



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Summary

- Parenteral- challenge 72 days after vaccination
- Rapid virus clearance
- Good memory from parenteral vaccine
- Less lung lesions
- Role for secretory IgG respiratory and reproductive disease

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Immunity and Energy

- Immune system doesn't get a free ride- energy consumer
- Multiple demands on energy for the postpartum cow

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Diet and Immune Response

Order of importance of nutrients to immune system

- Energy
- Protein
- vitamin A, D
- vitamin E
- Copper, Zinc, Selenium
- IRON

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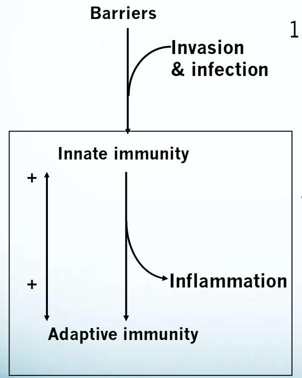
Immune responses



1st Line of Defense

Dehydration

2nd Line of Defense

Cellular and humoral defenses

interferon, cytokines (pro-inflammatory and T stimulatory), complement proteins, phagocytosis, NK cells

Dehydration

3rd Line of Defense

Cellular and humoral defenses

Antibodies, cytokines, T helper cells, cytotoxic T cells

From David J. Topham, Introduction to Viral Immunology:Part

Dehydration

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Points to Ponder in Developing Vaccination Schedules

- Vaccinate with What?
  - What are the disease problems on the farm or ranch?
- How Soon?
  - Immune Maturity
  - Route- IN vs Parenteral
- How Often?
  - Maternal Interference
  - Active Interference
- What type of vaccine?
  - MLV vs Inactivated
  - IN vs Parenteral

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Observations

- In general we vaccinate cows and calves too much and too soon
- On primary vaccination-if we vaccinate and we see nothing, nothing happened
- Interval for boosting needs to be 21 days or longer-length depends on vaccine

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Laws of Immunological Common Sense for Cows

- Vaccination of dams 4-6 weeks prior to calving improves colostral antibodies
- Vaccination of pregnant cows- two targets-calf and cow
- Vaccination of post-calving cow- wait at least 3-4 weeks after calving

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Take Aways

- Avoid turning on pro-inflammatory response at times of stress
  - Vaccination
  - Parturition
  - Weaning
  - Surgery
- Animals properly hydrated
- Can we modulate pro-inflammatory responses?
  - Using NSAIDS-Timing- Need to give before inflammation-
  - Need modulate initial pro-inflammatory response

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Harvey Dunn (1884-1952) Prairie is My Garden, South Dakota Art Museum

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Tips and Tricks to Feeding 2022 Corn Silage

John Goeser | Cows Agree Consulting LLC | john@cowsagree.com

Notes:

PowerPoint Slides on next page

Tips & Tricks to Feeding 2022 Corn Silage

John Goeser
PhD, PAS, Dipl. ACAN

ROCK RIVER LABORATORY, INC.

1

Goeser's Agenda

- Economic opportunity in Dairy
- Basic silage nutrition training
- Zero in on 2022 Silage quality
- Arm you with insight & strategy for better nutrition decisions:
  - Feeding 2022 silage
  - Growing & harvesting better 2023 silage

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3

ECM, lb.	Purch. Feed $ / cwt ECM	Total Feed $ / cwt ECM	ECM / DMI - Feed Effic.	DMI
106.52	$5.51	$8.25	2.01	53.1
106.60	$6.24	$9.13	1.77	60.4
103.49	$5.22	$8.54	1.80	57.6
109.60	$5.74	$9.29	1.79	61.3
107.35	$8.97	$8.97	1.62	66.2
98.02	$5.37	$8.80	1.76	55.8
98.75	$4.08	$9.07	1.74	56.8
90.99	$3.06	$8.14	1.71	53.2
98.59	$6.17	$9.52	1.76	55.9
93.82	$2.31	$8.85	1.74	53.8
92.54	$5.39	$9.09	1.58	58.6
95.84	$3.56	$10.25	1.55	61.8
104.69	$6.91	$11.07	1.73	60.6
102.79	$6.69	$10.76	1.68	61.2

$2.43 / cwt. ECM

1.73 v 1.80 FCE

Data courtesy Stacy Nichols, personal communication

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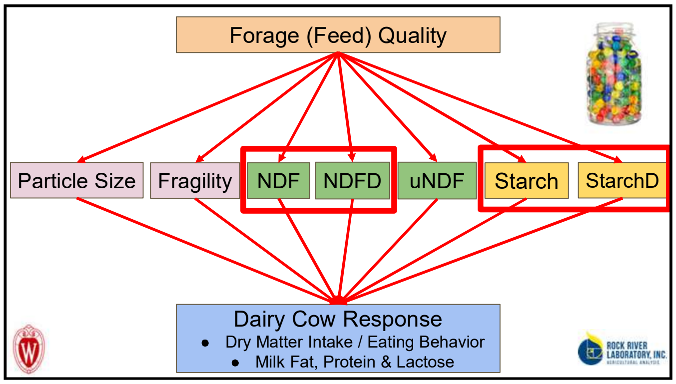

Forage (Feed) Quality
Particle Size
Fragility
NDF
NDFD
uNDF
Starch
StarchD
Dairy Cow Response
Dry Matter Intake / Eating Behavior
Milk Fat, Protein & Lactose
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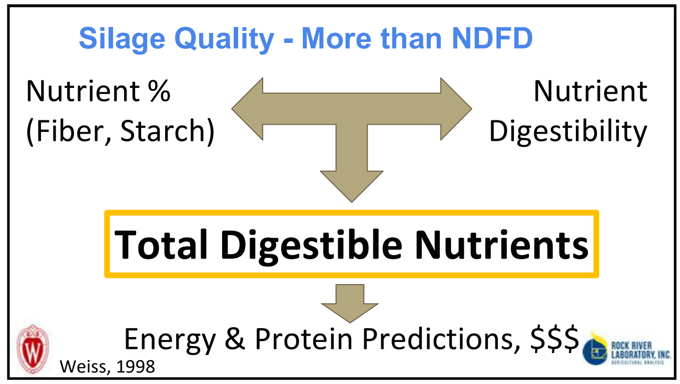
5



Silage Quality - More than NDFD
Nutrient %
(Fiber, Starch)
Nutrient
Digestibility
Total Digestible Nutrients
Energy & Protein Predictions, $$$
Weiss, 1998
ROCK RIVER LABORATORY, INC.

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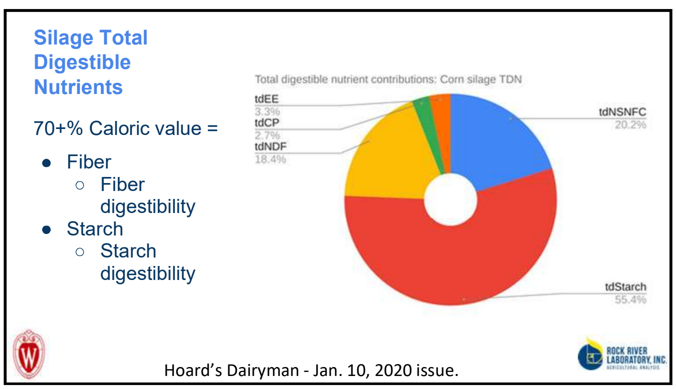

Silage Total Digestible Nutrients
70+% Caloric value =
Fiber
Fiber digestibility
Starch
Starch digestibility
Total digestible nutrient contributions: Corn silage TDN
tdEE 3.3%
tdCP 2.7%
tdNDF 18.4%
tdNSNFC 20.2%
tdStarch 55.4%
Hoard's Dairyman - Jan. 10, 2020 issue.
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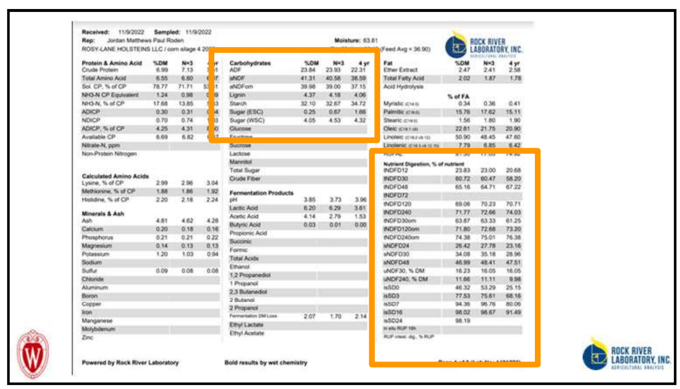

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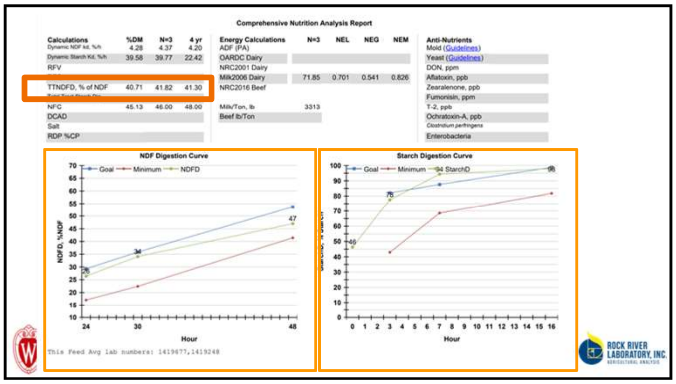

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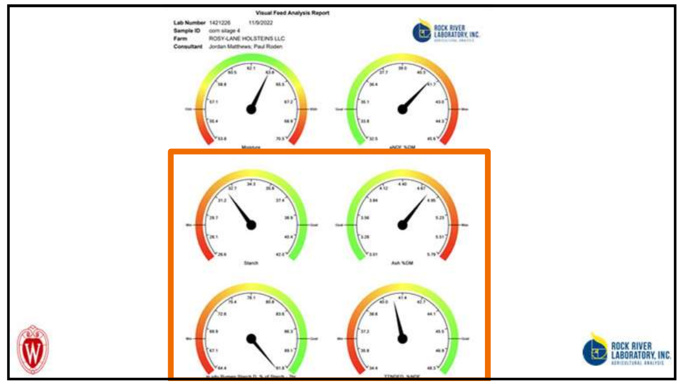

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General Thoughts

- 2022 was a wild ride
  - Extreme drought out West
  - Extremely expensive input
    - Water
    - Fertilizer
- Highly variable growing conditions for US as a whole
- 2022 looked like 2021 for some…
- 2022 Silage? A unique beast in starch & fiber
  - ***Zero in*, know what you've got, & feed around it**

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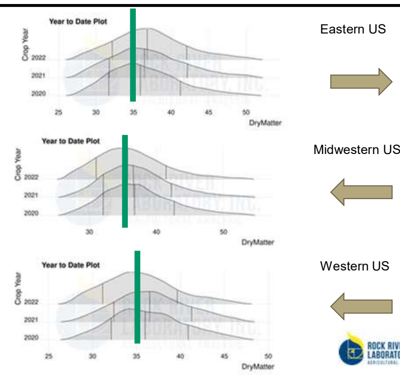
'22 Silage Dry Matter / Moisture

- Very different crop by region
- E -> drier
- MW -> wetter
- W -> wetter

…Maturity impact?



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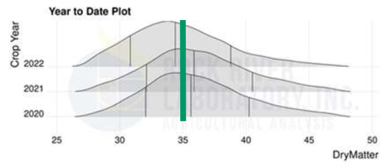
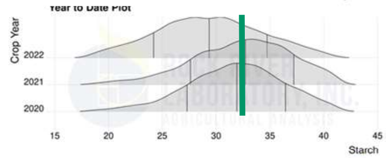
Western Corn Silage

- Ideal moisture in 2022
- Starch levels are way down
  - Expensive input impact?
  - Water $ impact?





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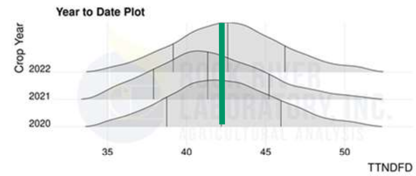
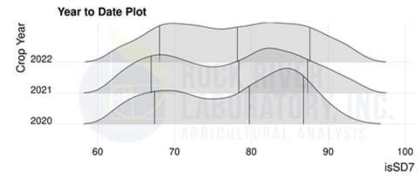
Western Corn Silage

- TTNDFD looking good on average
  - Faster digesting fiber
- Wide ranging StarchD
  - Western silage winning here





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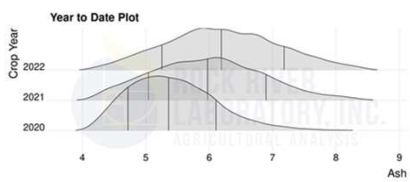
Western Corn Silage

- Ash is an issue
- Extreme drought & blowing dust / dirt

Watch-Out: fermentation quality



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Overly Simple 2022 Silage Recap

Region/Parameter	Moisture	Maturity	Starch	NDFD	StarchD	Feeding Potential?
East	Down	Up	Up	Down	Down	Down
Midwest	Up	Not sure	Up	Up	Down	Neutral to Up
West	Up	Down	Down	Up	NC	Neutral to Down

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Unique Observations / Questions

- Extremely wide range to quality across the US this year
  - **Western US higher moisture, less starch, ash creeping up and average NDFD**
  - Eastern US lower moisture and more mature corn silage
  - Midwestern US ideal moisture, more starch but less starchD, and decent TTNDFD … Black Sheep?!
  - Southern US silage looks to be good quality
- Watch outs for feeding 2023
  - ***Know what you've got… incredible variation in our pits & piles***
  - West? Fermentation quality
  - East & Midwest? Rumen starch digestibility!

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Zeroing in on your Silage - Like sighting in a rifle

— Dr. John Goeser —

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Sample with a 3 to 5 shot group

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Sample with a 3 to 5 shot group

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Single samples miss the buck

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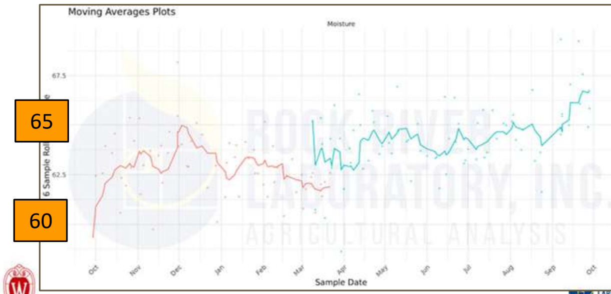
Six shot average for the win



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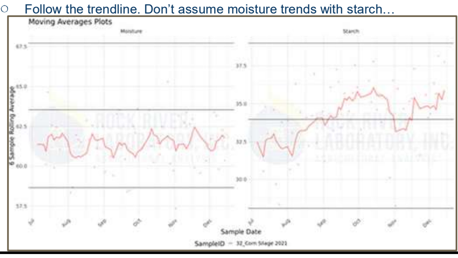
Making Silage Adjustments

- Use 3 to 5 shot groups
- There's more changing in your silage than we've known
  - Follow the trendline. Don't assume moisture trends with starch…



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Planning your next $500,000 purchase

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Hybrid Plots: Your Dairy can do this!

- Control for:
  - Growing conditions
  - Plant population
  - Soil type & fertility
  - Crop protection
- **Basic**:
  - Run strips
  - Measure yield & 3+ samples per hybrid for quality
  - Compare hybrids
- **Advanced**:
  - Plant replicated plots
  - Measure Yield
  - Several samples per replicate plot
  - Data robust for stats analysis

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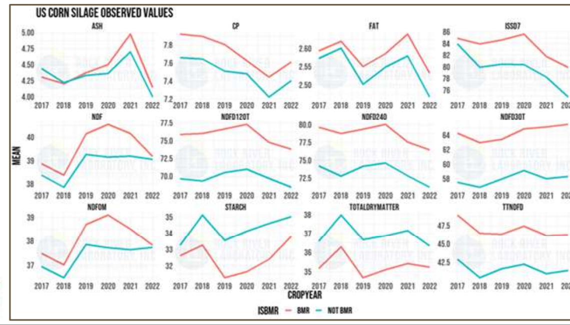
BMR v Conventional: RRL Database



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Turning the page to 2023 - Economic Driven Decisions

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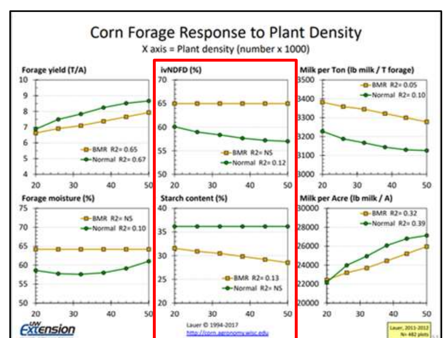
Plant Population Impact

- Plant populations matter
- Conventional corn responds differently than BMR



Slide adapted from J. Lauer

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Crop Input Decisions

- Expensive $$$, but…
- 2023 crop needs to be in position to succeed
  - Fertility
  - Crop health / NDFD
  - Grain yield

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Harvest 2023

Moisture vs. Kernel maturity disconnect may impact our harvest timing

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Cut Height Impact

Table 2. Effects of cutting height on nutritive value of whole-plant corn silage.[1,2]

Parameter	n	Effect
Dry matter, % of as fed	62	+2.18
NDF, % of DM	64	-2.48
Lignin, % of DM	25	-0.29
NDFD, % of NDF	49	+2.02
Starch, % of DM	55	+2.08
DM yield, ton/acre	52	-0.52

[1] Adapted from Paula et al. (2019).
[2] Data expressed as expected response per each 10-inches of increased cutting height.
[3] NDFD – ruminal in vitro or in situ NDF digestibility at 30 or 48 h.

Table courtesy of Luiz Ferraretto (2020, personal communication)

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Cut Height Performance Impact

High cut vs Normal CS			Diet outcome		
	Normal	High (+10")		Normal	High (+10")
CP	7.6	7.6	CP	15.4	15.4
aNDF	40.0	37.5	aNDF	28.2	27.4
Starch	33.0	35.1	Starch	26.3	27.0
Fat	2.5	2.5	Lbs dig fiber	7.34	7.26
Ash	4.0	4.0	Lbs rumen dig starch	10.5	10.8
uNDF240	10.0	9.0	Lbs uNDF240	4.09	3.90
NDF kd	3.0	3.2			
0h Starch	25.0	25.0			
Starch kd	25.0	25.0	TTSD	95.60%	95.60%
Rum. StarchD	77.7	77.7	Rum. StarchD	72.3	72.3
TTNDFD	41.5	43.6	TTNDFD	47.3	48.2
NDFD240	75.0	76.0			
Lbs Fed	19.0	19.0	DMI	55	55
			Forage/Conc	52.7%	52.7%
			Milk/Cow	88.0	89.2
			FCE	1.60	1.62
Milk Price	$20.00	$20.00	Milk $/cow	$17.61	$17.85
Cost/lb TMR	$0.11	$0.11	Feed $/cow	$6.05	$6.05
			Feed cost / CWT	$6.87	$6.78

Projections using table provided by Luiz Ferraretto (2020, personal communication)

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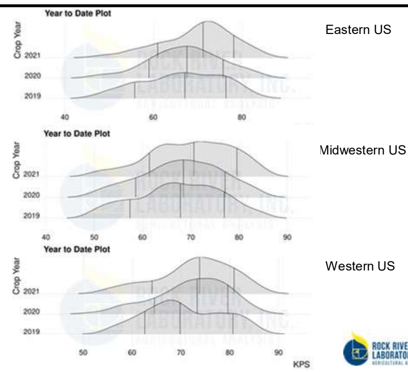
Corn Silage Kernel Processing Score

- Western US leading the pack!
- *New goal in KPS is 75 to 80*
  - Top 15% producers hitting this mark



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Too Many? Not Enough? Costs and Opportunities

Mike Overton | Zoetis | michael.overton@zoetis.com

Notes:

PowerPoint Slides on next page

COSTS AND OPPORTUNITIES ASSOCIATED WITH DAIRY REPLACEMENT HEIFER INVENTORY

Michael Overton
Zoetis Animal Health

Steve Eicker
King Ferry, New York

zoetis

1

Introduction

- Replacement rate, (also commonly called “cull rate” or “herd turnover”) is a very controversial subject
- In most dairies, youngstock development for replacement typically ranks as the 2nd or 3rd largest variable cost
- Consequently, producers and consultants tend to focus on this large *explicit* cost and conclude that the goal should be to lower herd turnover as much as possible
  - i.e., they overlook the lost opportunity cost of this decision
- Terminology refresher:
  - Explicit Cost (or Direct Cost):
    - Tangible, out-of-pocket payment; Expenses paid
    - E.g. the rent a dairy pays for an off-site heifer pasture
  - Implicit Cost:
    - Opportunity cost; hidden, non-monetary cost that is difficult to quantify well
    - E.g. rent your neighbor could have made by renting pasture to you but instead houses his wife’s horses on it

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However, a Few Things to Consider:

- Excessive focus on the explicit cost of heifer programs while ignoring potential lost opportunity cost of failing to appropriately replace less profitable cows may result in incorrect decision making and reduced whole herd profitability
  - Raising fewer heifers → Lower replacement rate → Lower explicit cost
  - But likely higher implicit cost due to reduced future milk production
- Using cost ranking to prioritize spending cuts is inappropriate. Feed cost is the single largest variable cost. That does not imply that a dairy should feed every other day feeding to save money…
- Spending should be prioritized based on ROI, risk, time-frame, and cash flow

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Definition of Cull Rate and Replacement Rate:

Assuming a stable herd size:

- **Cull Rate (or Herd Turnover):**

  (# Sold + # Died)/Avg # Milking and Dry (all within the same 12-month period)

  EVENTS\5S SOLD DIED for LACT>0 *(numerator)*

  ECON\ID *(denominator)*

  OR

- **Replacement Rate:**

  # 1st time Calvings /Avg # Milking and Dry (all within the same 12-month period)

  COUNT FDAT>-365 LACT=1\B *(numerator)*

  ECON\ID *(denominator)*

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Comparison of Calculation Approaches

	# Fresh	Replacement Rate (Fresh)	Avg Milking and Dry (Year)
Dairy 1	596	35%	1714
Dairy 2	1308	36%	3627
Dairy 3	1649	39%	4214
Dairy 4	771	35%	2185
Dairy 5	620	32%	1940
Dairy 6	1036	37%	2805
Dairy 7	1411	44%	3197
Dairy 8	361	37%	984
Average/Total	7156	38%	18952

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Comparison of Calculation Approaches

	# Fresh	Replacement Rate (Fresh)	Cull Rate (Sold & Died)	# Sold or Died	Avg Milking and Dry (Year)
Dairy 1	596	35%	43%	743	1714
Dairy 2	1308	36%	45%	1620	3627
Dairy 3	1649	39%	40%	1695	4214
Dairy 4	771	35%	36%	781	2185
Dairy 5	620	32%	32%	612	1940
Dairy 6	1036	37%	36%	1001	2805
Dairy 7	1411	44%	40%	1264	3197
Dairy 8	361	37%	24%	238	984
Average/Total	7156	38%	38%	7211	18952

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Comparison of Calculation Approaches

	# Fresh	Replacement Rate (Fresh)	Cull Rate (Sold & Died)	# Sold or Died	Avg Milking and Dry (Year)	Avg Milking and Dry (Last Month)	% Change
Dairy 1	596	35%	43%	743	1714	1650	-4%
Dairy 2	1308	36%	45%	1620	3627	3520	-3%
Dairy 3	1649	39%	40%	1695	4214	4190	-1%
Dairy 4	771	35%	36%	781	2185	2190	0%
Dairy 5	620	32%	32%	612	1940	1970	2%
Dairy 6	1036	37%	36%	1001	2805	2830	1%
Dairy 7	1411	44%	40%	1264	3197	3300	3%
Dairy 8	361	37%	24%	238	984	1040	6%
Average/Total	7156	38%	38%	7211	18952	19040	0%

Notice → calving an insufficient number of heifers relative to the number Sold or Died resulted in reduction in herd size

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Replacement Rate is a Balancing Act… Driven by Heifer Availability

- Dairy operations are often viewed incorrectly as negative pressure systems, i.e., cows get sick or die and when they leave the herd, that "pulls" a heifer into the dairy
  - But having a cow suffer a major health event today does not retrospectively cause a replacement heifer to get pregnant 9 months previously
- Assuming a stable herd size, dairies operate as a positive pressure system, i.e., as heifers calve and enter the herd, cows can be replaced

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Replacement Rate is a Balancing Act… Driven by Heifer Availability

- To put it another way… herds "plan" for a "maximum" level of turnover based on how many heifers are raised (assuming no purchases)
- Cows that can, and should be culled:
  1. Dead cows
  2. Incurable or chronic disease issues
  3. Cows that fail to become pregnant
  4. Cows affected by disease leading to reduced production
  5. Poor producers but otherwise healthy
  6. Genetics (heifers +/- cows)

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Culling and Replacement is About Improving the Herd

- Expected or predicted quality of incoming heifers should impact replacement decisions
- Once the obvious biologic failures on the cow side have been replaced, there is usually an opportunity to "upgrade" the dairy via "selective replacement"
  – If numerous heifers are available → more cows *could* be replaced (but not necessarily)
    • If heifer quality is excellent → more cows should be replaced
    • If heifer quality is poor → fewer cows should be replaced
  – If inventory is inadequate, alternative plans need to be made
    • Either heifers must be purchased, or cull cows retained longer

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YES – Turnover Can be Expensive

Estimated Net Herd Replacement Cost/d in Milking and Dry Herd

Replacement Cost	Whole Herd Replacement Rate: 31.0%	34.0%	37.0%	40.0%	43.0%	46.0%
$1,600	$0.82	$0.90	$0.97	$1.05	$1.13	$1.21
$2,000	$1.21	$1.33	$1.44	$1.57	$1.69	$1.82
$2,400	$1.59	$1.75	$1.92	$2.08	$2.25	$2.43

- Underlying assumptions:
  – Market cow value = $0.82/lb
  – Average mortality risk = 6%
  – Average condemnation risk at time of slaughter = 7%

No surprise, higher turnover and/or higher replacement heifer cost → higher cost/d for replacement. **But…** this is not the whole story

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Before Proceeding → Brief Overview of A New Economic Model Used Throughout this Presentation

- A spreadsheet-based economic model was built to mimic the major variable costs and revenue streams associated with milking and dry cows from first calving until removal from the herd (up to 10 lactations)
- Imagine building a hypothetical herd:
  – Year 1:
    • Original group (A) of heifers calve for first time and enter lactation (Lact=1)
    • Some get culled but most survive to the next lactation
  – Year 2:
    • Survivors of the original group now becomes Lact=2
    • New group (B) calves for the first time and enter lactation
  – Year 3:
    • Survivors of original group A now become Lact =3
    • Survivors of group B become Lact=2
    • New group (C) calves for first time and enter lactation
  – Process continues

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Economic Model Overview, Continued

- Parity-specific risks, costs, and milk production are modeled and adjusted to a Net Present Value (NPV) at time of first calving using 7% cost of capital:
  - Replacement risk (died, sold with revenue, or sold but condemned)
  - Market cow weight and value
  - Cumulative ECM production and length of lactation for cows removed vs cows that are retained (go dry)
  - Dry period length
  - Calf revenue realized after removing stillbirths, based upon calf type (dairy bull, dairy heifer, or beef cross)
  - Projected transition cow disease costs and management costs (preventive management inputs such as dry cow tubes, vaccines, additives, etc.)

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Model Outcome (and Economic Concept Used in this Presentation): Income over Cost (IOC)

- Similar to IOFC (income over feed cost) but IOC goes a bit further:
  - (Milk + Wet Calf Revenue) – (Feed + Dry Cow + Transition + Replacement Cost)
  - IOC is first tabulated as a Lifetime Value
    - A cohort of animals enter the "herd" and experience lactation-specific production, reproduction, culling risks
    - Lifetime production (and costs) are adjusted back to a net present value as of the day of calving
  - Then, IOC is converted:
    - Average Value/d (Lifetime Value/# days in adult herd)
    - *Annualized Value* (Average value/d * 365 d)

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Examining the Relationship Between Replacement Rate and Milk Production on IOC*

Relative Milk Production	Herd Replacement Rate: 34%	37%	40%	43%
2% Below Average	$2,284	$2,249	$2,207	$2,161
Average Cow	$2,364	$2,329	$2,288	$2,242
2% Above Average	$2,443	$2,409	$2,368	$2,322

A higher replacement rate is costly IF production does not change

- Increasing RR can be valuable if culling and replacement yields a higher level of production
- Reducing RR can result in lower revenue if low producing cows are retained or if replacement is delayed

*IOC = (Milk & calf revenue) – (Lactating & dry cow feed cost + Transition cost + Net Replacement cost)

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Striving for Continuous Improvement…

- *It is critically important to continue working to reduce the risk of cows losing sufficient value to* ***warrant*** *replacement!*
  - Reduce disease risk, improve repro, reduce lameness, etc.
  - Genetics, nutritional management, improve cow comfort, etc. are all important
- But, while we are doing all of that, let's also continue focusing on making good economic decisions to improve profitability
- Remember, the question that we need to continuously ask ourselves…

  "Is the immediate and long-term value of *THIS* **slot** improved by keeping the current cow or by replacing her with a fresh heifer?"
- Increasing replacement rate *can* improve profitability…

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Net Replacement Cost for a Cow

- If we approach a cow like a loan:
  - Interest rate: 7%
  - Number of months of payments: (1/RR)*12
    - 37% RR → 1/.37 = 2.7 yr * 12 mo/yr = 32 months
  - Amount of loan (fresh heifer cost):$2200
  - Future (residual) value = NPV of net salvage value (minus dead/condemned)
    - Projected market value today = $960
    - Projected losses:
      - 5% mortality/year over 2.7 years = 13%
      - 5% condemnation risk at time of slaughter
    - Future market value after losses =$836
      - NPV in 2.7 years of $836 = $696
  - ($2200 - $696)/(2.7*365) = $1.52/d of productive life

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Net Replacement Cost vs. Marginal Milk

- In the previous example, replacement cost = $1.52/d
- 2.7 years minus 2 dry periods = 875 days → $1.72/d of lactation
- If milk = $0.20/lb and feed = $0.14/lb dry matter → marginal milk value = $0.14/lb of milk
  - 12 lb marginal milk/d of lactation to pay the animal's cost
- So, how much more milk is need if RR = 40% vs. 37%?
  - Using similar assumptions → $1.86/d of lactation
  - 13 lb marginal milk/d of lactation
  - 1 extra lb of milk/d of lactation
- Don't you think that if you selectively removed a few more poorly performing cows, herd average would go up > 1 lb/day???

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Raising a Few More Heifers → More Options

- More heifers → More Options
  - Calving more heifers → opportunity to selectively remove poor quality heifers from inventory based on genomic testing early in life *BEFORE* investing heavily in raising
  - More *potential* replacement of the cow herd:
    - Can be a good thing if each animal is evaluated individually (i.e., not all replacement heifers deserve to become a milking cow)
      - Chance to "upgrade" a cow slot with a better animal
    - Can be a bad thing
      - Costly to raise replacements
      - Reduces the number of beef-cross calves produced
      - *Blindly* adding an animal simply because you raised her, and she represents the next generation (holds promise) is a bad thing

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CAUTION! Not Raising Enough Replacements Can be a HUGE Mistake

- Raising fewer heifers → saves cash flow now but can hurt long term profits
- If a herd with a 39% replacement rate "decides" to raise only enough heifers to support a 35% replacement rate, they are "deciding" to retain cull cows longer (assuming that no management changes occurred that truly changed replacement risk)
- 39% → 35% replacement rate due to insufficient heifers…
  - Now, the average market cow is retained ~ 100 days longer
  - Under current conditions, miking these less productive cows longer than optimal results in lost opportunity of approximately $150-$200 or more per delayed replacement

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Question for every producer…

- At what production level should a healthy, “Do Not Breed” cow be replaced?
- i.e., how many pounds of milk should a cow be producing to still be considered “good enough to keep in the herd”?

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Replacement Timing for a Designated Cull Cow

	Unit	Current Cow	Replacement
Projected 305d Milk (lactation = 1)	Lb	xxx	22,500
Milk /day (lact=1, then lifetime incl dry)	Lb	65.0	72.8
Milkfat	%	4.1%	3.9%
Protein	%	3.3%	3.2%
Milk price	Lb	$0.233	$0.224
Annual herd turnover	%		39%
Expected productive life	Yrs		2.6
Annual mortality risk	%		5%
Interest rate	%		7%
Beef value/unit body weight	Lb	$0.80	
Condemnation risk at culling	%	7%	
Current cost or market value/cow		$1,063	$2,400
Time discounted net salvage value			$877
Projected replacement cost, $/day			**$1.98**

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Current cost or market value/cow		$1,063	$2,400
Time discounted net salvage value			$877
Projected replacement cost, $/day			**$1.98**
Maintenance (+ growth) feed/day	Lb	23.0	23.0
Marginal milk feed factor	Lb	0.45	0.43
Dry Matter Intake/day	Lb	52.0	54.4
Feed Cost	Lb	$0.140	$0.140
Feed Cost/cow/day		$7.28	$7.62
Income over feed and variable cost/cow/day		$5.56	$6.38
IOFC & VC (includes 100% of repl cost), $/day		**$5.56**	**$4.41**

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23

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Protein	%	3.3%	3.2%
Milk price	Lb	$0.233	$0.224
Annual herd turnover	%		39%
Expected productive life	Yrs		2.6
Annual mortality risk	%		5%
Interest rate	%		7%
Beef value/unit body weight	Lb	$0.80	
Condemnation risk at culling	%	7%	
Current cost or market value/cow		$1,063	$2,400
Time discounted net salvage value			$877
Projected replacement cost, $/day			**$1.98**
Maintenance (+ growth) feed/day	Lb	23.0	23.0
Marginal milk feed factor	Lb	0.45	0.43
Dry Matter Intake/day	Lb	52.0	54.4
Feed Cost	Lb	$0.140	$0.140
Feed Cost/cow/day		$7.28	$7.62
Income over feed and variable cost/cow/day		$5.56	$6.38
IOFC & VC (includes 100% of repl cost), $/day		**$5.56**	**$4.41**
Decline in milk/day	Lb	0.18	
Absolute Breakeven milk (empty stall)	Lb	32.5	
Days to absolute breakeven	Days	181	
Target level of milk/ for replacement	Lb	**58.3**	
Days until target level milk is reached	Days	37	
IOFC & VC from today to Target day, $		**$21**	
Lost IOFC & VC if sold at absolute breakeven milk		**-$316**	

At 0.18-lb decline/d for each additional day of delay in replacement, there is an average lost opportunity of $1.75/d

-$316/181 d = -$1.75

-$1.75 * 100d = -$175/market cow due to delayed replacement

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Projected Milk Production (i.e. "Quality") of Incoming Replacements Influences When Cows Should be Replaced

Milk production level for targeted replacement of DNB cows:

Milk Price/Lb	Projected 305 Milk for Lact=1 (lb)						
	18,000	**19,000**	**20,000**	**21,000**	**22,000**	**23,000**	**24,000**
$0.17	34	36	39	41	43	45	48
$0.18	38	40	43	45	48	50	53
$0.19	42	44	47	50	52	55	58
$0.20	45	48	51	54	57	60	62
$0.21	49	52	55	58	61	64	67
$0.22	53	56	59	63	66	69	72
$0.23	56	60	63	67	70	74	77

Other important variables other than incoming heifer quality:
- Replacement cost
- Beef value
- Expected turnover risk
- Feed cost

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Producing a "Better-Quality" Heifer

- "Better-quality" means:
  - Higher genetic potential
  - Closer to mature size at calving (both height and weight)
    - Assuming ~725 kg mature weight (Holstein):
    - 92-95% of mature body weight (~675 kg or 1490 lb) pre-calving
    - 1^{st} Post-calving wt: 82-85% of MBW (~600 kg or 1350 lb)
    - 95% of mature height at calving (~1.4 m or 55")
  - Timely: older heifers means greater lost opportunity cost
  - Fewer calfhood health issues that may carry over to impact future productivity

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Why is it SO Important that Heifers are Grown Better PRIOR to First Calving?

- Cows don't typically reach their mature size until ~ 4^{th} lactation
- If heifers weigh 82-85% of mature weight after calving (~1350-1375 lb), much less growth is required in first lactation
- Consider the following derived from published research[1]:
  - Holsteins calved at ~ 1225 lb
  - Over the course of a 305-d of lactation:
    - ~7% of energy consumed went to growth (200 lb)
    - Represents sufficient energy to support ~ 2,100 lb milk
  - Imagine if the calving weight had been 1325 lb and half of the energy consumed could have been diverted to milk instead of growth ➔ represents ~ 1000 lb more milk during first lactation

[1]Olson, K., et al. (2010). Energy balance in first-lactation Holstein, Jersey, and reciprocal F_1 crossbred cows in a planned crossbreeding experiment. *Journal of Dairy Science*. 93(9), 4374-4385.

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What is the Value of Producing a "Better" Heifer?

- A retrospective analysis of farm data project was conducted to help investigate the "lifetime" value of improving heifer quality
- Data from heifers that calved for the first time in 2017-2018 for two Holstein dairies were used
  - These two dairies were chosen because they had genomic test results AND animal weights recorded at 1-3 d after first calving
  - To be included, each animal had to have the following info:
    - Projected 305d milk (NOT mature equivalent)
    - 1^{st} calving weight (within 1-3 days of first calving)
    - Genomic test results
  - These animals were followed through 4 lactations

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Modeled 305M in Various Ways for Lactations 1-3

Multivariable regression was used to examine the relationship between key variables and net revenue (Income over Cost)

Questions to be answered:

- What factors are associated with 1^{st} lactation 305M?
- What factors are associated with the difference from 1^{st} lactation 305M to 2^{nd} lactation?
- What factors are associated with the difference from 2^{nd} lactation 305M to 3^{rd} lactation?
- What factors are associated with the difference from 3^{rd} lactation 305M to 4^{th} lactation?
- **Goal was to be able to predict milk impact across the first 4 lactations as a result in changes in heifer "quality"**

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Key Economic Inputs Used in the Model

Replacement cost (Fresh Heifer value):			$2000
Market cow value: $0.65/lb		Interest (cost of capital):	7%
Lactating ration:	$0.14/lb DM	Dry cow feed cost/d:	$3.00
Dairy bull calf:	$35 (22%)	Dairy heifer calf:	$200 (45%)
Beef cross calf:	$150 (33%)	DOA risk (all calves):	4%
Component-based milk pricing (4% fat, 3.3% protein):			$0.20/lb
Transition management cost (preventive medicine):			$75
Weighted average transition disease cost/lactation:			$125

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Key Economic Outputs

- Net Replacement Cost/d:
  - (Replacement cost – NPV of net salvage value)/(# days in lactation + # days dry)
- Income over Cost (IOC) – similar to Income over Feed Cost (IOFC) but also includes other items:
  - (Milk + Calf Revenue) – (Feed + Dry Cow + Transition + Replacement Cost)
  - Reported as a Lifetime Value but converted to:
    - Average Value/d (Lifetime Value/# days in adult herd)
    - Annualized Value (Average value/d * 365 d)

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Results of the First Statistical Model: Predictors of Milk in ***First Lactation***

- Standard Least Squares Means (LSM) model for prediction of 1^{st} lactation 305M:
- Explanatory Variables:
  - Month of calving — Age at 1^{st} calving (d)
  - Weight at 1^{st} calving (lb) — Weight at 1^{st} calving (lb)^2
  - Genomic PTA Milk — Genomic body size composite (BDC)

Age at First Calving (d)	Weight at First Calving: 1200	1250	1300	1350	1400	1450
650	20843	21227	21563	21853	22094	22289
675	20861	21245	21582	21871	22113	22307
700	20880	21264	21601	21890	22132	22326
725	20899	21283	21620	21909	22151	22345
750	20918	21302	21638	21927	22169	22364
775	20936	21320	21657	21946	22188	22382
800	20955	21339	21676	21965	22207	22401
Lb 305M per lb increase in weight at first calving		7.7	6.7	5.8	4.8	3.9

For each additional day of age, 0.7 lb more 305M
- But, 1 day of extra raising cost >>> $0.09 to $0.10 more marginal milk value

For each lb of Genomic PTAM, 3 lb more 1^{st} lactation 305M

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Summarization of Projected Value Across a Lifetime for Heifers Calving into These Herds

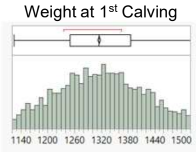
When accounting for the other variables:

- Age at first calving was NOT important:
  - Each additional day of Age at 1st Calving = -$0.03 in annualized IOC
- Size at calving was VERY important:
  - Each additional lb of weight at 1st calving = $0.41 in annualized IOC but varied by weight
  - 1200 → 1250 lb = $0.54/lb; 1400 → 1450 lb = $0.26/lb
  - Weight range for 90% of heifers:

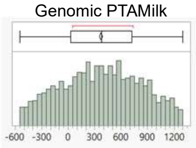
    1125 to 1520 lb = ~ $160 in IOC
- Genetics was MOST important:
  - Each additional lb GPTAMilk = $0.39 in annualized IOC
  - Range for 90% of heifers:

    -550 to 1300 = ~ $720 in IOC

Weight at 1st Calving



Genomic PTAMilk



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There is a lot of mention about "Lifetime Milk", But Just To Be Crystal Clear…

I am NOT Promoting More Lifetime Milk Per Cow as the *SOLE FOCUS*

- Improving the health, management and genetics such that animals have the ***capacity*** for greater lifetime milk is GREAT!
- BUT:
  - Lifetime productivity is a reasonable outcome to compare ONLY IF key inputs are held constant
    - i.e., parity-specific turnover
  - ***Greater net revenue per day per slot is a much better goal***
  - Growing better quality heifers and getting them into production sooner is much better than the alternative
  - Keeping animals in the herd longer as the ***sole*** focus increases lifetime milk but will reduce herd profitability

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Consider the Following Two Investment Options

- Option A:
  - Invest $10,000 today
  - In 5 years, you get back $20,000
- Option B:
  - Invest $10,000 today
  - In 3 years, you get back $17,716

Which option do you want?

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Two Investment Options

- Option A:
  - Invest $10,000 today
  - In 5 years, you get back $20,000
  - Rate of return = 15%
  - Lifetime profit = $10,000
  - Avg profit per year = $2000
- Option B:
  - Invest $10,000 today
  - In 3 years, you get back $17,716
  - Rate of return = 21%
  - Lifetime profit = $7,716
  - Avg profit per year = $2572

Assuming both options are available for renewal, which option do you want?

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Now, A Comparison of Two Heifer Options

- Option A:
  - Heifer cost of $1500
  - 1st calving:
    - 1275 lb @ 760 d
    - GPTAM of 25
  - Lact=1 305 M: 20,000 lb

Lact	Culling Risk	Milk/Lact (PREG & Ret)
1	20%	21297
2	26%	26330
3	34%	27102
4	38%	28484
5	41%	28861
6	44%	28697
7	48%	29377
8	49%	28084
9	60%	29759
10	100%	8486
	30%	**25283**

- Option B:
  - Heifer cost of $2200
  - 1st calving:
    - 1350 lb @ 710 d
    - GPTAM of 475
  - Lact=1 305 M: 23,500 lb

Lact	Culling Risk	Milk/Lact (PREG & Ret)
1	30%	25089
2	35%	29783
3	48%	29787
4	66%	30161
5	72%	30560
6	76%	30386
7	83%	31106
8	86%	29738
9	99%	31511
10	100%	7826
	40.0%	**27629**

Which option do <u>you</u> want?

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Comparison of Two Heifer Options

	Option A	Option B
Average ECM/DIM (ALL)	75	81
Total Projected Days (Milk + Dry)	1147	842
Projected lifetime milk (lb ECM)	75,300	60,800
Average IOC/Lifetime	$4,994	$3,738

- Which would you say is the winning option?

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Comparison of Two Programs

	Option A	Option B
Average ECM/DIM (ALL)	75	81
Total Projected Days (Milk + Dry)	1147	842
Projected lifetime milk (lb ECM)	75,300	60,800
Average IOC/Lifetime	$4,994	$3,738
Avg Projected Lifetime IOFC/DIM	$6.28	$7.37
Net Replacement Cost/Day	$0.72	$1.76
Avg IOC/Day	$4.35	$4.44
Annualized Average IOC	$1,589	$1,619

- Now, which would you say is the winning option?

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A Few Notes About Heifer Inventory

- Heifer inventory and "heifer completion rate" are two items that are often monitored by consultants
  - Crappy monitor (lag of 2 years); why not measure stages of heifer growth?
- But the statement – "you should not have more than X% of your herd as heifers" – is very problematic
- Heifer inventory (% of adult herd) is driven by several factors:
  - Reproductive rate of the herd
  - Type of semen used (sexed vs. conventional vs. beef)
  - Heifer management and removal practices (disease, death, selective culling)
    - Is 88% completion rate "better" than 80%???
    - Focus on the right things to measure → leading indicators + morbidity, mortality, fertility, etc.
- Excessively high inventory → costly; probably not optimal
- Too few replacements → we wait for cows to get lame, mast, sick, skinny, before they are replaced

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Estimated Heifer Inventory (live birth to calving) Expressed as % of Milking and Dry Cows

(Assumes 24 months age at first calving and creating "just enough" heifers)

% of Heifers Born Alive that Actually Calve

Replacement Rate	70%	75%	80%	85%	90%
33%	80%	77%	74%	72%	70%
37%	90%	86%	83%	81%	78%
41%	100%	96%	92%	89%	87%
45%	109%	105%	101%	98%	95%

Example: for a 1000 cow herd with a 38% replacement rate and 80% heifer completion, need ~86% of milking and dry herd or ~860 heifers from birth to calving

Under normal economic conditions, excessively high replacement rate and heifer inventories are not optimal but there is not a single, optimal target for inventory

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Planning for the Future – How Many Heifers?

- Remember: the number of future replacements that calve creates the "limit" for cows that may be replaced
- Typically work from historical replacement needs and historical youngstock removal risks
- Risky:
  - What happened in the future may not repeat itself
    - "Anticipate" future replacement needs
  - Heifer quality changes
  - Add in a bit of a buffer for flexibility
    - Adds cost but provides a bit of insurance

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Raising a Few More Heifers → More Options

- More heifers → More Options
  - Calving more heifers → opportunity to selectively remove poor quality heifers from inventory based on genomic testing early in life *BEFORE* investing heavily in raising
  - More *potential* replacement of the cow herd:
    - May be a good thing if each animal is evaluated individually (i.e., not all replacement heifers deserve to become a milking cow)
      - Chance to "upgrade" a cow slot with a better animal
    - May not be optimal
      - Costly to raise replacements
      - *Blindly* adding an animal simply because you raised her, and she represents the next generation (holds promise) is a bad thing

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Example for Dairy X

Annual Replacement Rates for the Past 10 Years

Year	New	AVG	RR	
2012	1180	2731	43%	
2013	1079	2684	40%	
2014	1010	2671	38%	
2015	1096	2706	41%	
2016	1035	2727	38%	
2017	1133	2766	41%	
2018	1096	2833	39%	
2019	1066	2818	38%	
2020	997	2774	36%	
2021	1029	2806	37%	
Mean	1072	2752	39%	
	24		2.2%	std dev
Target	1096			

Baseline target for "just enough" replacements:
- 1072 + 24 = 1096
- 1096 springers → can support 40% turnover assuming stable herd size

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Projecting Heifer Needs for Dairy X

At a minimum, we need to produce enough heifers to meet anticipated future culls

	All	L=1	L=2	L>2
Avg # Milking and Dry	2752	992	769	991
# Sold	927	233	218	476
# Died	145	28	27	90
Herd Turnover (i.e., Replacement Rate)	39%	26%	32%	57%
	1072+24	**1096**		

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Projecting Heifer Needs for Dairy X

At a minimum, we need to produce enough heifers to meet anticipated future culls

	All	L=1	L=2	L>2
Avg # Milking and Dry	2752	992	769	991
# Sold	927	233	218	476
# Died	145	28	27	90
Herd Turnover (i.e., Replacement Rate)	39%	26%	32%	57%
	1072+24	**1096**		

# Heifers Needed for Replacement		**1096**	Net # Heifers that "Enter Lactation"
% of Pregnant Heifers that leave prior to Calving	3%		
		1130	# Heifers that Get Pregnant
% of Breeding Heifers that Conceive	95%		
		1189	# Heifers Enter Breeding Pen
% Sold prior to breeding	3%		
% Dead prior to breeding	3%		
		1265	# Heifers Born Alive
% DOA	4%		
		1318	# Dairy Females births
Heifer completion (born alive to calving)	**87%**		

Notice: Prior to breeding, this herd removes 3% for chronic health issues

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Projecting Heifer Needs for Dairy X

At a minimum, we need to produce enough heifers to meet anticipated future culls

	All	L=1	L=2	L>2
Avg # Milking and Dry	2752	992	769	991
# Sold	927	233	218	476
# Died	145	28	27	90
Herd Turnover (i.e., Replacement Rate)	39%	26%	32%	57%
	1072+24	**1096**		

Moving forward, the herd would like to remove 5% after weaning using genomic results in addition to the baseline 3% being culled due to health issues

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Projecting Heifer Needs for Dairy X

At a minimum, we need to produce enough heifers to meet anticipated future culls

	All	L=1	L=2	L>2
Avg # Milking and Dry	2752	992	769	991
# Sold	927	233	218	476
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Herd Turnover (i.e., Replacement Rate)	39%	26%	32%	57%
	1072+24	**1096**		

Moving forward, the herd would like to remove 5% after weaning using genomic results in addition to the baseline 3% being culled due to health issues

# Heifers Needed for Replacement		**1096**	Net # Heifers that "Enter Lactation"
% of Pregnant Heifers that leave prior to Calving	3%		
		1130	# Heifers that Get Pregnant
% of Breeding Heifers that Conceive	95%		
		1189	# Heifers Enter Breeding Pen
% Sold prior to breeding	8%		
% Dead prior to breeding	3%		
		1336	# Heifers Born Alive
% DOA	4%		
		1392	# Dairy Females births
Heifer completion (born alive to calving)	**82%**		

(vs. 1318 previously shown)

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Projecting Heifer Needs for Dairy X

At a minimum, we need to produce enough heifers to meet anticipated future culls

	All	L=1	L=2	L>2
Avg # Milking and Dry	2752	992	769	991
# Sold	927	233	218	476
# Died	145	28	27	90
Herd Turnover (i.e., Replacement Rate)	39%	26%	32%	57%

1072 + 24 + 57 **1129** Available to calve

Now have built in an additional 3% cushion (potential surplus).
These numbers support (but do not necessitate) a 41% RR

Cushion for unanticipated needs	8%	**57**	Cushion (extra heifers/year)
New herd turnover supported: 41%			
# Heifers Needed for Replacement		**1129**	Net # Heifers Available to Calve
% of Pregnant Heifers that leave prior to Calving	3%		
		1164	# Heifers that Get Pregnant
% of Breeding Heifers that Conceive	95%		
		1225	# Heifers Enter Breeding Pen
% Sold prior to breeding	8%		
% Dead prior to breeding	3%		
		1376	# Heifers Born Alive
% DOA	4%		
		1426	# Dairy Females births
Heifer completion (born alive to calving)	**82%**	**(or 76% if surplus is sold)**	

(vs. 1318 previously shown)

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Summary

- In the previous example, producing extra heifers (cushion) could be viewed as 0.1% total cost of "insurance"
  - $20,000 forsaken beef-cross calf revenue/$20 million total revenue
- Yes, dairy heifers are costly to raise… but it is essential to have enough to support replacement needs
  - Do not focus so heavily on explicit costs and ignore potential lost opportunity costs
- Improved management can help lower the cost of raising and enhance the "quality" of the heifers, thus improving profit potential
- Remember, herds plan for a maximum replacement rate in 2.5 to 3 years based on breeding approaches used today

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A Few Other Points for Consideration…

- A new replacement heifer provides the LUXURY of replacing the worst cow, or alternatively, selling a springing or fresh heifer
- If too few replacements, need to keep cull cows longer.
  - This is bad for the cow/welfare
  - Bad for market value
  - Bad for public opinion
  - Bad for total herd profitability
- If "excess" replacements, creates an opportunity to replace low performing low genetics cows BEFORE they get sick, lame, mastitic, skinny, etc.
  - Better for cow welfare
  - Better for market value
  - Better for public opinion
  - Better for profitability

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Thank You for Your Attention!

Questions?

Michael.Overton@zoetis.com

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Water Impact Factor on the Local Economy

Joe Harner | Kansas State University Emeritus | jharner@ksu.edu

Notes:

PowerPoint Slides on next page

Water Impact Factor on the Local Economy

Joe Harner & Mike Brouk
Kansas State University

1

Simple Web Search of Dairy and Water

Headlines of dairies impact on water aquifers

Residents say corporate mega-farms are drying up their wells

A mega-dairy is transforming aquifer and farming lifestyles

WATER CRISIS CHALLENGES DAIRY

Cheese in the Desert: Why Mega-Dairies are Piping Water

Milking the desert: How mega-dairies thrive

Opinion: legislature has a plan to save water in our desert

Dairy vs Water vs **Economic Impact**

Not every rural area (valley) can be a Silicon Valley

2

Fundamental Question

- What is the water usage necessary for a dairy to generate the 1st dollar of economic impact in moisture deficit states?
  - Dairies in regions w/ rainfall cropping systems vs irrigated cropping systems
  - Dairying vs crop production water usage in moisture deficit states
  - Potential economic impact of dairying in irrigated regions

3

Disclaimers

- Every dairy does some irrigation due to dewatering lagoons / ponds
- No intent to imply any type of agricultural enterprise is wasting water or not of economic value
- Every day new water conservation practices are adopted within the agricultural sector
- It is recognized that agricultural enterprises have an economic multiplier effect within a local community
- There are exceptions (both positive and negative) to all assumptions made in this analysis
- Some dairies in rain surplus communities may purchase forages or commodities from producers outside the region (i.e. alfalfa hay) or vice versa (i.e. soybean meal)

4

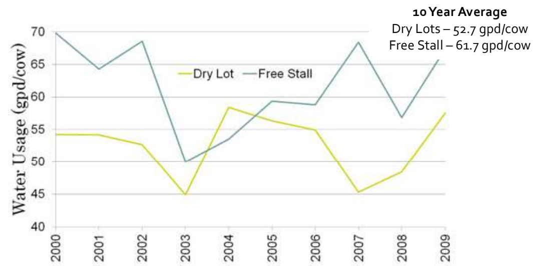
Summary of AZ Study

- 37.5 % of water used in wash pen
- Average water usage was 89.3 gpd/cow
- Avg. water usage w/out W.P. was 58.6 gpd/cow
- Wash pen water usage average 50 gpd/cow
- Water in milk center averaged 11.2 gpd/cow

Zaugg (1989)

5

Fresh Water Pumped per Lactating Cow



Potts & Brouk (2012)

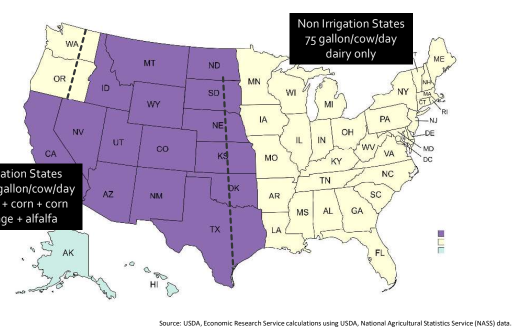
6

Idaho Study (6 dairies)

- 660 to 6,400 cows (equivalent cows)
  - No summer heat abatement
- Average 29.1 to 66.1 gpd / eq. cow
- Overall average 50.2 gpd / eq. cow
- Summer usage increased 26.4 gpd / eq. cow
- Waste water – 5.5 to 39.6 gpd / eq. cow
- Average water to milk ratio 6.8 +/- 1.8

Bjorneberg & King (2014)

7



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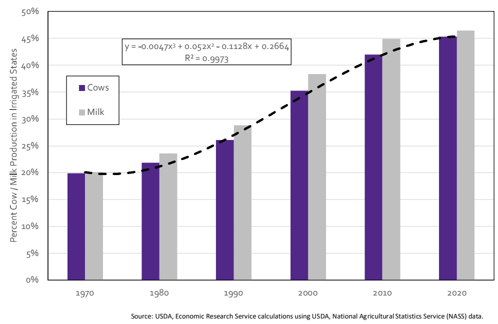

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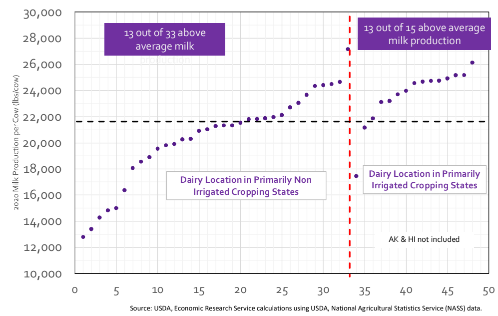

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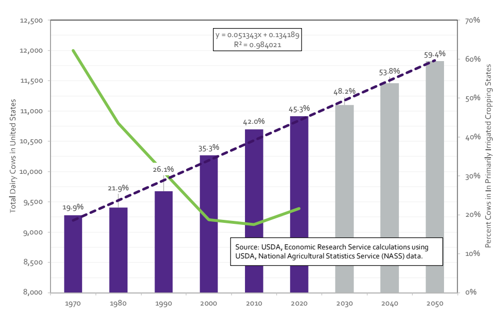
Potential movement of cows to states with moisture deficit



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Water Impact Factor

- Gallons of water necessary from an agricultural operation to generate the 1st gross dollar of economic impact
- Multiplier effect of operations are not considered
- Focus on gross dollars rather than net income or operating cost
- Corn & alfalfa yields & milk production vary by producers

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Water Impact Factor

Gallons of water / 1st gross dollar to local economy = Irrigated Water per Unit / $ per Unit

Cotton Example

480 gallons of water to generate $1 gross to the local economy = 325,000 gal water /acre / $0.75 / lb x 900 lb/acre

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Water Footprint of Every Day Products Updated 10/20/2022

*The Hidden Water in Everyday Products - Water Footprint Calculator (watercalculator.org)

Everyday Product*	Estimated Water Usage (gallons)	$/unit	Water Impact Factor (gal/$)
1 Car	13,737 - 21,296	$40,00	0.5
1 Smart phone	3,190	$1,000	3
Cotton jeans	2,866	$40	72
Cotton Bed Sheet	2,576	$40	64
Cotton T-shirt	659	$5	132
Paper (1 piece; A4)	1.3	$0.017	76

Side note: 53 gallons of water equals 1 latte

How Many Gallons of Water Does It Take to Make . . . (treehugger.com)

*Water footprint calculator was not verified

14

Corn and Corn Silage Production Assumptions

- Corn
  - 200 bushels per acre
  - 12,15, 18, 21,24 inches water per acre
  - $4, $5, $6, $7 or $ 8 per bushel
- Corn Silage
  - 28 ton / acre
    - 7 bu corn = 1 ton of silage
  - 12,15, 18, 21,24 inches water per acre
  - $40, $50,$60, $70 & $80 per ton of corn silage
    - Silage cost = 10 x $/ bu of corn

15

Alfalfa Production Assumptions

- Alfalfa
  - 8 ton per acre
  - 12,15, 18, 21,24 inches water per acre
  - $200, $250, $300, 350 or $400 per ton

16

Milk Production Assumptions

- Milk Production
  - 80 milk / day per cow
  - 12, 18, 24 inches water per acre of crops
  - $16, $18, $20, 22 or $24 per cwt
- Irrigated Crops in Ration
  - 10 lbs corn
  - 54 lbs silage
  - 10 lbs alfalfa
  - 75 gal/cow per day on dairy

17

Economic Impact of 200 bu Corn Production

(gallons of water per 1st dollar generated)

Irrigation Water (inches/acre)	Corn Prices ($/bushel)				
	$4	$5	$6	$7	$8
12	407	326	272	233	204
15	509	407	339	291	255
18	611	489	407	349	305
21	713	570	475	407	356
24	815	652	543	465	407

18

Water Impact Factor 28 ton Corn Silage

(gallons of water per 1st dollar generated)

Irrigation Water (inches/acre)	Corn Silage Prices ($/ton)				
	$40	$50	$60	$70	$80
12	285	228	190	163	143
15	356	285	238	204	178
18	428	342	285	244	214
21	499	399	333	285	249
24	570	456	380	326	285

19

Water Impact Factor for 8 ton Alfalfa

(gallons of water per 1st dollar generated)

Irrigation Water (inches/acre)	Alfalfa Prices ($/ton)				
	$200	$275	$350	$425	$500
12	204	148	116	96	81
15	255	185	145	120	102
18	305	222	175	144	122
21	356	259	204	168	143
24	407	296	233	192	163

20

Water Impact Factor for 80 lbs Milk Production
(gallons of water per 1st dollar generated)

Corn & Corn Silage Water (inches/acre)	Alfalfa Water (in/acre)	Crop Irrigation Water per Cow (gal/day)	Milk Price ($/cwt)		
			$16	$20	$24
12	12	802	65	52	43
18	12	1,102	87	69	58
24	12	1,401	109	87	72
12	24	1,006	79	64	53
18	24	1,306	102	81	68
24	24	1,605	124	99	82
Non-Irrigated Cropping System		75	4.7	3.8	3.1

21

Forgotten Irrigation Water on a Dairy in 48 inch Moisture Deficit Area

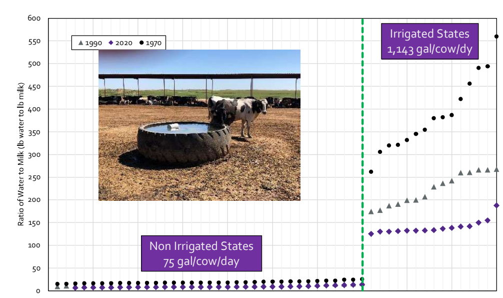
Water Balance on a Dairy	Annual Average Water Usage (gallons/cow/dy)	Percent Allocation
Evaporation from uncovered lagoon & concrete surfaces	19.0	29.3%
Net water in lagoon for future irrigation	26.5	40.8%
Water in milk shipped assuming 13 % solids	8.4	5.1%
Heat abatement water assuming 50 % evaporates	3.3	12.8%
Water in separated manure solids	2.2	8.7%
Unaccounted water	5.7	3.3%
Total water used in a freestall dairy	65.0	100%

22

Water Impact Factor of Ag Enterprises

Agricultural Enterprise	Gallon Water Pumped per 1st Gross $ Return
Corn Production	200-600
Corn Silage Production	200-500
Alfalfa Production	100-400
Milk + Rainfall Crops	4-6
Milk + Irrigated Crops	60-110
Milk + Irrigated - Lagoon	35-85

23



24

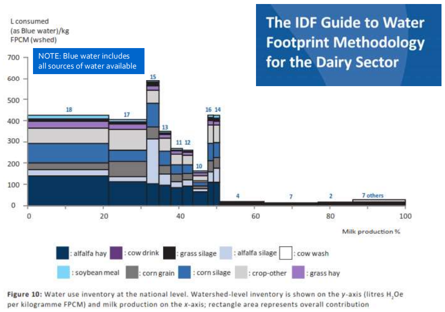
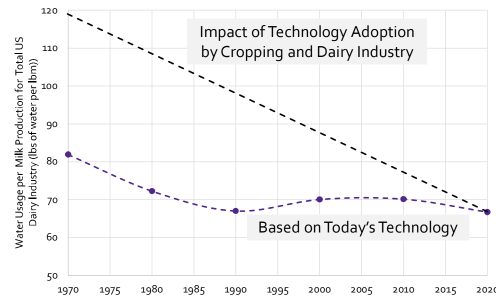


Figure 10: Water use inventory at the national level. Watershed-level inventory is shown on the y-axis (litres H_2Oe per kilogramme FPCM) and milk production on the x-axis; rectangle area represents overall contribution

25

Water Usage Across Entire Dairy Industry



26

Summary of Water Impact Factor

- 1st glance it appears dairying in moisture deficit states uses 3-4 times less water than crop production systems to generate the 1st dollar of gross return to a region
- Across the entire US dairy industry the pumped water to milk ratio needed for the 1st gross dollar generated is estimated to be about 65 when considering water necessary for irrigating crops in some regions. The 5 to 8 lb water to milk ratio reported in research probably does not consider water necessary for irrigated crop production in the vicinity of a dairy.

27

When Is the Best Time to Get Cows Pregnant

Kevin Dhuyvetter | Elanco | kevin.dhuyvetter@elancoah.com

Notes:

PowerPoint Slides on next page

When is the best time to get cows pregnant? A lactation curves analysis

Kevin Dhuyvetter, PhD
Technical Consultant, Elanco

Western Dairy Management Conference
Feb 27 – Mar 2, 2023
Peppermill Resort Spa Casino
Reno, NV

1

Issue (i.e., question that came to me)

- Given improved reproduction, should breeding of cows be delayed?
- What is purpose for delaying breeding?
  (longer lactation, lower milk at dry-off, improved first service conception, ???)
- Objective of analysis: Identify optimal DIM of conception
- Simplify problem for analysis to
  - account for herd-specific shape of lactation curves by parity group
  - account for impact pregnancy status has on lactation curves

2

Data from an individual herd

- Data for analysis from Elanco DDAS
  - DC305 backup dated 10/13/2022
  - JMP Ready file dated 10/12/2022
- Filters used for analysis (to remove extreme outliers)
  - Fresh data = 8/1/2019 to 7/31/2022 (3-year period)
  - Test DIM = 7 – 400
  - Test Milk = 10 – 180
  - L1Age at fresh (days) = 575 – 850 (~19-28 months)
  - Weight at fresh (L1 only) = 900 – 1700
  - Days in close-up pen = 1 – 70
  - Days dry (L>1 only) = 20 – 100

3

Test day data (all filters applied)

Lact = 1 Cows

	TestDIM				TestMilk			TestECM			
Test	N	Mean	Min	Max	Mean	Min	Max	N	Mean	Min	Max
1	6941	23.8	7	214	65.1	10	123	6610	71.6	11	141
2	6765	54.7	34	211	80.4	11	132	6679	83.8	12	173
3	6500	86.3	62	239	82.6	12	126	6442	85.5	20	143
4	6208	117.7	91	274	82.6	10	127	6149	86.5	27	160
5	5885	149.2	125	302	82.4	15	135	5863	87.1	15	140
6	5581	180.7	154	298	81.2	33	130	5562	86.6	34	140
7	5332	212.5	182	299	79.1	25	127	5310	85.3	29	157
8	5055	243.6	217	327	75.4	28	130	5036	82.7	35	139
9	4451	272.6	245	355	72.4	26	127	4442	80.6	34	147
10	2668	300.6	280	383	69.9	20	119	2665	78.7	23	130
11	1199	332.9	308	378	68.7	28	119	1199	78.0	35	137
12	536	364.6	337	400	68.7	28	107	535	78.6	31	123

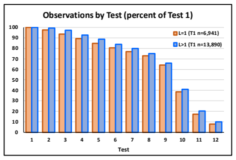
Lact > 1 Cows

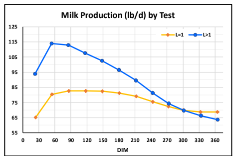
	TestDIM				TestMilk			TestECM			
Test	N	Mean	Min	Max	Mean	Min	Max	N	Mean	Min	Max
1	13890	22.9	7	236	93.9	11	174	13455	101.9	14	220
2	13808	53.8	34	264	114.0	13	179	13738	118.8	17	245
3	13509	85.3	62	299	113.0	15	179	13455	117.0	16	260
4	12888	116.6	91	327	107.6	14	177	12860	113.2	14	190
5	12321	148.2	125	355	102.6	19	166	12299	109.0	21	203
6	11657	180.1	154	277	96.5	12	165	11631	103.4	16	181
7	11090	211.8	182	305	89.6	18	160	11062	96.9	18	198
8	10417	243.2	217	286	81.3	11	153	10387	89.4	9	186
9	9159	273.2	245	315	74.3	11	152	9146	83.0	13	166
10	5683	301.6	280	343	69.7	10	125	5675	78.3	11	135
11	2810	333.6	308	378	66.3	11	121	2806	75.3	12	138
12	1386	364.8	336	400	63.7	10	112	1383	72.4	14	155

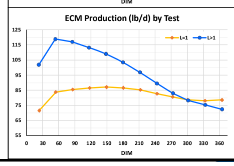
The number of observations drops considerably from the 9th test to 10th test and then considerably more from 10th to the 11th test and thus there is likely some "survivor bias" in these data that will impact results somewhat. Data from 10 tests were included to ensure cows with ~300 DIM existed for model estimation, however data from tests 11 and 12 are excluded due to survivor bias concerns.

4

Test day data (all filters applied)







Data from Tests 11 and 12 (i.e., data points > 300 DIM on figures) are excluded from lactation curve analyses.

Number of L=1 cows drops faster over time compared to L>1 cows – this is not what would generally be expected or what has been observed in other herds.

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5

Estimating lactation curves

J. Dairy Sci. 87:2146–2157
© American Dairy Science Association, 2004.

An Economic Spreadsheet Model to Determine Optimal Breeding and Replacement Decisions for Dairy Cattle

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[2]Animal Breeding and Genetics Group, Wageningen University, The Netherlands

$$Y = A\,(DIM)^b\, e^{c\,DIM}\, e^{gDP}$$

← Used this basic model as starting point (after transforming), and included some additional variables (did not explicitly include GNRHA)

Y = daily milk yield (kg),
A = ((GNRHA/100 – a)/2.96),
GNRHA = rolling lactation average (genetic rolling herd average) (kg/yr),
DIM = days in lactation (milk),
DP = days in gestation (days pregnant),
e = base of natural logarithm, and
a, b, c, g = constants that determine the shape of the lactation curves.

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6

Multivariate statistical models estimated (by parity group)

- Dependent variables
  - Milk, ECM, Fat + Protein – LN of lb/day for all variables
- Independent (explanatory) variables
  - Month fresh and Year fresh (Year fresh is Aug of first year through Jul of following year)
  - Calf outcome (female, male, twin, other)
  - Calvings same week by parity (primiparous or multiparous)
  - Days in close-up pen (linear and squared terms)
  - Age at L1 fresh, days (linear and squared terms)
  - Weight at fresh (linear and squared terms) – L=1
  - Days dry (linear and squared terms) – L>1
  - PTA Milk
  - Previous lactation 305 ME – L>1
  - Disease in first 30 DIM (Y|N) – Mastitis, Metritis, and RP
  - DIM at transfer to Site2 (linear and squared terms)
  - DIM at test (linear and LN terms)
  - Days pregnant
  - Days pregnant x DIM interaction – allows slope to vary by pregnant status

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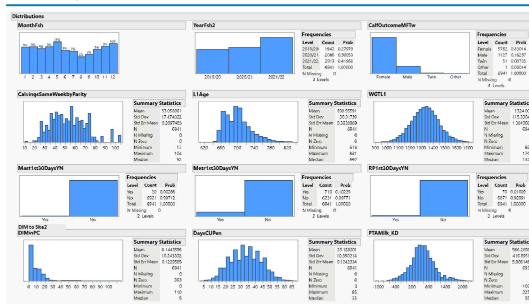
7

Summary statistics for various factors for Lact = 1



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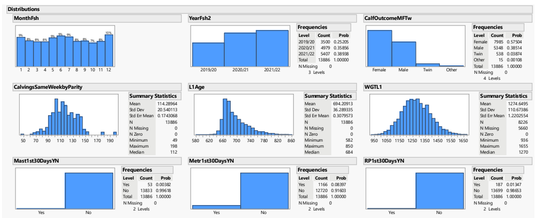
8

Summary statistics for various factors for Lact > 1



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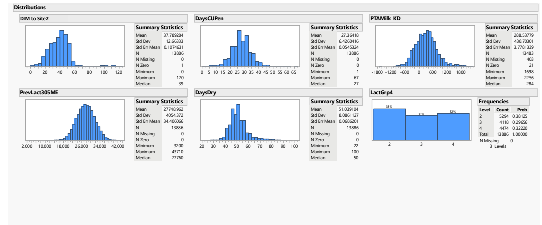
Summary statistics for various factors for Lact > 1



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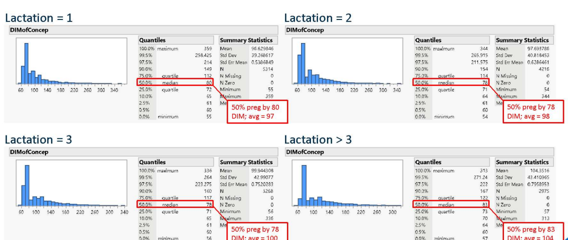
10

Distribution of DIM of conception (all filters applied, FDAT 8/1/19 – 4/30/22)



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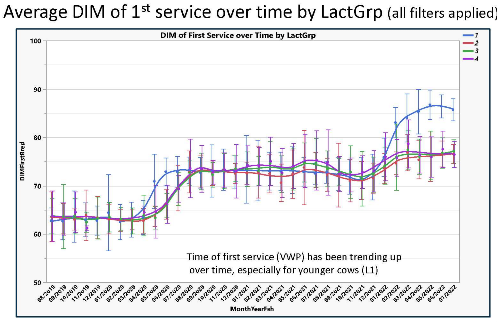
11

Average DIM of 1st service over time by LactGrp (all filters applied)



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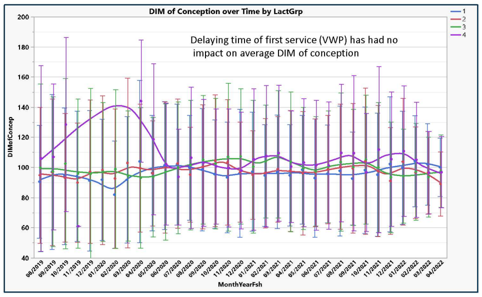
12

Average DIM of conception over time by LactGrp (all filters applied)



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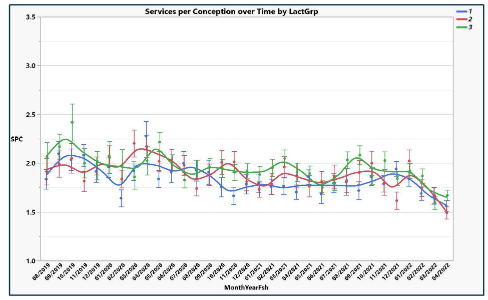
13

Average services/conception over time by LactGrp (all filters applied)



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Results

- Total of 12 models estimated:
  Three dependent variables (Milk, ECM, and Fat+Protein) x four lactation groups (L=1, L=2, L=3, and L>3) – only ECM curves shown below
- Focus of results here is on production over lactation curve (DIM 10-300) versus pregnancy status – Specifically, getting cow pregnant at 80, 110 or 140 days in milk (values can be changed)
- All variables other than day of conception are held constant at means by lactation group in figures that follow
- Models were estimated such that lactation curves are "forced" to be equal to conception and then they can "go where the data suggest" (still subject to functional form)…

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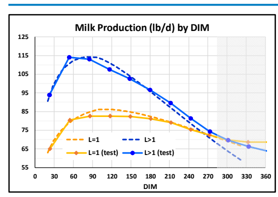
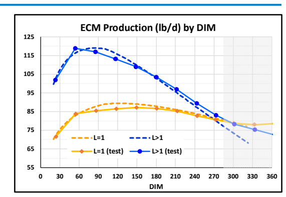
Test day average data vs Model estimated results





- Model results appear to match test day average data lactation curves quite well (remember that last two tests were not used for model estimation)
- Why go through all this hassle to estimate models?
- Having equation behind the line allows for additional analyses

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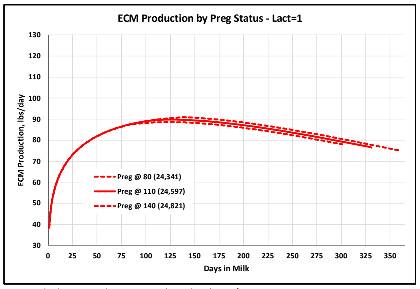
Results – ECM lactation curves for Lactation = 1*



Difference in cow becoming pregnant at 110 versus 140 DIM is 223 pounds less production from DIM 10-300 (256 lbs. less for 80 vs 110).

Time of conception dictates the length of lactation and to a lesser extent the persistency of the lactation curve.

* Values in parenthesis represent the total production from DIM 10-300

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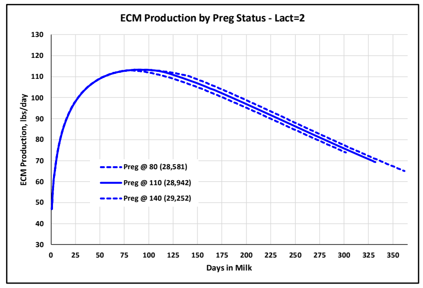
Results – ECM lactation curves for Lactation = 2*



Difference in cow becoming pregnant at 110 versus 140 DIM is 311 pounds less production from DIM 10-300 (360 lbs. less for 80 vs 110).

Time of conception dictates the length of lactation and to a lesser extent the persistency of the lactation curve.

* Values in parenthesis represent the total production from DIM 10-300

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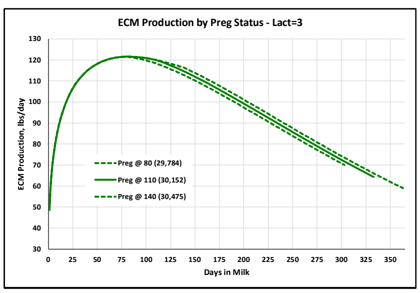
Results – ECM lactation curves for Lactation = 3*



Difference in cow becoming pregnant at 110 versus 140 DIM is 323 pounds less production from DIM 10-300 (367 lbs. less for 80 vs 110). Across 7 other herds with similar analysis, difference ranged from 137 – 590 pounds between 90 and 150 DIM).

Time of conception dictates the length of lactation and to a lesser extent the persistency of the lactation curve.

* Values in parenthesis represent the total production from DIM 10-300

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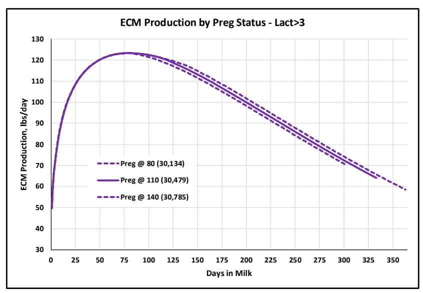
Results – ECM lactation curves for Lactation > 3*



Difference in cow becoming pregnant at 110 versus 140 DIM is 306 pounds less production from DIM 10-300 (345 lbs. less for 80 vs 110).

Time of conception dictates the length of lactation and to a lesser extent the persistency of the lactation curve.

* Values in parenthesis represent the total production from DIM 10-300

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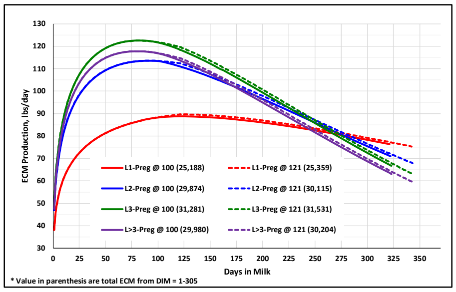
Results – ECM lactation curves by parity group



Cows conceiving 21 days later (121 DIM vs 100 DIM) will produce 171-250 pounds more milk in first 305 days due to slightly more persistent lactation curve.

Additionally, they will have a 21-day longer lactation curve.

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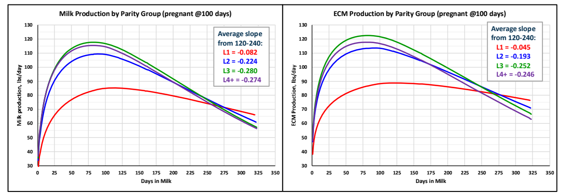
Persistency of lactation curves (conception @ 100 DIM)



- Lactation curves estimated with ECM are more persistent than those estimated with milk
- Lactations curves peak at roughly the same DIM (previous analyses of other herds has generally shown that ECM curves peak quicker than milk curves)
- This would suggest that optimal time to get cow pregnant based on MILK lactation curves likely would be equal or earlier than optimal time based on ECM lactation curves

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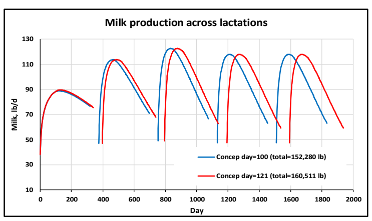
Lactation curves with different DIM of conception

- Getting a cow pregnant later in lactation will always result in more lifetime milk for that cow (all else equal), but milk/day of productive life is slightly lower. Does this comparison have any meaning/value?



If a cow makes it through 5 lactations, getting her pregnant, on average, at 121 DIM every time versus at 100 DIM would result in 8,231 additional pounds of production over her lifetime (1,941 total days vs 1,836 days). Milk/day of productive life = 82.7 for 121 DIM vs 82.9 for 100 DIM.

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Production and economic assumptions

- Production
  - Voluntary waiting period = 70
  - Gestation length = 275-278 (L1 = 275, L2 = 277, L>2 = 278)
  - Dry period = 55 days
  - Max DIM at dry off = 400
- Economic
  - Maintenance and marginal feed = 20 lb/day and 0.444 lb DM/lb of milk
  - Feed cost = $0.135/lb DM for lactating cows and $3.50/day for dry cows
  - Milk price = $18.00/cwt
  - Springer value = $2,000
  - Average calf value = $175
  - Price of cull cow = $0.60/lb
  - Fixed cost = $7.00/hd/day for lactating cow and $4.00 for dry cow
  - Interest rate = 8.0%

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What metric should be used to determine what is optimal?

- Total lifetime milk
- Milk production per day of productive life
- Income over feed costs (IOFC) – milk income minus feed costs
- Income over total costs (IOTC) – milk income minus total costs
- Net cash flow (IOTC plus include cost of springer, calf and salvage value)

- Do we need to account for the time value of money?
- Do we need to account for repeating the entire process?

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Economic model

- Calculate IOFC, IOTC, and Net cash flow for each day of 5 full lactations (including dry days)
  - Milk production is based on estimated ECM lactation curves (L4=L5=L>3 model)
  - Cow is sold for salvage value at end of fifth lactation
  - Net Present Value (NPV) is calculated for stream of income and expenses*
  - NPV for 5 lactations is then repeated into infinity

* NPV simply accounts for the "time value of money" (i.e., a dollar today is worth more than a dollar tomorrow)

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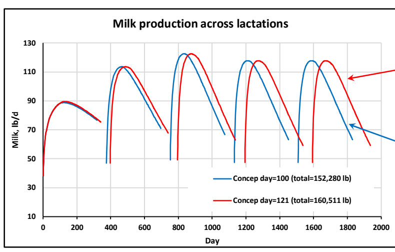
Lactation curves and economic returns versus DIM of conception



Net cash flow of 5-lactation series = $734. NPV = $96, interpretation of NPV is that you could pay $2,096 ($2000 + $96) for springer and realize an 8% rate of return (i.e., discount factor used). Repeating NPV every 1,941 days into infinity = $286.

Net cash flow of 5-lactation series = $764. NPV = $139, interpretation of NPV is that you could pay $2,139 ($2000 + $139) for springer and realize an 8% rate of return (i.e., discount factor used). Repeating NPV every 1,836 days into infinity = $433.

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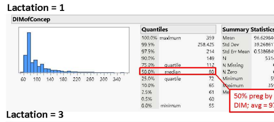
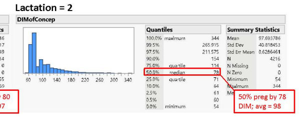
Various economic metrics based on current conception DIM

Lactation =>	1	2	3	4	5		Discount		Discount	Net		Repeat	5-lact	5-lact	Milk/day
	Optimal DIM of conception					IOFC	IOFC	IOTC	IOTC	cash flow	NPV	NPV	ECM, lbs	total days	prod life
Current average	**97**	**98**	**100**	**104**	**104**	**$13,149**	**$10,863**	**$951**	**$750**	**$756**	**$133**	**$415**	**152,452**	**1,839**	**82.90**
Average +21 days	118	119	121	125	125	$13,851	$11,338	$918	$726	$723	$89	$265	160,664	1,944	82.65
Current median	80	78	78	83	83	$12,440	$10,371	$949	$748	$754	$150	$490	144,274	1,738	83.01

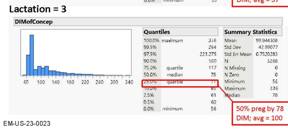
Lactation = 1



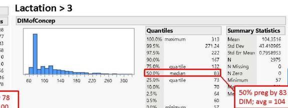
Lactation = 2



Lactation = 3



Lactation > 3



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Economic model

- Calculate IOFC, IOTC, and Net cash flow for each day of 5 full lactations (including dry days)
  - Milk production is based on estimated ECM lactation curves (L4=L5=L>3 model)
  - Cow is sold for salvage value at end of fifth lactation
  - Net Present Value (NPV) is calculated for stream of income and expenses*
  - NPV for 5 lactations is then repeated into infinity
- Various economic metrics are "maximized" using Solver by choosing conception DIM (i.e., this assumes a cow becomes pregnant when she is bred)
- Constraints for Solver (by lactation)
  - Conception DIM <= Latest DIM of conception (Latest DIM at dry off – (Gestation length – Dry period))
  - Conception DIM = Integer
  - Conception DIM >= VWP
- Solver gets "close" but isn't perfect (manually iterated to find max value)

* NPV simply accounts for the "time value of money" (i.e., a dollar today is worth more than a dollar tomorrow)

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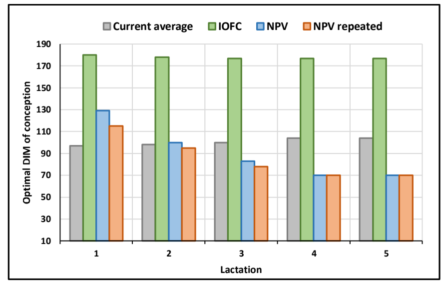
Summary of optimal DIM of conception vs economic metric



When total costs and income (value of springer, calf and cull cow) are included, along with the time value of money, what is optimal changes considerably. In a "perfect world" dairy could delay breeding slightly on first lactation cows, but they should get mature cows (L3+) pregnant faster.

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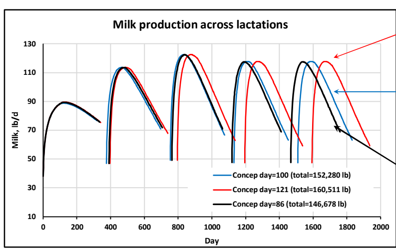
Economics of optimal breeding day in milk



Net cash flow of 5-lactation series = $734. NPV = $96, interpretation of NPV is that you could pay $2,096 ($2000 + $96) for springer and realize an 8% rate of return (i.e., discount factor used). Repeating NPV every 1,941 days into infinity = $286.

Net cash flow of 5-lactation series = $764. NPV = $139, interpretation of NPV is that you could pay $2,139 ($2000 + $139) for springer and realize an 8% rate of return (i.e., discount factor used). Repeating NPV every 1,836 days into infinity = $433.

Net cash flow of 5-lactation series = $791. NPV = $167 with Conception days of 115 for L1, 95 for L2, 78 for L3 and 70 for L4-L5. Repeating NPV every 1,764 days into infinity = $539.

Delaying when cows get pregnant increases milk, but makes all economic measures shown here (net cash flow, NPV, and repeated NPV) worse.

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Optimal conception DIM depends upon economic metric used

Lactation =>	1	2	3	4	5	IOFC	Discount IOFC	IOTC	Discount IOTC	Net cash flow	NPV	Repeat NPV	5-lact ECM, lbs	5-lact total days	Milk/day prod life
	Optimal DIM of conception														
Current average	97	98	100	104	104	$13,149	$10,863	$951	$750	$756	$133	$415	152,452	1,839	82.90
Average +21 days	118	119	121	125	125	$13,851	$11,338	$918	$726	$723	$89	$265	160,664	1,944	82.65
Current median	80	78	78	83	83	$12,440	$10,371	$949	$748	$754	$150	$490	144,274	1,738	83.01
Objective to Maximize															
IOFC	180	178	177	177	177	$15,564	$12,437	$664	$541	$469	-$148	-$396	181,264	2,225	81.47
Discounted IOFC	180	178	177	177	177	$15,564	$12,437	$664	$541	$469	-$148	-$396	181,264	2,225	81.47
IOTC	180	119	96	70	70	$13,436	$11,063	$1,014	$789	$819	$157	$482	155,563	1,871	83.14
Discounted IOTC	174	115	94	70	70	$13,351	$11,006	$1,013	$789	$818	$160	$494	154,585	1,859	83.15
Net cash flow (NCF)	180	119	96	70	70	$13,436	$11,063	$1,014	$789	$819	$157	$482	155,563	1,871	83.14
Net Present Value*	129	100	83	70	70	$12,837	$10,652	$996	$781	$801	$168	$536	148,701	1,788	83.17
NPV repeated	115	95	78	70	70	$12,659	$10,527	$986	$774	$791	$167	$539	146,678	1,764	83.15

* As defined here, Net Present Value (NPV) is the same as Discounted NCF

- IOFC – poorest metric as it ignores opportunity value of stall (delay breeding)
- IOTC and Net cash flow – better than IOFC, but does not account for time value of money
- Discounted Net CF (NPV) – good metric, but ignores that process can be repeated
- NPV repeated – most appropriate metric for an on-going business – max returns to stall vs cow
- With exception of IOFC, early conception for L>1 is generally better

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Summary

- Determining the optimal time to breed cows is complex and depends upon many factors
  - Reproductive efficiency
  - Injury risk
  - Transition risk
  - Shape of lactation curves by parity – peak and persistency
  - Economic factors (prices, costs)
- Given shape of lactation curves estimated here (energy-corrected milk), it appears that delaying breeding is not warranted (with exception of primiparous cows) as optimal DIM was generally earlier than current average. However, it does depend upon which metric is used.

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Transition Risk (only filter applied is fresh date)

Early Removals by Lactation Group (FDAT 8/1/2019 - 7/31/2022)

	Removed in first 30 DIM*				Removed in first 60 DIM*			
Lact Grp	Yes	No	Total	% Yes	Yes	No	Total	% Yes
1	56	6,969	7,025	0.8%	142	6,883	7,025	2.0%
2	24	5,589	5,613	0.4%	79	5,534	5,613	1.4%
3	43	4,350	4,393	1.0%	108	4,285	4,393	2.5%
4	72	5,459	5,531	1.3%	173	5,358	5,531	3.1%

* Excludes Sold for Dairy

Is this risk high enough to impact breeding decisions?

	Conception DIM by Lactation						Discount		Discount	Net	Disc (NPV)	Repeat	5-lact	5-lact	Milk/day
	1	2	3	4	5	IOFC	IOFC	IOTC	IOTC	cashflow	Net CF	NPV	ECM, lbs	total days	prod life
Net cashflow	176	113	92	86	86	$13,978	$11,468	$1,393	$1,078	$1,198	$444	$1,354	160,439	1,890	84.89
Discounted Net CF*	128	91	76	75	79	$13,225	$10,956	$1,368	$1,069	$1,173	$458	$1,462	151,828	1,786	85.01
NPV repeated	85	77	70	70	70	$12,647	$10,552	$1,329	$1,044	$1,134	$451	$1,492	145,277	1,709	85.01
Optimal including transition risk															
Net cashflow	176	113	92	86	86					$882	$213	$389	160,439	1,890	84.89
Discounted Net CF*	135	93	78	75	79					$862	$224	$442	152,755	1,797	85.01
NPV repeated	118	87	72	70	71					$847	$222	$447	149,224	1,755	85.03

* Also referred to as NPV (Net Present Value)

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Thank You

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