Where Does the Time Go? Time Budgets and Cow Comfort Economics

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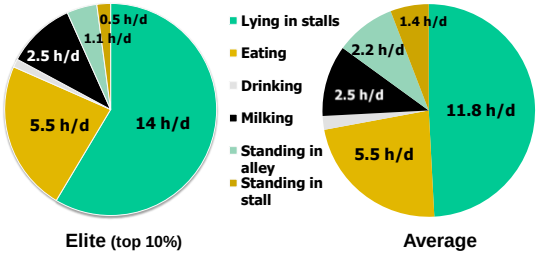
Time Budget: What does a cow need to do each 24 hours?

Typical time budget of dairy cow (free-stall environment)

- 5.0 h/d eating
- 12-14 h/d lying (resting)
- 2.0-3.0 h/d standing, walking, grooming, agonistic, idling
- 0.5 h/d drinking
- 20.5 to 21.5 h/d total needed
- 2.5 to 3.5 h "milking" = 24 h/d

Lame cows — Healthy cows

Average versus "elite" cows
(Matzke and Grant, 2003)



Elite (top 10%) Average

Question…

How often do we take advantage of natural cow behavior versus *simply taking advantage of the cow?*

Cow Comfort Economics

- With continuing volatility in feed and milk prices, we need to sharpen our focus on the ***consistent economic benefits of improved cow comfort.***
- ***Modest investments*** in housing, or changes in cow management routines, can pay ***large dividends*** in greater cow health and performance.

How much does it cost …

- To ensure feed availability 24/7?
- To keep "time outside pen" less than 3.5 h/d?
- To lock cows in headlocks less than 1 h/d?
- To remove some cows from a pen to reduce overcrowding?
- To group first-calf heifers separately from older cows?
- To be gentle, calm, and considerate?

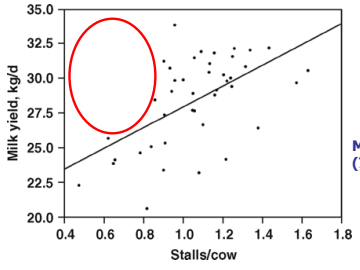
Will this management environment affect response to diet?

How about this environment?
Non-uniformity of feed delivery

Importance of management environment (Bach et al., 2008)

- 47 herds with similar genetics were fed same TMR
- Mean milk yield=65 lb/d
  - Range: 45 to 74 lb/d
- Non-dietary factors accounted for <u>56%</u> of variation in milk yield
  - Feeding for refusals (64.1 vs 60.6 lb/d)
  - Feed push-ups (63.7 vs 55.0 lb/d)
  - Stalls per cow

Stalls per cow and milk production in 47 herds fed same TMR (Bach et al., 2008)



Milk yield = 20.4 + (7.5 x stall/cow)

R^2=0.32

Stall stocking density and herd milk production (Bach et al., 2008)

	<80%	80 - 100%	100 - 120%	>120%
Milk yield, lb/d	68.1	64.3	64.4	52.7
Standard dev.	±3.3	±6.4	±8.1	±5.1

➢ What are the economics associated with losing 12 lb/d of milk?

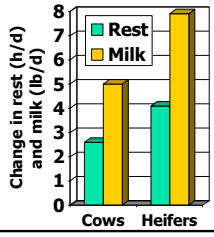
For cows, time is money …

Common ways to disturb time budgets on-farm …

- Excessive time outside pen
- Mixing of primi- and multiparous cows
- >1 h/d in headlocks, esp. fresh cows
- Short pen stays during transition – social turmoil
- Inadequate exercise – tie stalls
- Uncomfortable stalls
- Inadequate feed availability
- Overcrowding, excessive competition
- Inadequate heat stress abatement

Time away from pen and access to resources: do time budgets really matter?

- **3 vs 6 h/d outside pen**
  - Adjusted pen size versus parlor capacity
  - Mixed primi- and multiparous cows
  - 100% stocking density
  - 14-d periods



➢Economics of 5 to 8 lb/d more milk?

(Matzke, 2003)

Measured time outside of pen (von Keyserlingk et al., 2012)

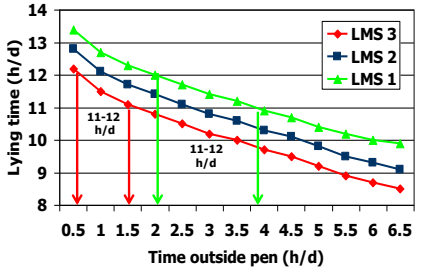
- Time away from the pen in 40 Northeastern and 39 Western US dairy herds:
  - Average: 4.8, 3.9 h/d
  - Range: 3.0 to 7.7 h/d
    2.3 to 7.7 h/d

Time Budgets and Lameness

Prevalence of lameness in high producing cows
(Espejo and Endres, 2007)

- 53 high-production pens on 50 dairy farms
- Greater lameness prevalence most highly associated with
  - Greater time outside the pen
  - Constrained access to resources
  - Time budgeting!

Lameness, Resting Requirement, and Time Outside the Pen (Gomez and Cook, 2010)



Lame versus sound cows
(Hill et al., 2006)

	100%	113%	131%	142%
Sound - lame				
Milk, lb/d	-9.4	+1.9	+16.7	+13.9

- Milk losses reflect reductions in resting and rumination activity.
- Economics of 11 to 26 lb/d less milk?

Payback on comfort can be quick
(1 to 5 scale; Hernandez-Mendo et al., 2007)

- Gait score improved 0.22 units per week for cows kept continuously on pasture for 4 weeks versus free-stall

- Pasture/exercise lot?
- Sand stalls?
- Deeper bedded mattresses?

TIME BUDGET EVALUATOR

Farm Name:	AI Dairy		
Date:	25-Feb-10		
Group of cows:	High cows		

	Activity	Time (h)	Time Remaining (h) 24-h day	"Standard " Time for Activities (h)				
1. Time Away From Pen								
	Milking[1]	5.2	18.8					
	Treatment[2]	0.8	18.0					
2. Behaviors in the Pen[3]								
	Eating	5	13.0	5.2				
	Drinking	0.5	13.3	0.5				
	Standing & Other[3]	3.0	10.3	3.0				
3. Adjustment to Standing for Stocking Rate								
Enter cows in pen	100							
Enter number of useable stalls:	100							
Stocking rate (%)	100%							
Adjusted standing time (h)	3		10.3	Standing time increases above ~20% stock rate				
4. Resting (Lying) Time Available			10.3					
5. Adjustment to Resting (h) for Stocking Rate			10.3	Lying time reduced above 120% stocking rate				
			Average Cow	Elite Cow				
6. Resting Requirement (h/day)			11.5	11.5	"Elite" cows are top-10% by milk yield.			
7. Resting Required - Resting Time Provided (h)			1.2	0.2				

Impact of Resting Activity:

	Average cow	Elite Cow	
Milk loss min	-2.1	-4.2	pounds milk/cow/day
Milk loss max	-5.3	-11.2	pounds milk/cow/day
Energy value	-0.53	-2.11	Mcal NEL/cow/day
Energy value loss	-0.36	-1.45	Mcal/cow/day
Body condition loss	-0.30	-0.70	Score change in 100 days

[1]Enter time spent in transit to parlor, holding area, in parlor being milked, and time to travel back to pen.
[2]Time spent at management rail or elsewhere outside of pen.
[3]Enter times measured for your herd for eating and drinking, or use "standard" measures in column at right.
[4]Includes standing in alleys/stalls, grooming, fighting, estrous activity, idling, etc.

Stocking Rate (SR) and Milk Loss - Primiparous Grouped with Multiparous Cows:

Note: milk loss expressed as difference between multi- and primiparous cows

<120% SR	0 lb/d	For SR<120%, no loss in milk yield expected.
120-130% SR	Check other SR	Expect loss of 7.7 lb/d for prim versus multiparous cows.
130-140% SR	Check other SR	Expect loss of 14.9 lb/d for prim versus multiparous cows.
>140% SR	Check other SR	Expect loss of 8.8 lb/d for prim versus multiparous cows. At 140% SR, milk yield of both multi and primiparous cows declines.

Stocking Rate (SR) and Milk Loss - Lame versus Healthy Cows[4]

Note: milk loss expressed as difference between healthy (locomotion score 1 and 2) and lame cows (score 3 and 4).

<120% SR	0 lb/d	For SR<120%, no loss in milk yield expected.
120-130% SR	Check other SR	Expect loss of 2 to 11 lb/d for lame versus healthy cows in mixed groups.
130-140% SR	Check other SR	Expect loss of 16 to 26 lb/d for lame versus healthy cows in mixed groups.
>140% SR	Check other SR	Expect loss of 14 to 23 lb/d for lame versus healthy cows in mixed groups.

[1]Milk yield loss for primi and multiparous, lame and nonlame cows predicted from Hill (2006).

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Heifers Need Their Space…

Time Budget Behaviors: Primi- versus Multiparous Cows

- **Numerous natural behavioral differences**
- **Heifers take smaller bites, eat more slowly, spend more time feeding**
- **Heifers typically less dominant, more easily displaced from manger, stalls, and water**
- **Heifers avoid stalls previously occupied by dominant cows and ruminate up to 40% less**

Effect of competition with older cows on first-calf heifers . . .

- DMI reduced by 10%
- Resting reduced by 20%
- Milk reduced by 9% (Kongaard and Krohn, 1980)
- Greater loss of BW by 30 DIM
- Reduced FCM/DMI by 30 DIM (Bach et al., 2006)
- Less drinking, rumination, and milk fat % (Bach et al., 2007)
- Separate pens for 1 month after calving increased milk yield by 506 lb per 305-d lactation and lower ketosis for primiparous cows (Ostergaard et al., 2010)

Rumination by primiparous cows in preferred/less preferred stalls
(Krawczel, 2007)

	Preferred	Less preferred	*P*-value
Rumination time, min/d	81.4	147.8	0.09
% resting time spent ruminating	35.2	58.4	0.05

➢Long-term implications?

Primi- versus multiparous cows and stocking density
(Hill et al., 2008)

	100%	113%	131%	142%
Multi - primi				
Milk, lb/d	+5.9	+13.8	+21.1	+14.9

➢Milk losses reflect reductions in resting and rumination activity
➢Economics of losing 8 to 15 lb/d of milk?
➢$1.58 lost income at only 113% stocking rate!

Question: Which is more important - eating or resting?

Resting influences feeding behavior

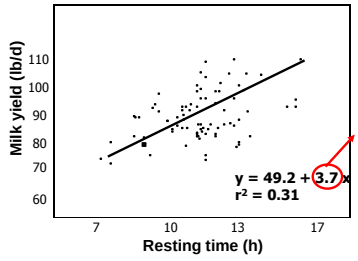
- Lying time has priority over eating
- Cows will sacrifice eating time to compensate for lost resting time
- With chronic rest deprivation
  - For every 3.5 min of lost rest, cows sacrifice 1 min of eating

(Metz, 1985; Hopster et al., 2002; Munsgaard et al., 2005; Cooper et al., 2007)

Lying deprivation and cow welfare, stress level

- Increased cortisol response
- Reduced growth hormone, reduced milk yield (Munksgaard and Simonsen, 1996)
- Less blood flow to mammary gland and gravid uterine horn
- Reduced feeding time, reduced rumination, increased standing
- Predisposes cows to sole hemorrhages, lameness

Relationship between resting and milk yield (Miner Institute data base)



➢Increased resting time with greater DIM, milk yield (Bach et al., 2010)

~3.7 lb/d more milk for each extra hour

2 to 3.5 lb/cow

(Grant, 2005)

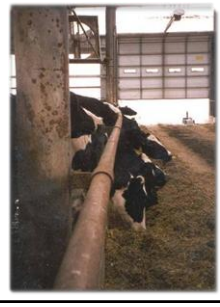
Economics of stall renovation: five case studies (Cummins et al., 2005; Cook, 2006)

Softer beds, larger stalls	• 48 to 54 in wide • 70 in long • 50 in neck rail height
Payback on investment	• 0.5 to 3 years (average 1.9 years)
Economic benefits:	• Greater milk (3 to 14 lb/d) • Lower turnover rates (-6 to -13%) • Lower SCC (-37,000 to -102,000) • Less lameness (-15 to -20%)

Cows naturally have aggressive feeding drive …

- Cows willingly exert >500-lb pressure against feed barrier while eating
  - 225 lb causes tissue damage
- Defines "aggressive feeding drive"
- Tie and free stalls

(Hansen and Pallesen, 1999)



What Naturally Stimulates Feeding Behavior?

- Delivery of fresh feed
- Feed push-up
  - More important during the day rather than at night (DeVries et al., 2005)
- Milking

- **Biggest driver of feeding is delivery of fresh feed**

1x versus 2x TMR feeding
(Sova et al., 2013)

- Twice versus once daily feeding:
  - More feed availability throughout day
  - Less sorting against long particles
  - Increased DMI by 3.0 lb/d, milk by 4.4 lb/d
- **Overall improvement in efficiency**
- Greater feeding frequency:
  - Improved rumen fermentation
  - Greater rumination
  - Greater eating time

Feeding frequency greater than 2x/day?

Reference	FF /d	Eating time %	DMI %	Milk %	Rest %
DeVries et al. (2005)	1 vs 2x 2 vs 4x	+3.5 +4.6	-2.0 -3.0	NR NR	-0.8 0
Mantysaari et al. (2006)	1 vs 5x	+ 7.0	-4.8	-1.0	-12.1
Phillips and Rind (2001)	1 vs 4x	+11.0	-6.3	-4.7	-8.6
Nikkhah et al. (2011)	1 vs 4x	NS	-5.2	-2.5	NS

Increased TMR feeding frequency improves efficiency: Is it desirable long-term?

Feed push-up (Armstrong et al., 2008)

- 1 to 2 hours post-feeding is most competitive; most displacements
- Push-up each ½ hour for first 2 hours versus once per hour

Item	1x/h	2x/h
DMI, lb/d	41.4	40.1
Milk, lb/d	61.3[b]	65.3[a]
Milk/DMI, lb/lb	1.48[b]	1.63[a]

Effect of empty-bunk time

(Matzke and Grant, 2003)

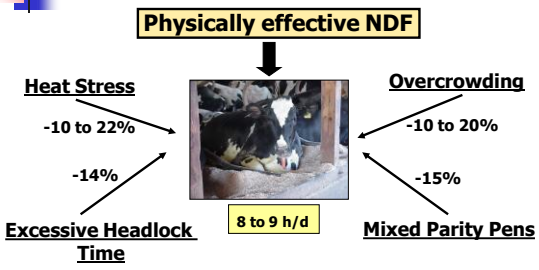
Compared 0 vs 6 h/d functionally empty bunk (midnight to 6:00 am)

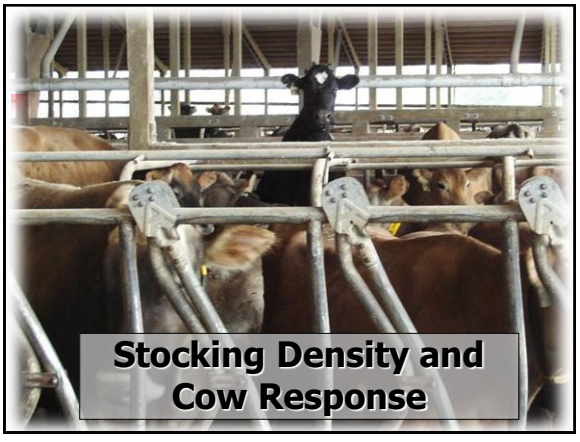
- +7.9 lb/d milk yield
- 1.8x greater lying in stalls
- 2x greater feeding at bunk
- Less restless

Ideal feeding management?

- 3% refusal target
- TMR fed 2x/day
- ½-hr push-ups for 2 hours post-feeding
- Consistent feed quality/quantity along the bunk
- Bunk empty <3 h/d
- Bunk stocking density ≤100%

Ruminating Behavior and Management Environment





What is optimal stocking density?

- Close-up and fresh: ≤80% of bunk space (30 in/cow)
  - Also a function of stall availability
- Lactating cows
  - 4-row barn: don't exceed 115-120% of stalls
    - Mixed heifer & older cows: 100%
  - 6-row barn: 100% of stalls?
- Ensure access to feed, water, stalls

Challenge: How do we effectively accommodate individual cow behavioral needs while managing them in a group?

Feed bunk space affects where cows choose to eat

(Rioja-Lang et al., 2012)

- Compared 30, 24, 18, and 12 inches of bunk space and preference for a
  - low-palatability feed alone
  - high-palatability feed next to a dominant cow
- Y-maze testing to offer choices

Space (in)	HPF Dominant	Equal choice	LPF Alone	*P*
12	0	1	11	<0.001
18	1	3	8	<0.05
24	3	4	5	>0.05
30	5	2	5	>0.05

Bottom Line: Time Budgets and Cow Comfort Economics

- Herds with similar genetics fed the same diet differ in milk by 29 lb/day!
- Meeting time budget behavioral needs and improving cow comfort enhances herd profitability.

Listen to your cows -- Focus on natural behaviors

Thank you