Stocking Density and the Feeding Environment

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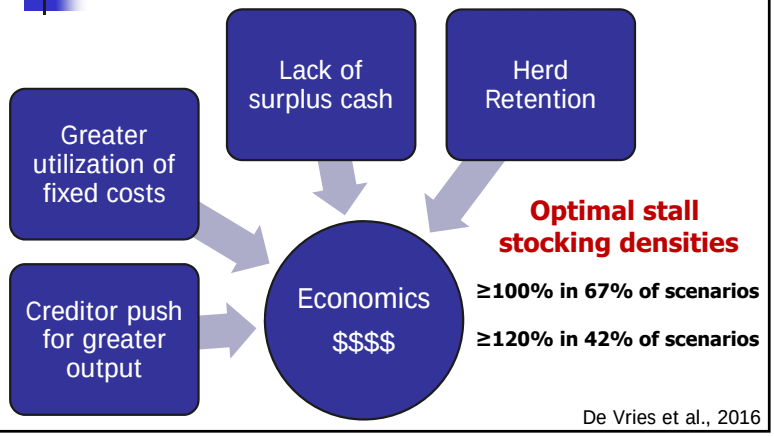
Economics Driving Overstocking



De Vries et al., 2016

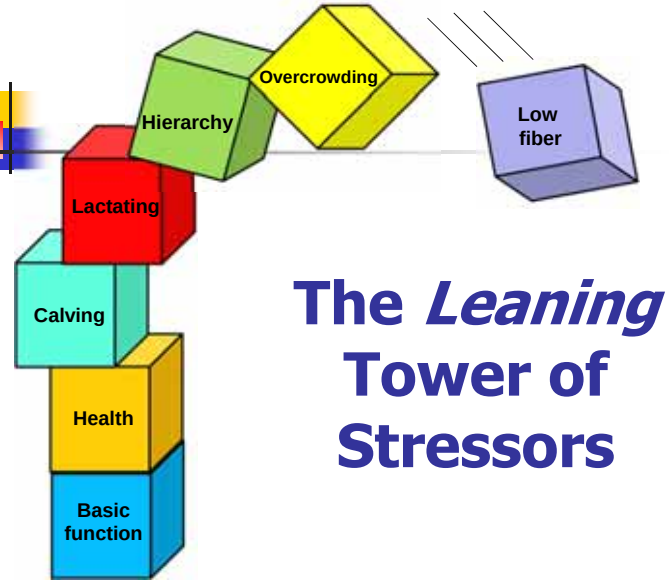
Overcrowding Consistently Compromises Well-Being

Changes in these behaviors

- Greater aggression
- Greater feeding rate
- Reduced resting time
- Increased idle standing
- Decreased rumination

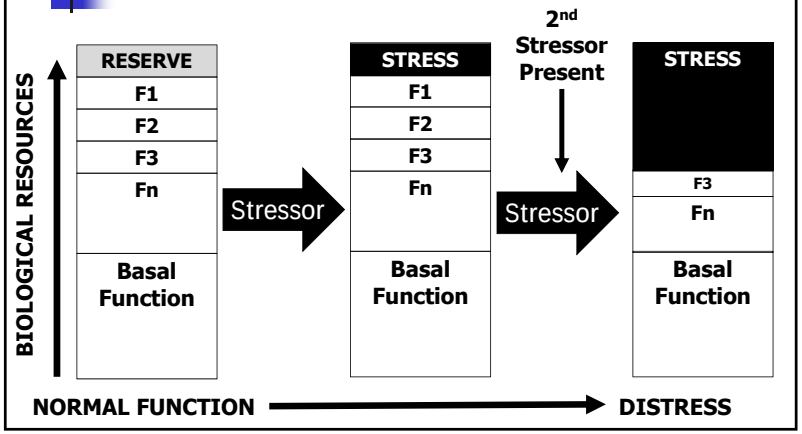
Results in these responses

- Less milk
- Lower milk fat
- Greater SCC
- More health disorders
- Increased lameness
- Fewer cows pregnant

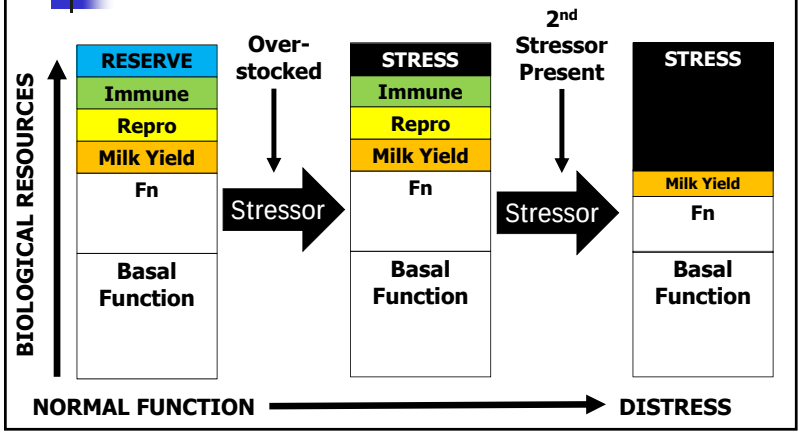


The *Leaning* Tower of Stressors

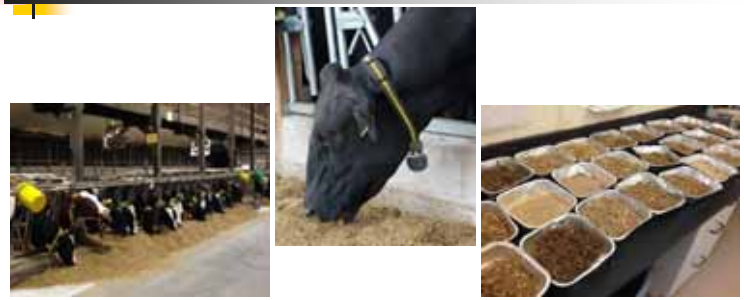
Sub-Clinical Stress of Overstocking (Moberg, 2000)



Sub-Clinical Stress of Overstocking (Moberg, 2000)



What happens when the feeding environment becomes the second stressor?



Feeding Optimal Fiber

Risk of SARA:	Increased	Marginal	Low
NDF, % of DM	25	28 - 32	35
Forage NDF, % of DM	16	20 - 25	27
peNDF, % of DM	18	21 - 23	25
Ruminal pH	< 5.6	5.8	> 6.4

Stone, 2004; Zebeli et al., 2006

Interaction Between Factors

- Higher stocking densities negatively affect feeding and resting behavior.
- Higher forage, higher peNDF diets can lead to more normal feeding behavior and increased rumination.
- What effect does the feeding environment have on the cow in an overstocked scenario?

Determination of Treatments

- **Stocking Density**
  - Values at two ends of spectrum seen in industry
  - 100% as control vs 142% as upper limit
  - Restricted access at both headlocks and free-stalls

Determination of Treatments

- **Source of Forage Fiber**
  - Based on preliminary research
  - Associated with the risk of SARA
    - No straw, lower peNDF – higher risk
    - Straw, higher peNDF – lower risk

Ration Formulation

Item	No straw (NS)	Straw (S)
Ingredients, % of ration DM		
Corn silage	39.7	39.7
Haycrop silage	6.9	2.3
Wheat straw, chopped	––	3.5
Citrus pulp, dry	4.8	4.8
Whole cottonseed, fuzzy	3.5	3.5
Soybean meal, 47.5% CP solv.	––	1.1
Molasses	3.2	3.2
Concentrate mix	41.9	41.9

Chemical Composition and Digestibility

Item (% of DM)	NS	S	SEM
CP	15.0	15.1	0.3
NDF	30.8	30.1	0.4
ADL	3.8	3.8	0.1
Starch	25.0	25.5	0.5
Sugar	7.4	8.1	0.4
Ether Extract	5.9	5.7	0.1
7-h starch digestibility, % of starch	73.3	74.3	0.9
Physically effective $NDF_{1.18\ mm}$	23.9	25.9	0.7
30-h $uNDF_{om}$	13.1	14.9	0.3
240-h $uNDF_{om}$	8.5	9.7	0.2

Ruminal pH

	100%		142%			*P* - value		
	NS	S	NS	S	SEM	STKD	DIET	STKD x Diet
Mean pH	6.17	6.13	6.09	6.10	0.03	0.07	0.62	0.39
pH < 5.8, h/d	2.29	1.90	4.12	2.77	0.41	<0.01	0.01	0.10
AUC < 5.8, pH units x h/d	0.38	0.19	0.58	0.34	0.10	0.06	0.03	0.75

3-5 hours - Concern for risk of SARA > 5 hours - High risk of SARA

Ruminal pH – Time < pH 5.8

100%	142%	Straw	No Straw
2.1 h	3.5 h	2.3 h	3.2 h
1.4 h difference		0.9 h difference	

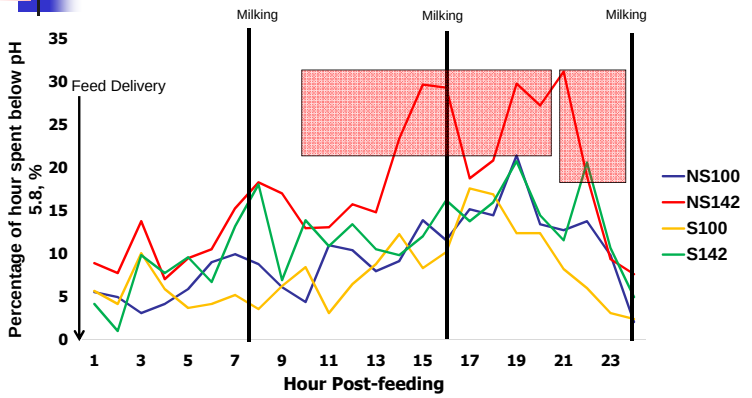
- Greater contribution to SARA from overstocking than dietary treatment.

Ruminal pH – Time < pH 5.8

Adding straw at 100%	Adding straw at 142%
0.4 h difference	1.4 h difference

- Reductions in SARA at both levels of stocking density.
- Greater benefit at higher stocking density.

SARA – Daily Distribution



Ingestive Behavior

	100%		142%			*P* - value		
	NS	S	NS	S	SEM	STKD	Diet	STKD x Diet
Intake, kg DM/cow	25.4	25.3	25.3	25.2	0.4	0.78	0.69	0.87
NDF intake, kg/d	7.5	8.3	7.2	8.0	0.3	0.23	<0.01	0.91
peNDF intake, kg/d	6.2	6.8	6.0	6.6	0.3	0.42	0.02	0.95
$uNDF_{om}240$, kg/d	2.20	2.47	2.09	2.49	0.08	0.47	<0.01	0.32

Similar DM intake, but greater peNDF/uNDF intake

Ingestive/Chewing Behavior

	100%		142%			*P* - value		
	NS	S	NS	S	SEM	STKD	Diet	STKD x Diet
Eating time, min/d	233	237	242	241	4	0.13	0.76	0.48
Rumination time, min/d	498	491	489	496	9	0.72	0.96	0.19
Eating bouts, bouts/d	6.8	6.7	7.0	6.9	0.1	0.60	0.11	0.64
Eating latency for fresh feed, min	20	28	39	40	4	0.02	0.35	0.46

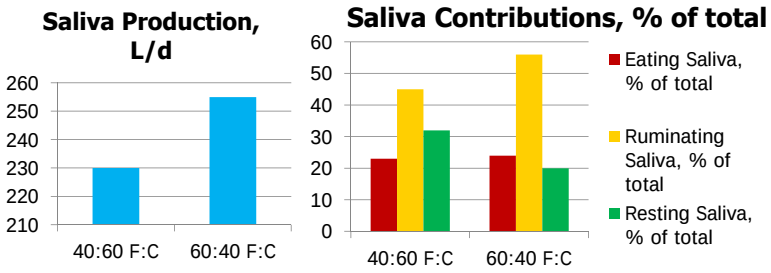
If eating and rumination time haven't changed, where is the buffering potential coming from?

Ruminal pH

	100%		142%			*P* - value		
	NS	S	NS	S	SEM	STKD	DIET	STKD x Diet
Mean pH	6.17	6.13	6.09	6.10	0.03	0.07	0.62	0.39
pH < 5.8, h/d	2.29	1.90	4.12	2.77	0.41	<0.01	0.01	0.10
AUC < 5.8, pH units x h/d	0.38	0.19	0.58	0.34	0.10	0.06	0.03	0.75

3-5 hours - Concern for risk of SARA **> 5 hours - High risk of SARA**

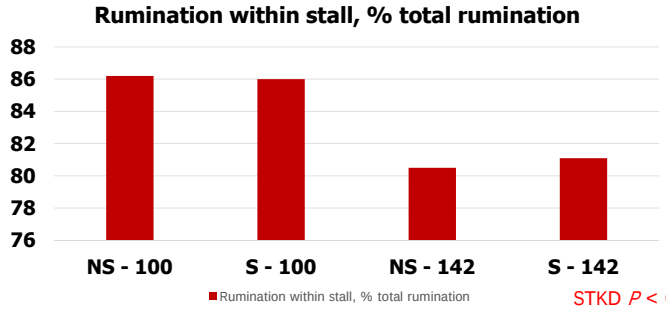
Saliva Production – Chewing Matters



Straw (extra peNDF/uNDF) may have added greater saliva production during rumination and eating although total time remained the same.

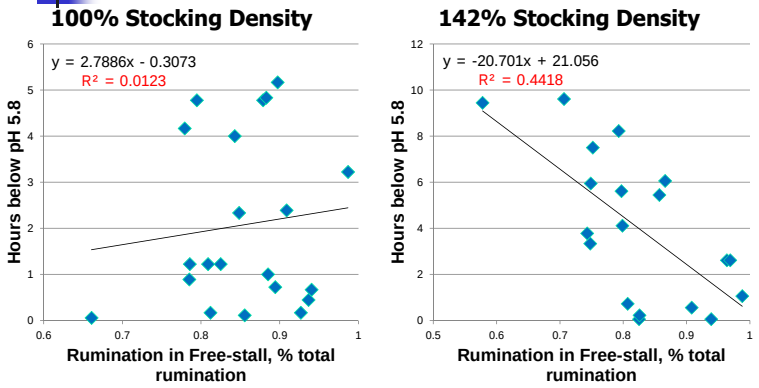
Maekawa et al., 2002

Where does the buffering come from with stocking density?

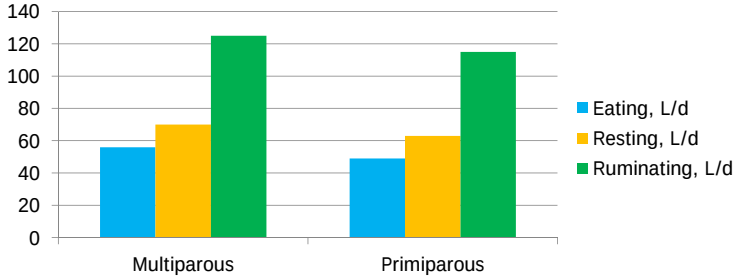


Could there be different rates of saliva production based on where rumination occurs?

Location of rumination vs. ruminal pH



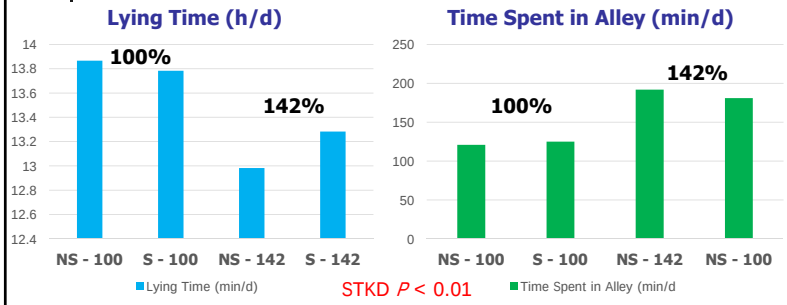
Saliva Production – Resting is Key



- **Resting and rumination contribute significantly to buffer production.**
- **Likely the combination will contribute the greatest buffer.**
- **Primiparous cows will likely be more susceptible to overstocking.**

Maekawa et al., 2002

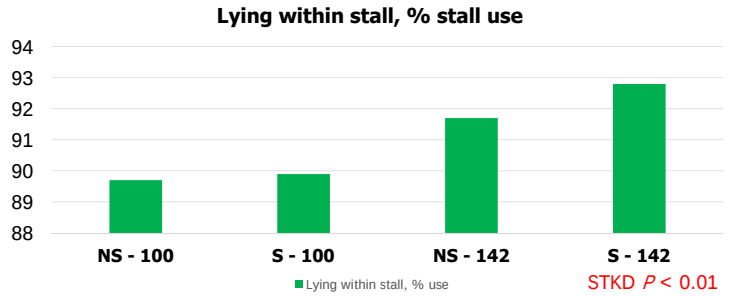
Importance of that free-stall



STKD $P < 0.01$

Overstocking significantly reduced lying time and increased idle standing time in alley

When the going is good, the cows get going



STKD $P < 0.01$

Greater stall-use efficiency at higher stocking densities

How else can the feeding environment serve as a secondary stressor?

Determination of Treatments

- **Stocking Density**
  - Values at two ends of spectrum seen in industry
  - 100% as control vs 142% as upper limit
  - Restricted access at both headlocks and free-stalls

Determination of Treatments

Stocking Density

Feed Access

- **Feed Access**
  - Represent typical feeding practices seen in industry
    - Feeding for 0% refusals
    - Lack of feed push-up early morning
  - 0 h restriction as control, 5 hours restriction as upper limit
  - Removal of feed from feed bunk

Ruminal pH

	100%		142%			*P* - value		
	NR	R	NR	R	SEM	STKD	FR	STKD x FR
Mean pH	5.96	6.03	5.98	5.89	0.06	0.14	0.80	0.08
pH < 5.8, h/d	6.62	5.23	6.78	8.77	1.27	0.02	0.49	0.02
AUC < 5.8, pH units x h/d	1.66	1.24	1.73	2.55	0.63	0.09	0.52	0.11

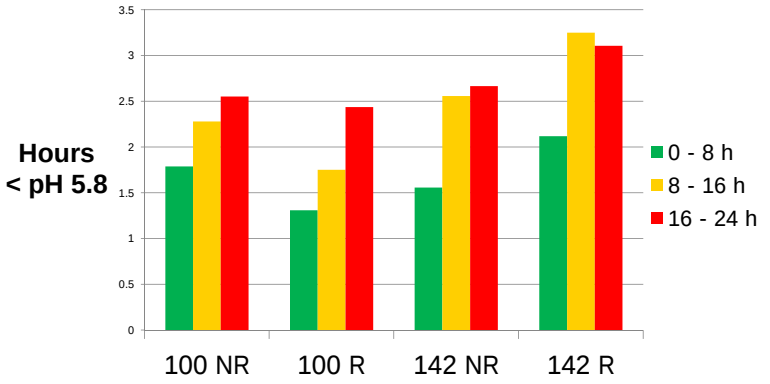
3-5 hours - Concern for risk of SARA > 5 hours - High risk of SARA

Ruminal pH – Time < pH 5.8

100%	vs.	142%	NR	vs.	R
5.9 h		7.8 h	6.7 h		7.0 h
1.9 h difference			0.3 h difference		

- Greater contribution to SARA from overstocking than restriction treatment.
- 6x more SARA risk with overstocking.

SARA builds throughout day

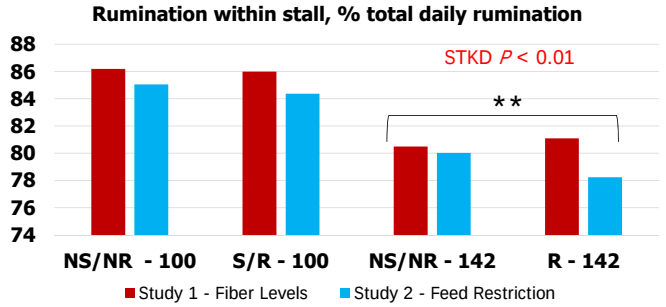


Ingestive Behavior

	100%		142%			*P* - value		
	NR	R	NR	R	SEM	STKD	FR	STKD x FR
Intake, kg DM/cow	25.7	25.4	25.7	26.0	0.6	0.56	0.93	0.54
Eating time, min/d	230	222	227	219	5.8	0.08	<0.01	0.96
Rumination time, min/d	510	524	519	517	8.8	0.90	0.43	0.31

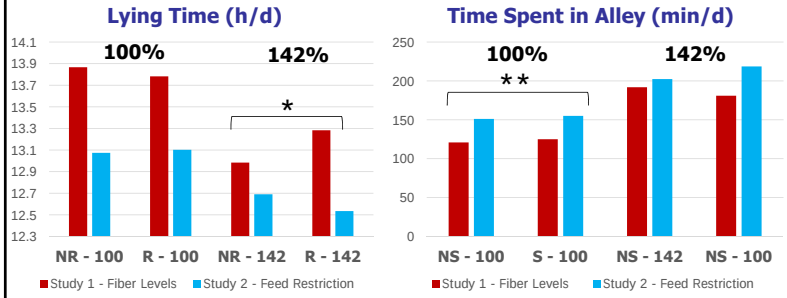
-Lower eating time for feed restriction, but we did not see pH effect
-Similar eating and rumination times for both stocking densities, where did buffer come from?

Overstocking inhibits adequate buffering potential



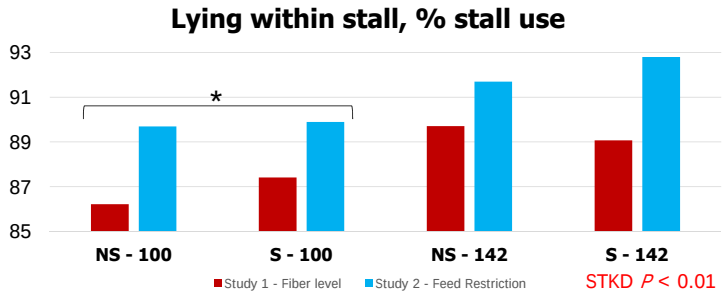
Similar responses among studies.
Less cow comfort during large bouts of buffer production.

Lying/Standing Behavior



Overstocking significantly reduced lying time and increased idle standing time in alley

Stall-Use Efficiency



Greater stall-use efficiency at higher stocking densities

How else can the feeding environment serve as a secondary stressor?



Piecing It All Together

- Higher stocking density and marginal fiber negatively affect ruminal pH; greater contribution from stocking density.
- Increasing dietary peNDF/uNDF helps to maintain ruminal pH, especially when overcrowded.
- Reduced feed access exacerbates the negative effects of high stocking density.
- With high stocking density, pH is low throughout day, but effect is greatest at night
  - Management implications?

Implications

- Don't feed marginal fiber on overstocked farms or when feeding for low refusals
  - Less lying, less buffer production at high stocking density
  - Possibility to adjust fiber content with two separate feedings?
  - Think about late night feeding management…is feed available?
- Location of rumination may be important
  - Stall comfort…are all stalls equally comfortable?
- 1st lactation animals will likely exhibit greater effects
  - Grouping strategies
  - Alter feeding environment to promote subdominant animals

Funding Sources

- USDA AFRI Foundational Grant
  #2016-67015-24733
- Miner Institute Enhancement Funding

Thank you …

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Minimal effect on short term production response

	100%		142%			*P*-value		
	NS	S	NS	S	SEM	STKD	DIET	STKD x DIET
Milk, kg/d	41.2	40.4	40.7	40.0	0.7	0.21	0.06	0.79
Fat, kg/d	1.29	1.30	1.30	1.25	0.02	0.48	0.12	0.08
True protein, kg/d	1.02	1.01	1.02	0.99	0.01	0.25	0.07	0.42
Lactose, kg/d	1.41	1.39	1.40	1.37	0.04	0.25	0.08	0.61

Remember:
-These are short-term responses…