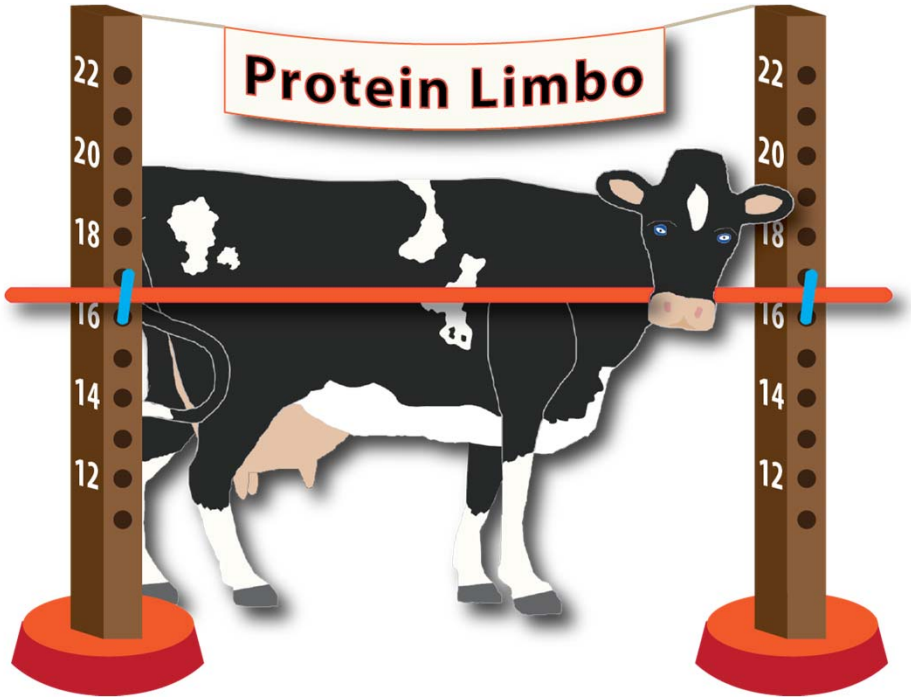
How low can you go with protein in dairy cattle diets?



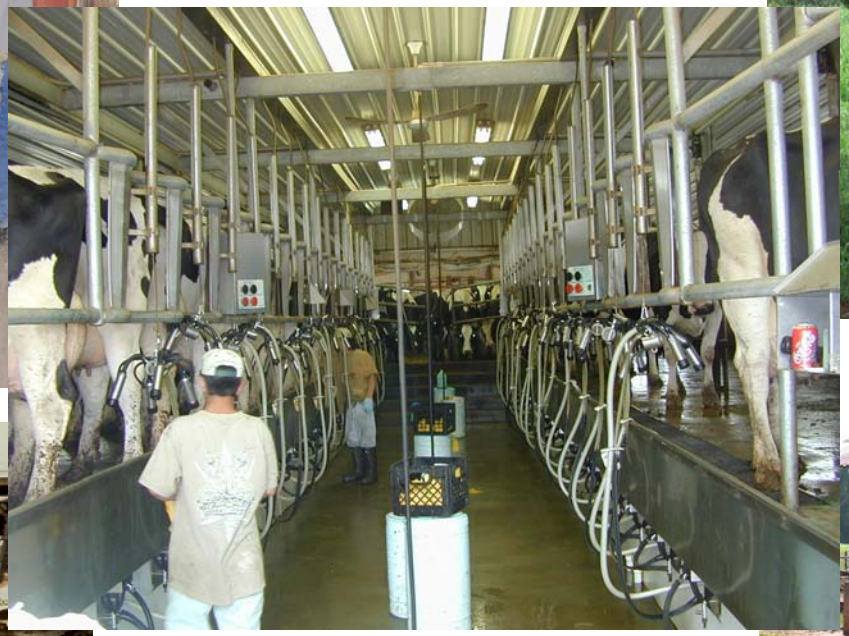
World Dairy Expo
October 3, 2012

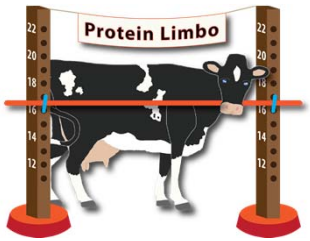
Glen Broderick
U.S. Dairy Forage Research Center
Madison, Wisconsin

USDA ARS

DFRC

How can we Maintain Production on Lower Protein Diets?





USDA ARS

DFRC

Strategies to Improve N-Utilization

1. **Optimize Microbial Protein in the Rumen**
   a. **Meet Requirements for Rumen-Degraded Protein**
   b. **Optimize Carbohydrate Fermentation**
2. **Feed Only the Crude Protein Needed.**
3. **Accurately Track Dietary CP.**
4. **Feed "Complementary" Rumen-Undegraded Protein & Rumen-Protected Amino Acids.**
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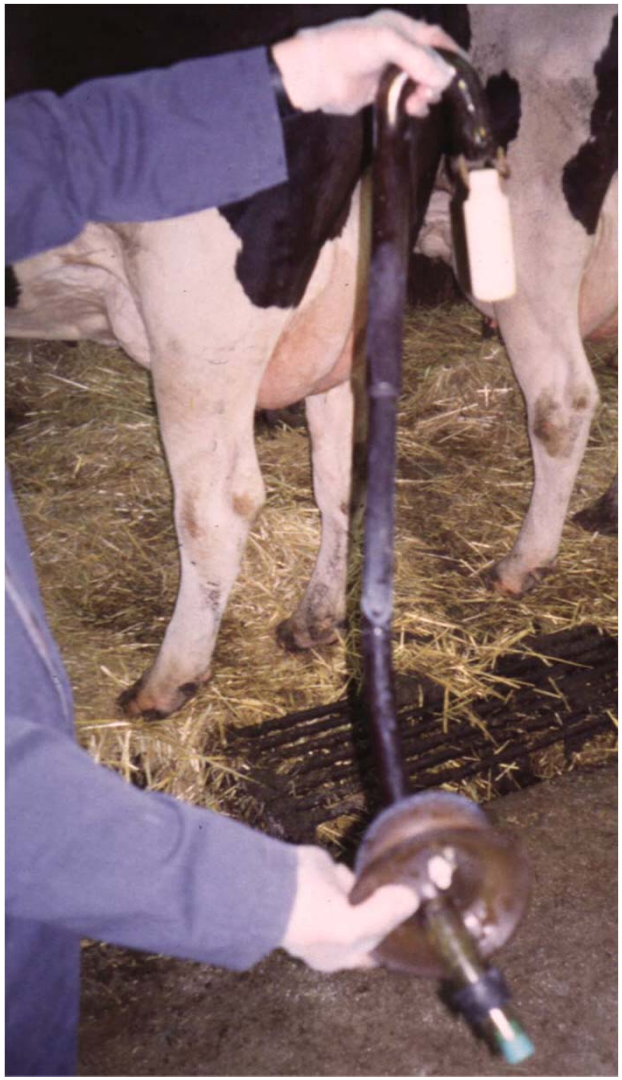
Rumen-Degraded Protein (RDP) Source

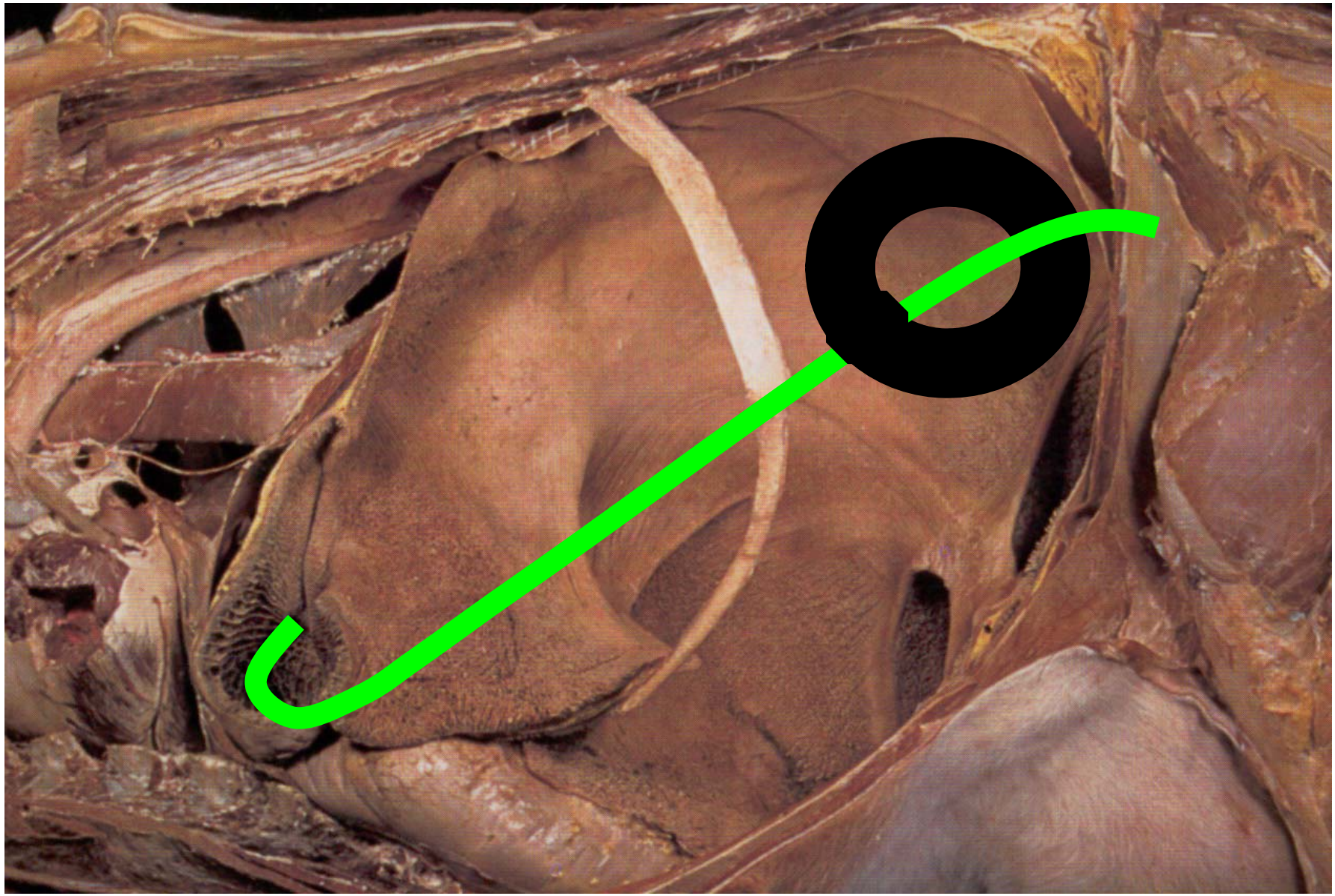
(Broderick & Reynal, 2009)

	RDP from Urea, % of DM			
Item	**0**	**1.2**	**2.4**	**3.7**
	----------(% of DM)----------			
Corn silage	40	40	40	40
Alfalfa silage	15	15	15	15
Ground corn	30	31	33	34
Solvent SBM	14.0	9.8	5.0	0
High RUP SBM	0	2.5	5.1	8.0
Urea	0	0.41	0.84	1.31
Crude protein	16.1	16.1	16.1	16.1
RDP (NRC, 2001)	10.6	10.5	10.5	10.5
NPN, % of Total N	20.3	27.8	35.5	43.6

Omasal Sampling Tube; Inserting Tube into Omasum

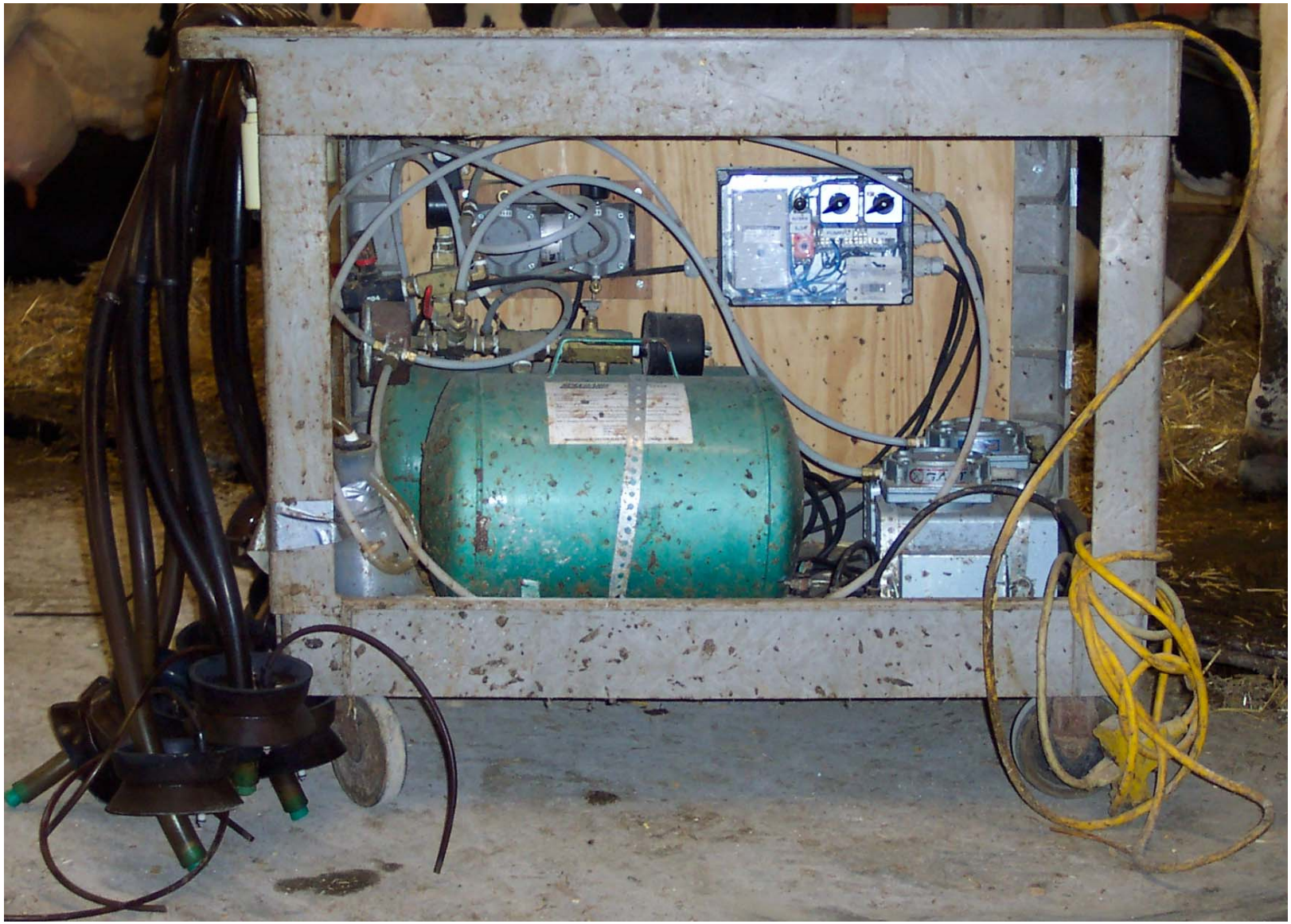


Sampling Tube Positioned thru the Omasal Orifice

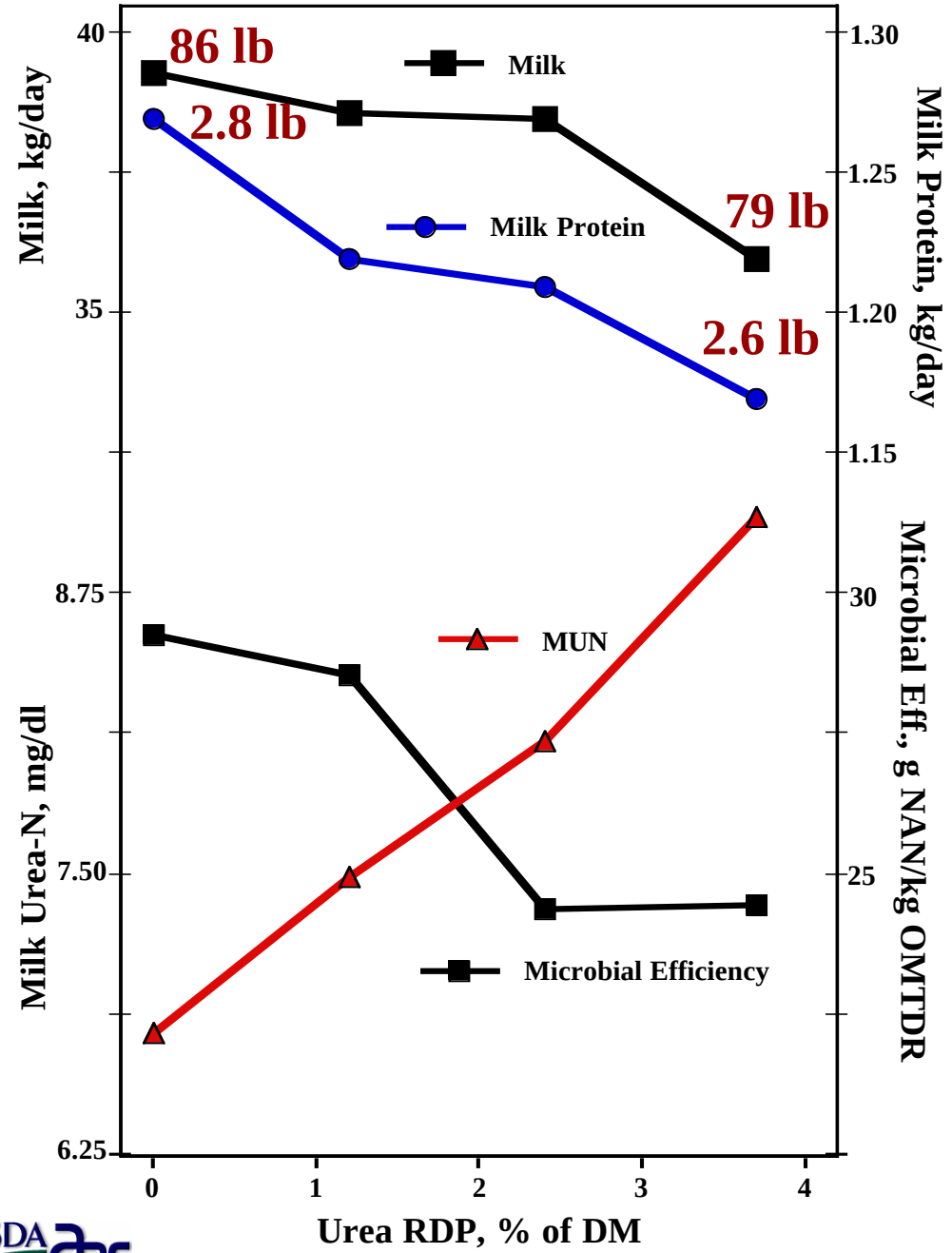


R.R. Ashdown

Wisconsin Omasal Sampler



Omasal Sample Collection



Replacing RDP from True Protein (SSBM) with RDP from Urea Reduced N-Utilization (16% Protein Diet)

(Broderick & Reynal, 2009)

Rumen-Degraded Protein from True Protein Stimulates Microbial Protein Formation

How low can you go with protein in dairy cattle diets?

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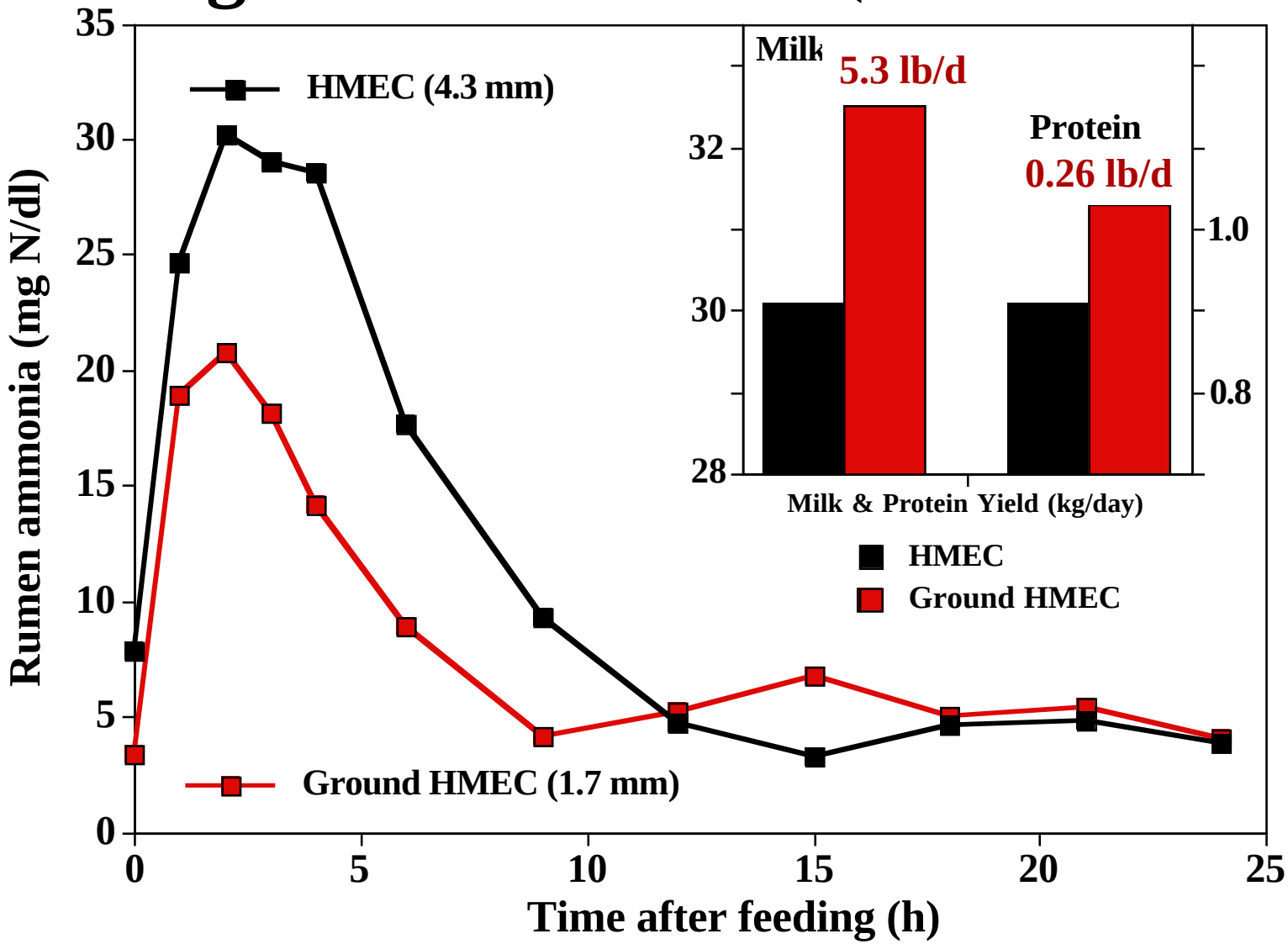
Effect of Processing on Digestibility of Corn & Barley Starch (Owens et al., 1986)

Processing Method	Proportion of Starch Digestion, %			
	Rumen	Small Intestine	Large Intestine	Total tract
Cracked Corn	69	13	8	89
Ground Corn	78	14	4	94
Steam-Flaked Corn	83	16	1	98
High Moisture Corn	86	6	1	95
Ground Barley (Oats & Wheat)	94	. . .	. . .	. . .

Reduce Corn Particle Size to Improve Rumen Digestion

Rumen NH_3 & Production of Cows fed Alfalfa Silage & High Moisture Corn (Ekinci & Broderick, 1997)



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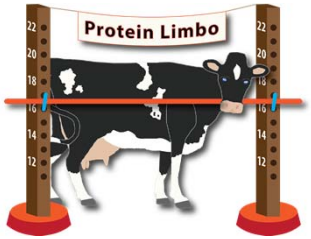
Production & Feeding--Top Wisconsin Herds

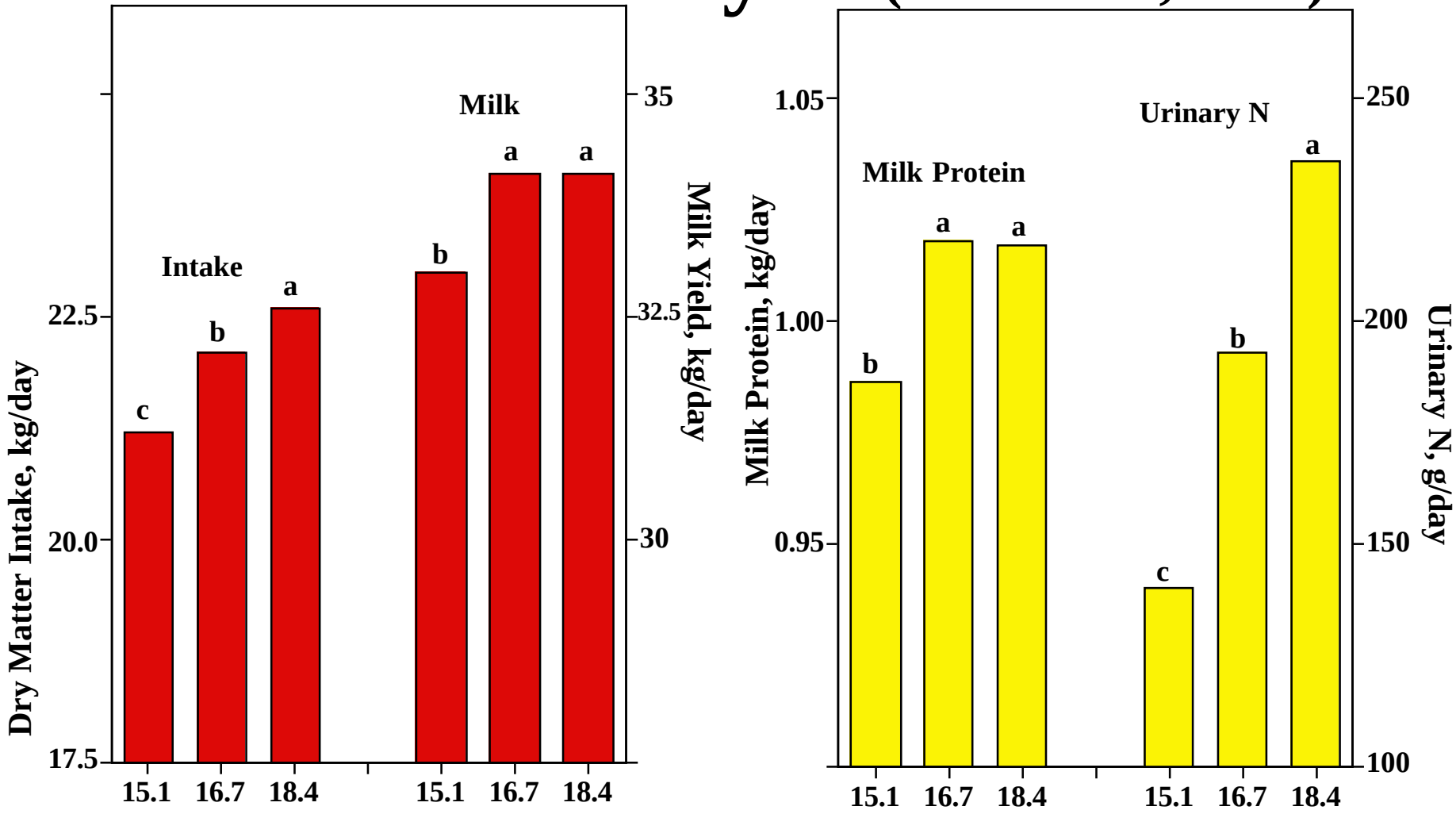
(Shaver et al., 1998)

RHA	Fat	Protein	Dietary CP
----------(lbs/lactation)----------			
31,300	1113	937	19.4%
(119 cows)	(3.55%)	(3.2%) (total protein)	(18.5-21.5%) (28% NDF)

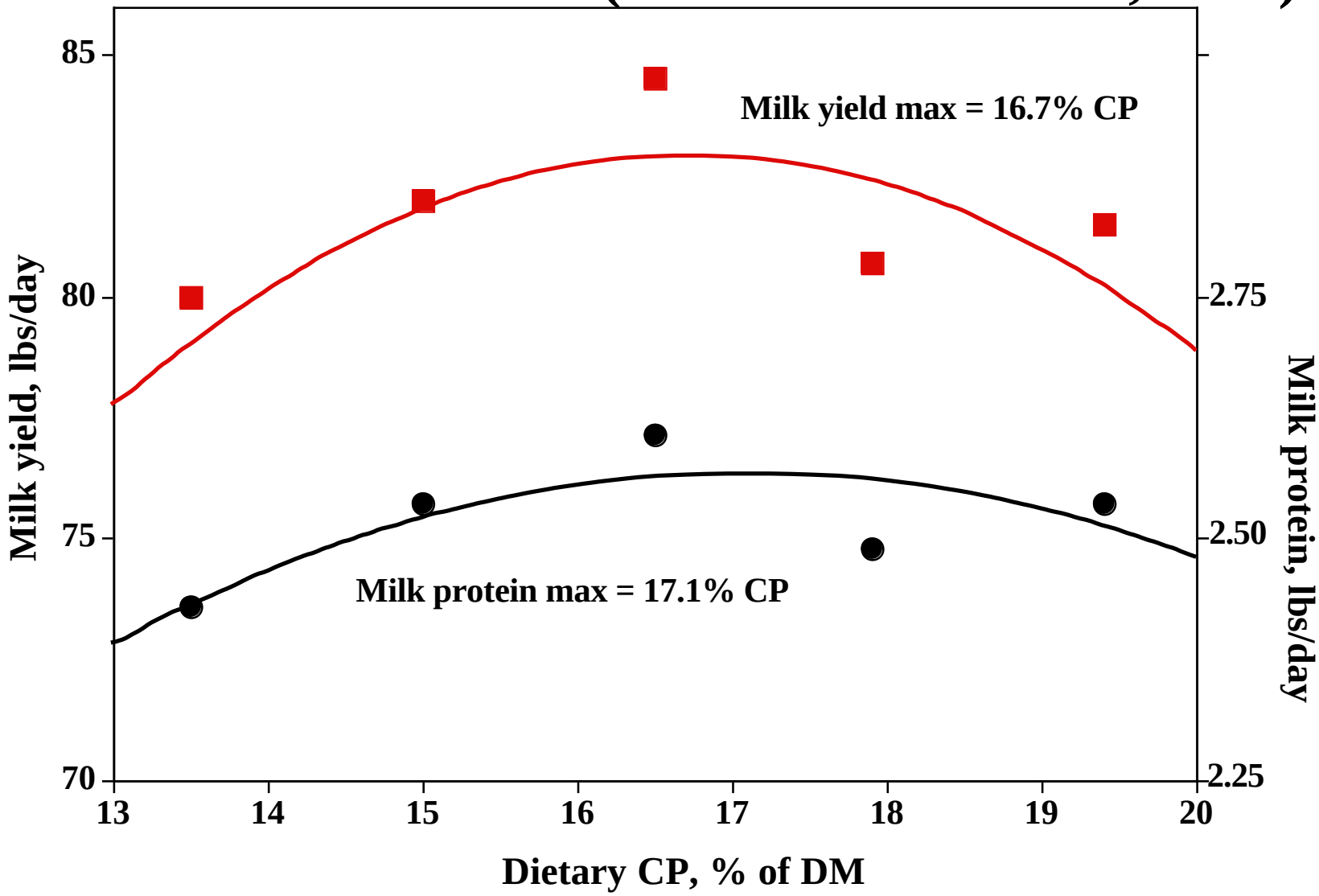


How low can you go with protein in dairy cattle diets?

Effect of Dietary [CP] on Intake, Yield & Urinary N (Broderick, 2003)



Effect of CP (Solvent SBM) on Milk & Protein Yield (Olmos & Broderick, 2006)



Production & Feeding--Top Wisconsin Herds

(Shaver et al., 2010)

RHA	Fat	Protein	Dietary CP
----------(lbs/lactation)----------			
34,250	1254	1032	16.9%
(696 cows)	(3.7%)	(3.0%) (true protein)	(16.3-17.5%) (28% NDF)

Production is Going Up while Dietary Protein is Going Down

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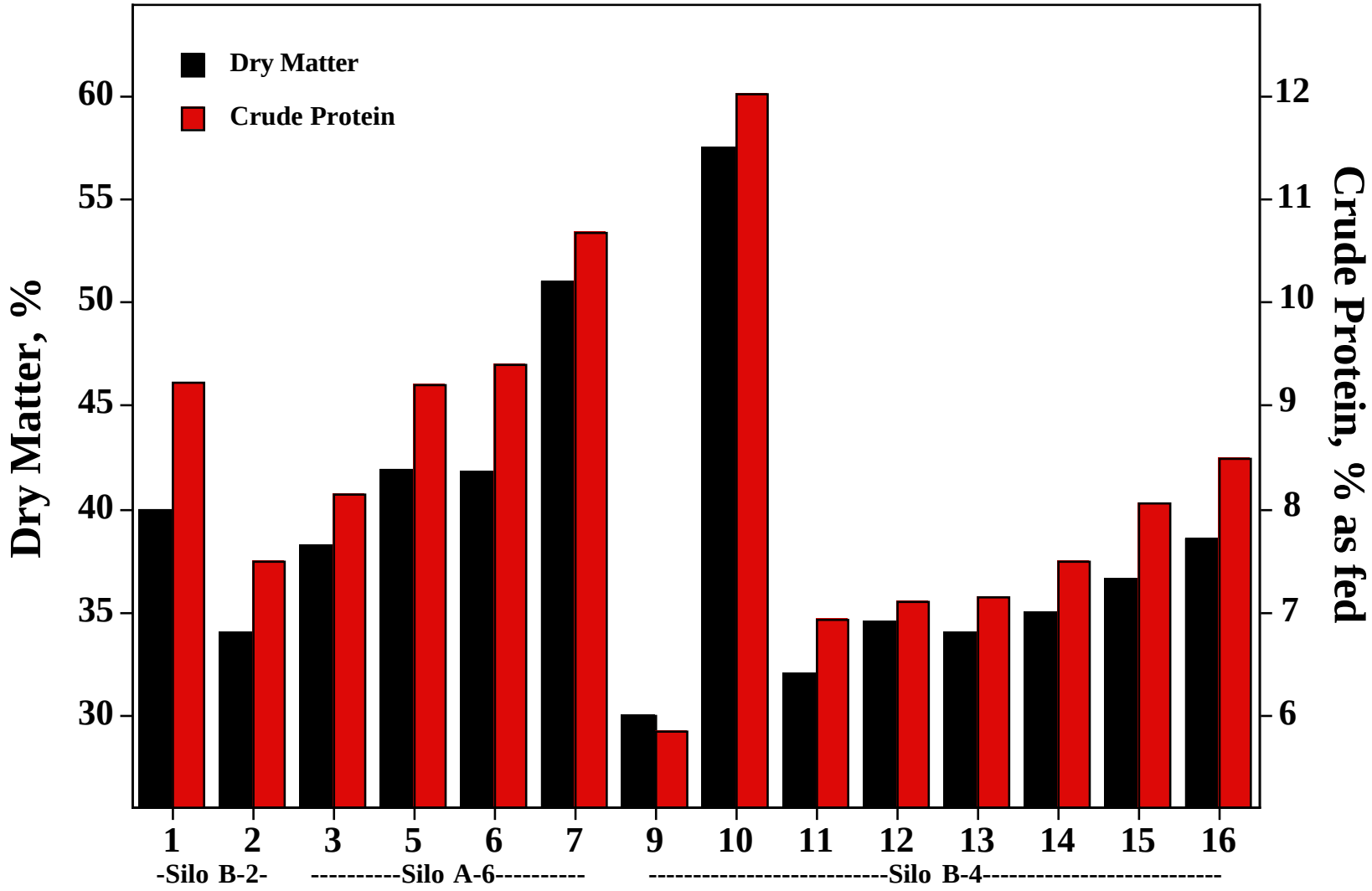
Sampling Forage is Very Important

How low can you go with protein in dairy cattle diets?

Variation of DM & CP in Alfalfa Silage

(GAB53)



How low can you go with protein in dairy cattle diets?

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Diet Composition (Brito & Broderick, 2007)

Item	Urea	SSBM	CSM	CM
	----------% of DM----------			
Alfalfa silage	21	21	21	21
Corn silage	35	35	35	35
High Moisture Corn	41	31	29	27
Urea	1.9	…	…	…
Solvent soybean meal	…	12.1	…	…
Cottonseed meal	…	…	14.1	…
Canola meal	…	…	…	16.5
Crude Protein	16.5	16.5	16.5	16.5



Protein Supplements & Production

(Brito & Broderick, 2007)

Item	CP Supplement				
	Urea	SSBM	CSM	CM	*P* > F
	----------(lbs/d)----------				
DM intake	48.7^{c}	53.4^{b}	54.5^{ab}	54.9^{a}	< 0.01
Milk yield	72.5^{b}	88.2^{a}	89.3^{a}	90.6^{a}	< 0.01
Protein yield	2.03^{c}	2.71^{ab}	2.60^{b}	2.80^{a}	< 0.01
Fat yield	2.23^{c}	2.69^{ab}	2.60^{b}	2.84^{a}	< 0.01

SSBM = Solvent Soybean Meal; CSM = Cottonseed Meal; CM = Canola Meal

^{a,b,c}($P < 0.05$)

Protein Supplements & Omasal Protein Flows (Brito et al., 2007)

Item	Diets[1]				*P* > F
	Urea	SSBM	CSM	CM	
Microbial Efficiency (g N/kg of OMTDR)	26.3[b]	29.0[a]	29.7[a]	29.5[a]	<0.01
	----------g/d----------				
Microbial Protein	2340[b]	2710[a]	2710[a]	2780[a]	0.04
RUP ('Bypass' Protein)	540[c]	990[b]	1350[a]	1150[ab]	<0.01
Total Protein	2880[c]	3700[b]	4060[a]	3930[ab]	<0.01

[1]SSBM = solvent soybean meal; CSM = cottonseed meal; CM = canola meal

[a,b,c]($P < 0.05$)

Essential Amino Acid Contents of Different Proteins (NRC, 2001)

Item	Cow's Milk	Bacterial Protein	Solvent SBM	Cottonseed meal	Canola meal
	----------(% of EA A)----------				
Lys	16.0	15.8	13.9	9.7	13.2
Met	5.5	5.2	3.2	3.7	4.4
Lys:Met	2.9	3.0	4.4	2.6	3.0
His	5.5	4.0	6.1	6.6	6.6

Greater Protein on Canola Meal due Partly to Better Amino Acid Pattern

Production of Cows Supplemented with Soybean Meal or Canola Meal

	Protein source		
Trait	**SBM**	**CM**	**P > F**
DMI, lb/d	55.1	56.0	0.04
Milk, lb/d	87.5	89.5	< 0.01
Milk/DMI	1.59	1.60	0.16
Fat, lb/d	3.48	3.57	0.11
True Protein, lb/d	2.65	2.71	0.04
MUN, mg/dl	11.5	10.4	< 0.01
Rumen NH_3-N, mg/dl	3.3	3.0	0.04
BCVFA, m*M*	2.7	2.4	0.01

Production of Cows Supplemented with Soybean Meal or Canola Meal

Trait	Protein source		
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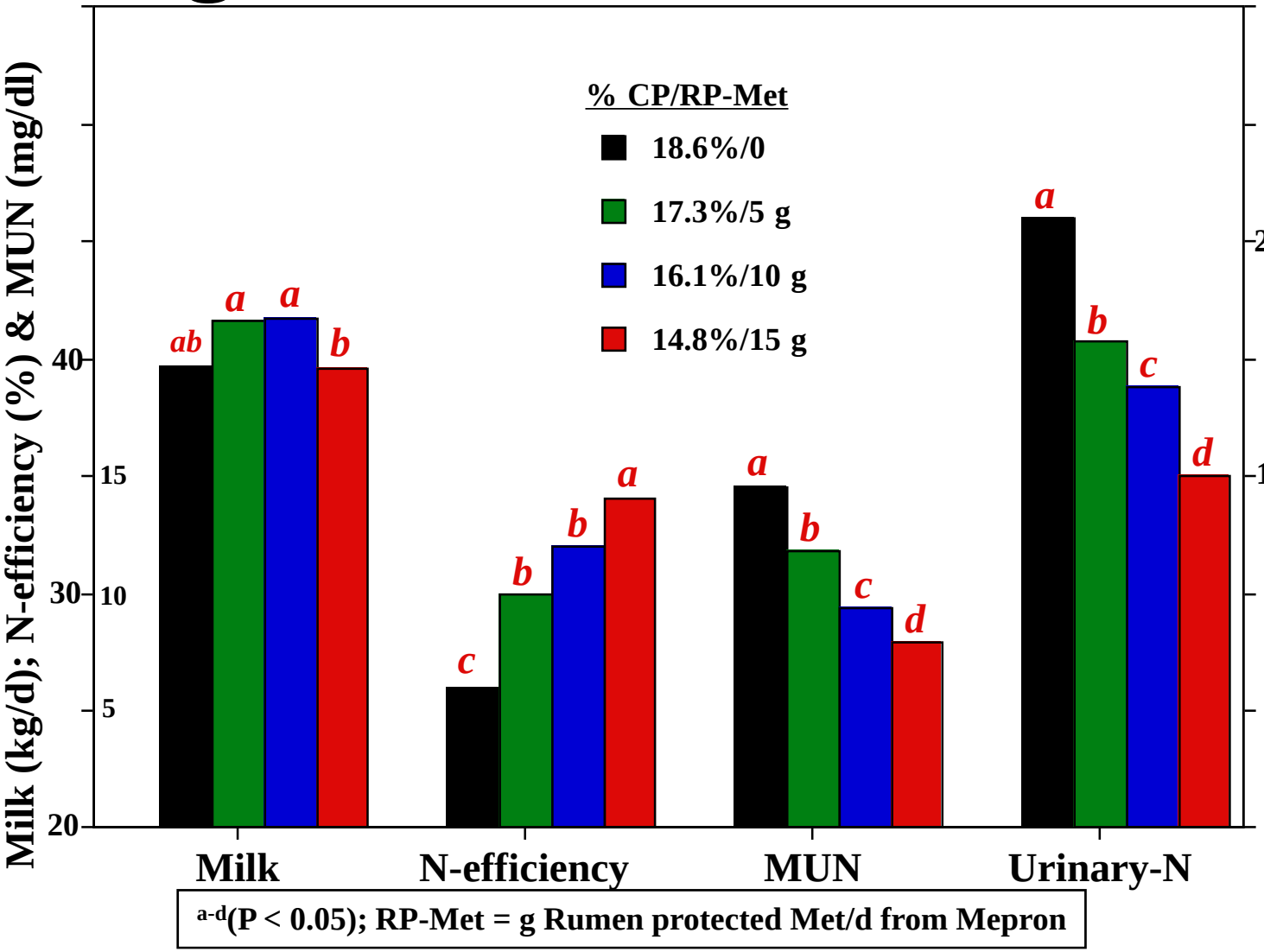
Greater Protein on Canola Meal due Partly to More RUP

Effect on Production & Efficiency of Replacing SBM-CP with Protected-Met



[a-d](P < 0.05); RP-Met = g Rumen protected Met/d from Mepron

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Effect of Lowering CP & Increasing RUP

Ingredient	Normal 17.5% CP	RUP/RP-Met 14.0% CP
	----------(% of DM)----------	
Alfalfa silage	25	10
Corn silage	35	50
High moisture corn	24.3	25.2
Solvent SBM	13.3	0
Expeller SBM	0	12.4
Protected-Methionine[1]	*0*	*0.06 (Lys/Met = 3.0)*
RDP[2]	11.7	7.4
RUP[2]	5.8	6.6

[1]Mepron, SmartAmineM or MetaSmart

[2]NRC (2001) Model

Effect of Lowering CP & Increasing RUP*

Item	Normal 17.5% CP	RUP/RP-Met 14% CP
MP, kg/d	2.68	2.56
NE_L-Milk, lb/d	84	84
MP-Milk, lb/d	90	83
Milk-N/NI, %	27	32
Manure-N, lb/Lact.	344	260

*Estimated using the NRC (2001) Model (DMI = 55 lb/d)

Summary & Conclusions

1. **<u>Optimize</u> Microbial Protein (True Protein RDP; Process Grains to Increase Rumen Digestion)**
2. **Do Not Over-Feed CP; Track Dietary CP & DM**
3. **Feed RUP with Complementary Amino Acid Pattern**
4. **Rumen-Protected Methionine May Help**
5. **Lowering Dietary CP to Maximize N-Efficiency???**
6. **Dietary Crude Protein Can be Reduced to ~16.5%**