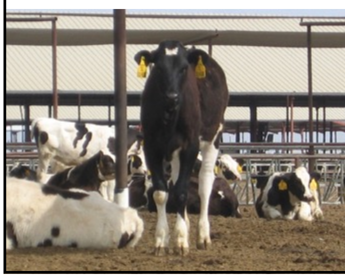
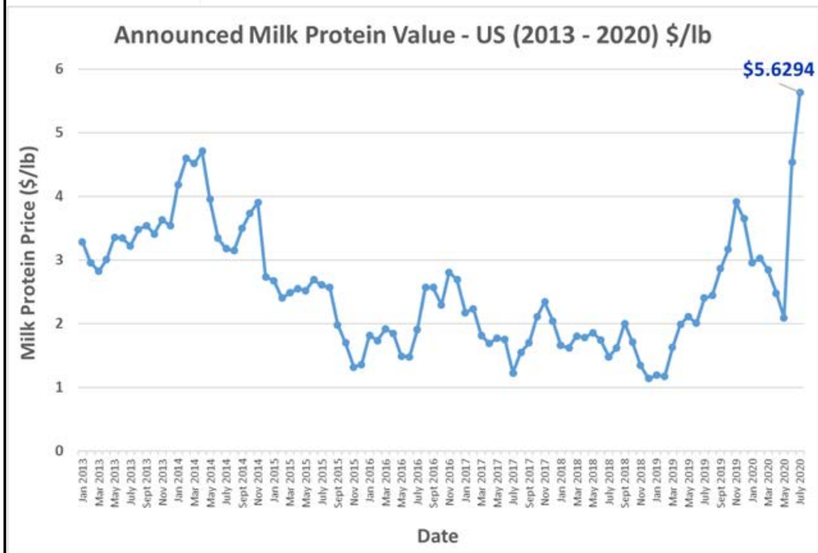
The Top 3 (?) Things You Need to Do to Increase Milk Protein and Practical Approaches to Balancing Diets for Amino Acids for Dairy Cattle

Mike Van Amburgh, Debbie Ross, Ryan Higgs, Alessandro Zontini, Marcelo Gutierrez-Botero, Mike Dineen, Andres Ortega, and Andrew LaPierre
Dept. of Animal Science



Today's discussion

- Milk protein is at an all time high – how do we capture that income opportunity
- Revisiting fermentable carbohydrates, forage vs byproducts and DMI
- DCAD – move it up
- Fatty acids – new data and fairly easy to implement
- Spend some money on rumen protected AA but make sure you don't overfeed protein
- Summary



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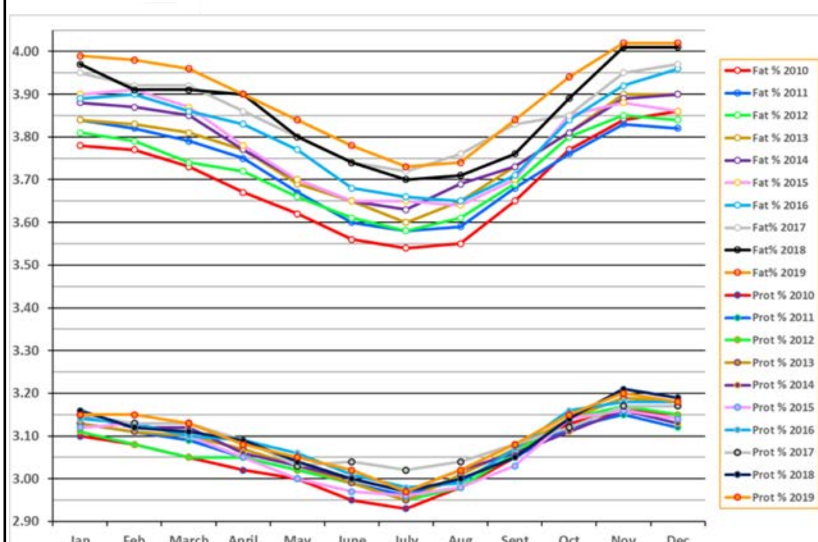
Northeast U.S. FMMO 1 Milk Fat and Protein % -- 2010 to 2019



Source: Zimmerman, Balchem Corporation - 2020

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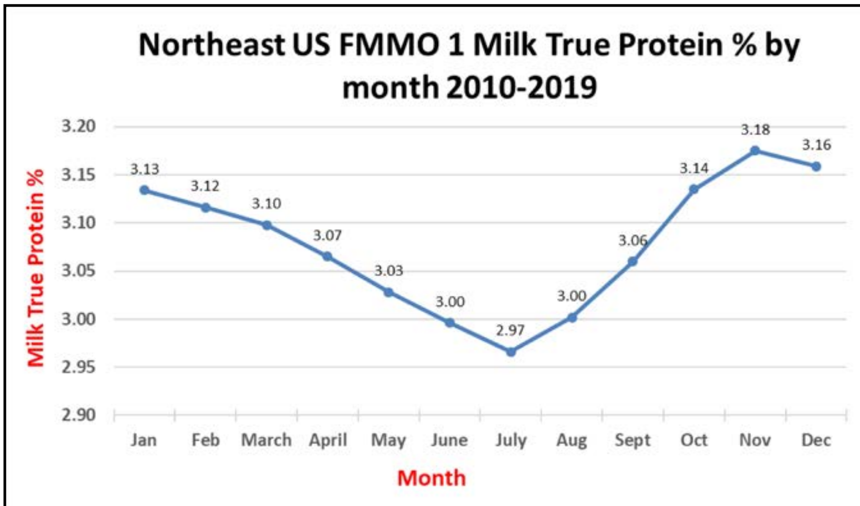

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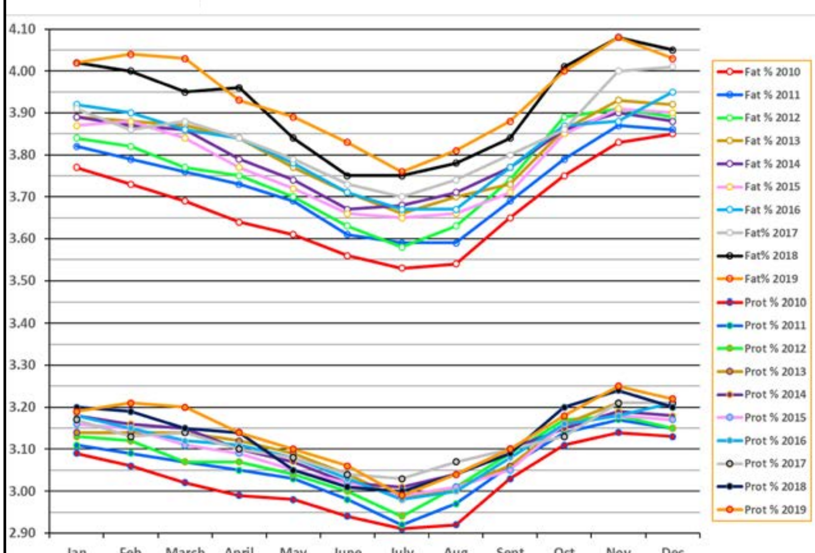
Source: Zimmerman, Balchem Corporation - 2020

Upper Midwest U.S. FMMO 30 Milk Fat and Protein % -- 2010 to 2019



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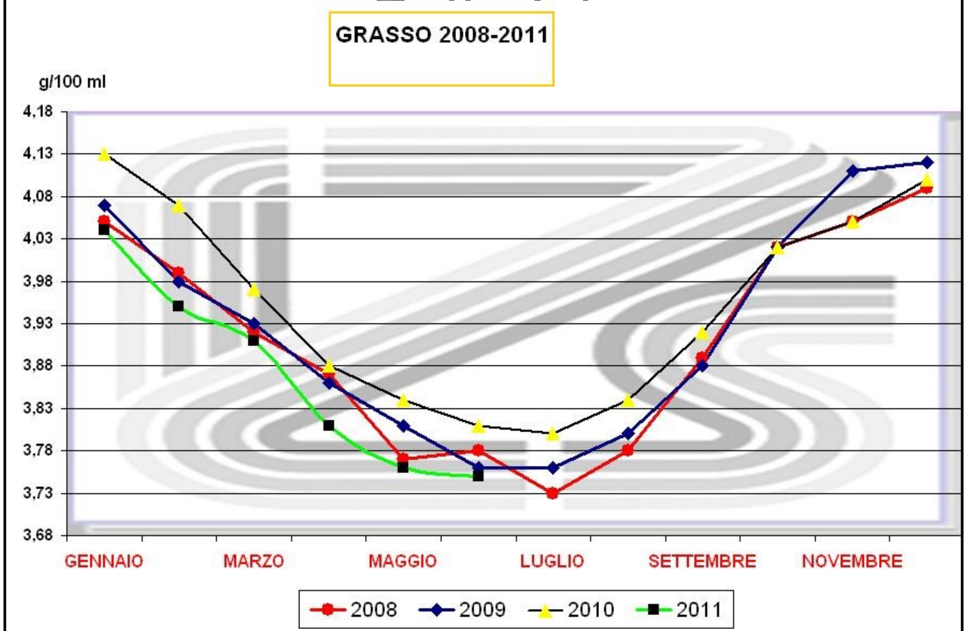
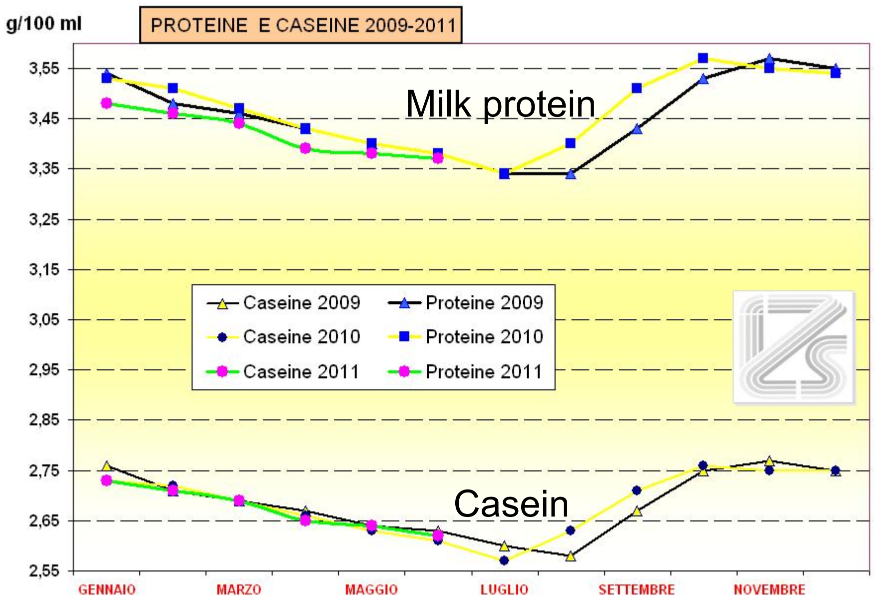


Protein and Casein



Simple things to ensure best productivity

- Cooling, fans, sprinklers – reduce heat stress and increase cow comfort
- Promote DMI and lying time
  - make sure feed availability 21 to 22 h/d
  - work towards >12 h lying time per day

Formulation considerations for amino acid balancing

Start with the basics:

1. Do we have current feed chemistry that includes NDF digestibility?

2. Have we characterized the cows appropriately?

3. Do we have DMI and when used on a pen basis, does actual mil line up with the ME and MP allowable milk?

4. Do we have BCS changes that would help with evaluation of early to peak lactation cattle?

5. What is first limiting milk yield?

Formulation/Input conditions that drive me crazy:

Cows weigh 1,650 to 1,800 lb but the nutritionist is using 1,350 to 1,450 lb to formulate

Not using actual DMI

Not using current feed chemistry or just minimum data like CP, NDF and basic analysis OR just using library values

Not taking the time to get the cows and the diet formulation system to agree with each other

CNCPS v6.55 predictions – cow BW 1,588 lb with a mature size of 1,764 lb

	Metab Energy (Mcal/day)			Metab Protein (g/day)		
	Avail	Rqd	Diff	Avail	Rqd	Diff
Total	80.8	80.5	0.4	3495	3533	-38
Maint	80.8	17.4	63.4	3495	964	2530
Preg	63.4	0	63.4	2530	0	2530
Lact	63.4	60.8	2.6	2530	2486	45
Growth	2.6	2.2	0.4	45	83	-38
Reserves	0.4	0	0.4	0	38	-38

DMI Predicted	64.37 lbs/day	Pept & NH3 Bal	81 g/d	135%
DMI Actual	66.78 lbs/day	Pept Bal	198 g/d	194%
Predicted Ruminal pH	6.36	Urea Cost	0.00 Mcal/d	
Target Growth	0.46 lbs/day	Target Milk	120.0 lbs/day	
Inputted Growth	0.46 lbs/day			
ME Allowable Growth	0.46 lbs/day	ME Allowable Milk	120.7 lbs/day	
MP Allowable Growth	0.25 lbs/day	MP Allowable Milk	118.2 lbs/day	

Same diet at same intake modeled with 1,350 lb cow at measured DMI

	Metab Energy (Mcal/day)			Metab Protein (g/day)		
	Avail	Rqd	Diff	Avail	Rqd	Diff
Total	80.2	76.3	3.9	3536	3452	84
Maint	80.2	15.5	64.8	3536	967	2569
Preg	64.8	0	64.8	2569	0	2569
Lact	64.8	60.8	3.9	2569	2486	84
Growth	3.9	0	3.9	84	0	84
Reserves	3.9	0	3.9	84	0	84

DMI Predicted	60.01 lbs/day	Pept & NH3 Bal	79 g/d	135%
DMI Actual	66.78 lbs/day	Pept Bal	190 g/d	193%
Predicted Ruminal pH	6.36	Urea Cost	0.10 Mcal/d	
Target Growth	0.00 lbs/day	Target Milk	120.0 lbs/day	
Inputted Growth	0.00 lbs/day			
ME Allowable Growth	0.67 lbs/day	ME Allowable Milk	127.7 lbs/day	
MP Allowable Growth	0.45 lbs/day	MP Allowable Milk	124.0 lbs/day	

Role of energy nutrition in milk protein synthesis

- Sporndly (1989) reported much stronger relationship of milk protein percentage with dietary energy intake than dietary protein intake
  - Often attributed to ruminal fermentation and microbial protein synthesis
  - Sugars, starches, and digestible fiber sources will drive microbial protein yield

Protein-energy interactions

"Although it has been traditional to consider 'protein' and 'energy' metabolism as separate entities in mammalian metabolism, most scientists recognize this is an artificial divide. Indeed, they should be considered together as this reflects how nutrients are ingested and utilized as part of normal feeding patterns during evolution."

Lobley, G. E. 2007. Protein-energy interactions: horizontal aspects. Pages 445-462 in Proc. Energy and protein metabolism and nutrition. Butterworths, Vichy, France.

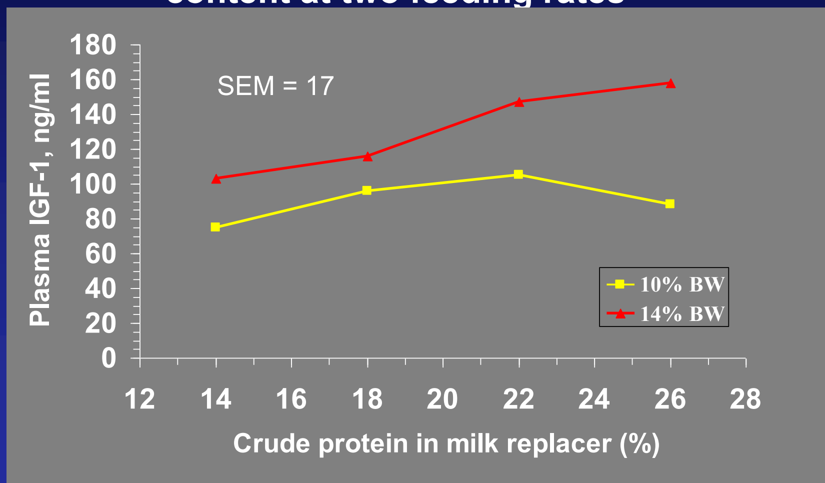
Milk Yield and Milk Protein Synthesis

- Are **energy** driven events
  - Relies on an adequate supply of amino acids
  - Driven by propionate production in the rumen
    - Propionate converted to glucose in the liver – which in turn stimulates insulin secretion
    - Intestinal glucose absorption also supplies energy substrate but there is a discount on energy for lactose synthesis – based on the data of Reynolds et al. and others, about an 18% discount due to tissue use prior to mammary availability

Milk Protein Synthesis - Basics

- Insulin secretion stimulates protein synthesis in the mammary gland
- Energy intake stimulates IGF-I secretion from the liver
- Protein supply per se is not an activator of milk protein output but can modulate some of the signaling – IGF-I, mTOR, elongation factors (methionine, leucine and others)

Concentration of IGF-1 in plasma of calves fed isocaloric intakes of milk replacers with varying protein content at two feeding rates



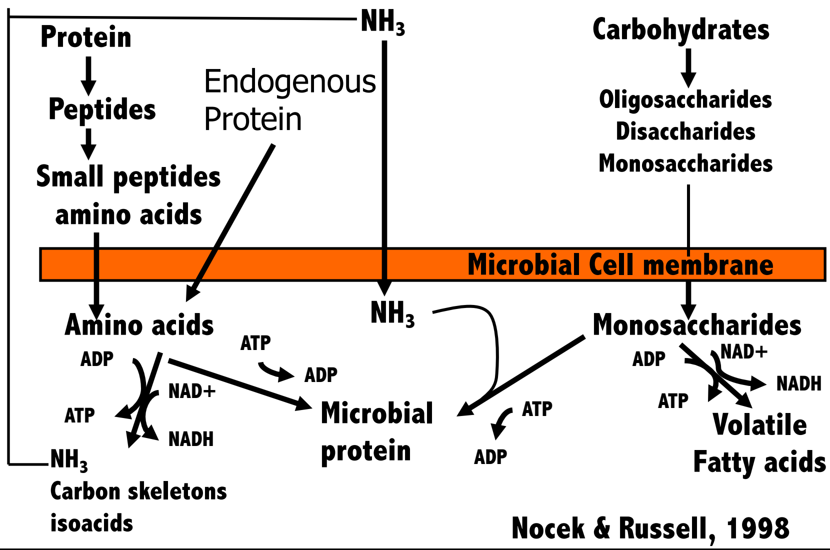
Feeding rate x CP linear ($P < 0.05$)

Bartlett et al., 2006

Effects of insulin on milk protein

- Hyperinsulinemic-Euglycemic clamps
  - Clamp alone
    - 15% increase in milk protein yield (Mackle et al., 1999)
  - Clamp w/ abomasal infusion of casein
    - 28% increase in milk protein yield (Griinari et al., 1997)
  - Clamp w/ abomasal infusion of BCAA & casein
    - 25% increase in milk protein yield (Mackle et al., 1999)
  - Clamp w/ IV infusion of AA (casein profile)
    - Insulin and insulin plus AA increased milk by 13 to 18% and protein by 10 to 21% in goats
      - (Bequette et al, 2001)

Protein and CHO To Optimize Microbial Yield



Nocek & Russell, 1998

Fermentable Nonstructural Carbohydrates to Optimize Microbial Yield and Milk Protein

Stage of lactation	Fermentable NSCHO, % DM	Fermentable starch, %DM	Fermentable sugar, %DM	Fermentable soluble fiber, %DM
Early	40-41	18.5 - 20	6	6
Peak	43	22 - 24	7	5
Mid	40	18.5 – 20.5	6	5

For high cows – 86% to 90% ruminal starch digestion

Hoover: Sugar in the 5% to 7% range improved microbial yield and fiber digestion – likely due to protozoa

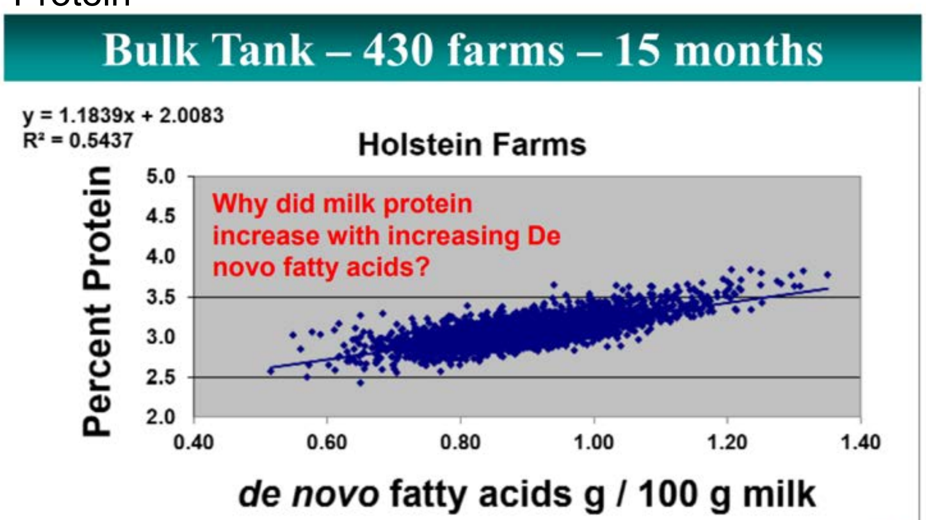
Modified from Sniffen et al.

Irish Pasture Grass Nutrient Composition

Nutrient composition	Diet G	Diet G+RB
CP, % of DM	16.3	15.4
Starch, % of DM	2.2	14.4
WSC, % of DM	23.9	19.3
NFC, % of DM	37.7	43.5
aNDFom, % of DM	36.3	32.7
12-h uNDFom, % of aNDFom	50.9	-
30-h uNDFom, % of aNDFom	20.9	-
72-h uNDFom, % of aNDFom	-	-
120-h uNDFom, % of aNDFom	11.8	-
240-h uNDFom, % of aNDFom	9.9	-
Ether extract, % of DM	3.1	2.9
Ash, % of DM	6.6	5.6

Dineen et al. 2020

Relationship between De Novo Fatty Acids and Milk Protein



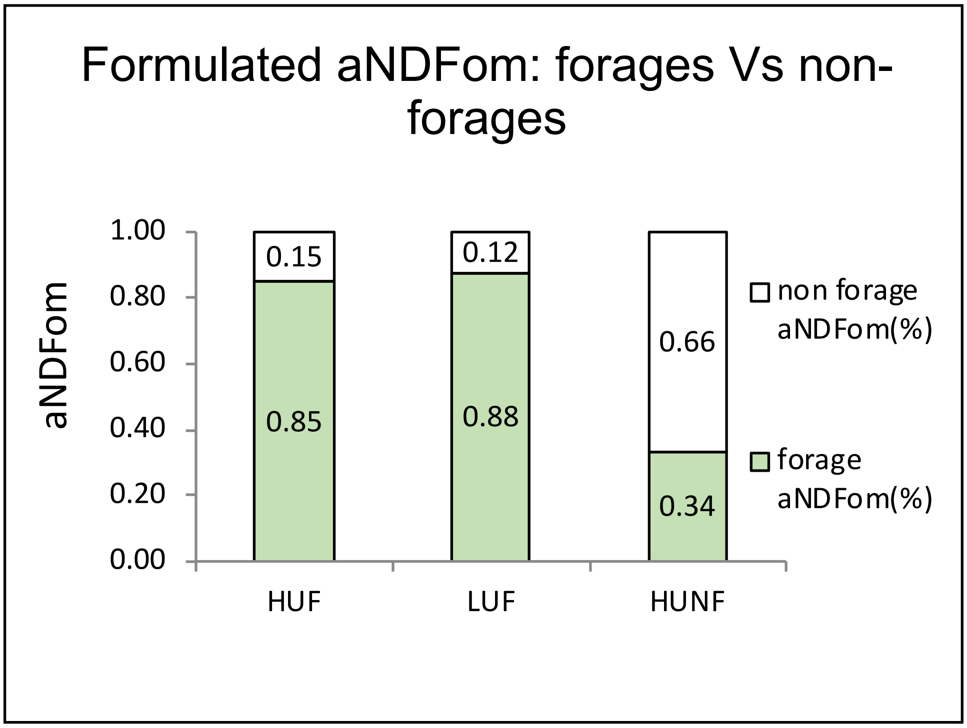
Barbano and Mellili, 2016

High Forage vs High Byproduct Diet

- Forages can be scarce
- High digestibility forages low in inventory
- How can we reformulate to increase intakes and improve milk components?
- Quick discussion of a high vs low forage study conducted to evaluate feed intake, milk yield, milk composition and rumination

Experimental Design

- 144 lactating cows (108 multiparous, 36 primiparous)
- 9 pens of 16 animals each (12 multiparous and 4 primiparous)
- Pens were randomly assigned to the three treatment diets in a 3x3 Latin square design
- 21-d adaptation periods and 5-d sampling periods.



Formulated Experimental Diets

Ingredient (pounds/head/day)	HUF	LUF	HUNF
Alfalfa hay (high-uNDFom)	7.7	-	-
Alfalfa silage (low-uNDFom)	-	18.5	7.3
Alfalfa silage (high-uNDFom)	9.9	-	-
BMR corn silage	-	23.4	-
Conv. corn silage	24.3	-	9.5
Citrus pulp	2.4	1.5	5.1
Corn gluten feed	-	-	2.4
Corn grain ground	8.8	10.1	14.6
Cottonseed delinted	-	-	4.4
Soybean hulls	1.1	-	3.3
Soy Plus	4.0	5.1	3.5
Sunflower seed hulls	-	-	4.0
Wheat middlings	-	-	4.6
Minerals and vitamins	2.9	2.0	2.2

Experimental diets

Chemical composition	HUF	LUF	HUNF
DM	46	41	63
CP, % DM	16.1	16	16.1
RUP, % DM	44.9	46.8	50
aNDFom, %DM	32.9	33.1	33.1
Fast pool, %aNDFom	31	67	55
Slow pool, %aNDFom	37	7	13
uNDFom, % aNDFom	32	26	32
Starch, %DM	24.4	24.7	25.1
Sugar, %DM	6	4.3	6.1
EE, % DM	4.0	4.2	4.4
ME, mcal/kg DM	2.48	2.49	2.45
ME allowable milk (lb/d)	96.56	96.78	98.77
MP allowable milk (lb/d)	103.40	105.38	106.26
Lys:Met	2.94	2.94	2.83

Results - based on formulated diets

Item	HUF	LUF	HUNF	SEM	P-value
DMI (lb/cow/d)	61.1[a]	61.3[a]	70.8[b]	1.01	0.0001
aNDFom intake, lb/d	20.1[a]	20.2[a]	23.4[b]	0.24	0.0001
uNDFom intake, lb/d	6.4[a]	5.2[b]	7.4[c]	0.09	0.0001
pdaNDFom intake, lb/d	13.7[a]	15.0[b]	16.0[c]	0.19	0.0001
Fast pool intake, lb/d	6.3[a]	13.4[b]	12.8[c]	0.15	0.0001
Slow pool intake, lb/d	7.4[a]	1.6[b]	3.2[c]	0.07	0.0001
aNDFom intake, %BW	1.30[a]	1.30[a]	1.48[b]	0.02	0.0001
uNDF intake, %BW	0.42[a]	0.34[b]	0.48[c]	0.01	0.0001
dNDF intake, %BW	0.89[a]	0.98[b]	1.01[c]	0.01	0.002

Production Results

Item[1]	HUF	LUF	HUNF	SEM	P-value
DMI (lb/cow/d)	61.1[a]	61.3[a]	70.8[b]	1.01	0.0001
Milk, (lb/d)	91.7[a]	96.3[b]	105.5[c]	1.06	0.0001
Energy corrected milk, (lb/d)	94.1[a]	96.8[b]	100.1[c]	1.15	0.0001
Fat yield, (lb/d)	3.48[a]	3.46[a]	3.31[b]	0.05	0.0021
True protein yield , (lb/d)	2.67[a]	2.84[b]	3.20[c]	0.05	0.0001
Fat, (%)	3.79[a]	3.58[b]	3.18[c]	0.04	0.0001
True protein, (%)	2.91[a]	2.95[a]	3.05[b]	0.01	0.0001
MUN mg/dl	11.7[a]	8.8[b]	10.4[a]	0.12	0.0001
Feed efficiency (ECM/DMI)	1.55[a]	1.58[a]	1.41[b]	0.02	0.0001

Chewing and rumination, body weight and BCS changes

Item[1]	HUF	LUF	HUNF	SEM	P-value
BW initial, lb	1,547	1,554	1,574	6.59	0.78
BW change, lb	7.1	20.5	39.2	9.17	0.08
BCS change	0.01	0.01	0.1	0.05	0.63
Rumination (min/cow/d)	593[a]	609[a]	534[b]	7.25	0.0001
Rumination (min/lb NDF intake)	29.5[a]	30.1[a]	22.9[b]	0.41	0.0001
Rumination (min/lb dNDF intake)	43.3[a]	40.7[b]	33.2[c]	0.58	0.0001

DCAD Levels, DMI and Milk Protein

Table 2. Least squares means for DMI, BW, milk yield, 4% FCM, and milk composition in experimental diets combining 3 levels of DCAD with 2 levels of CP

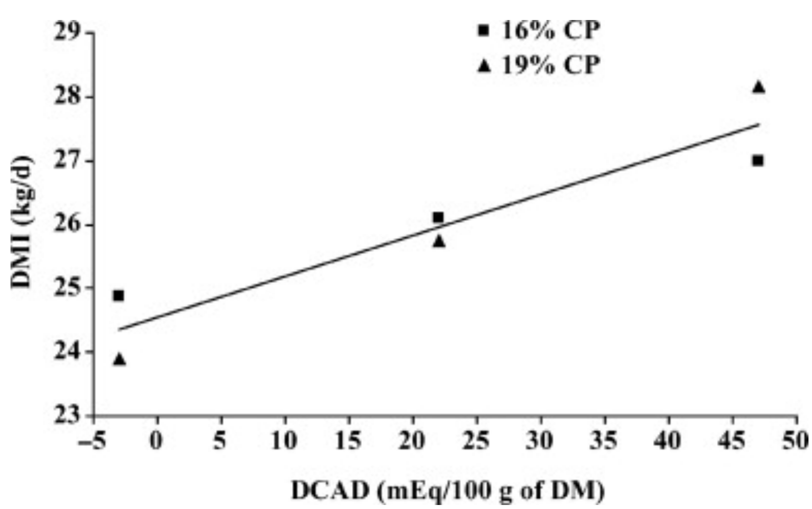
	DCAD[1] = –3		DCAD = 22		DCAD = 47			Orthogonal contrast[2]				
Variable	16% CP	19% CP	16% CP	19% CP	16% CP	19% CP	SE	A	B	C	D	E
DMI, kg/d	24.9	23.9	26.1	25.7	27.0	28.2	1.9	NS[3]	<0.01	NS	NS	NS
BW, kg	678	675	680	677	682	678	12	NS	NS	NS	NS	NS
Milk												
Yield, kg/d	35.3	36.7	36.4	35.8	36.1	36.6	2.3	NS	NS	NS	NS	NS
4% FCM, kg/d	31.1	30.3	32.4	33.1	33.9	34.5	2.7	NS	0.01	NS	NS	NS
Fat, %	3.12	2.85	3.27	3.46	3.57	3.62	0.50	NS	0.02	NS	NS	NS
Fat, kg/d	1.12	1.04	1.19	1.25	1.29	1.32	0.17	NS	0.01	NS	NS	NS
Protein, %	3.12	3.09	3.20	3.16	3.24	3.24	0.09	NS	<0.01	NS	NS	NS
Protein, kg/d	1.10	1.11	1.15	1.11	1.15	1.18	0.07	NS	0.07	NS	NS	NS
Lactose, %	4.79	4.82	4.78	4.79	4.90	4.90	0.09	NS	0.03	0.05	NS	NS
Lactose, kg/d	1.69	1.76	1.74	1.72	1.78	1.80	0.12	NS	NS	NS	NS	NS
SNF, %	8.58	9.01	9.11	8.98	9.09	8.82	0.13	NS	<0.01	NS	NS	NS
SNF, kg/d	3.18	3.21	3.22	3.17	3.27	3.31	0.21	NS	NS	NS	NS	NS
Urea, mg of N/dL	17.0	21.0	13.7	21.5	13.7	19.5	2.24	<0.01	0.02	NS	NS	0.08
SCC, ×1,000/mL	46	34	37	36	38	31	19	NS	NS	NS	NS	NS

[1]DCAD in milliequivalents of (Na + K – Cl – S)/100 g of DM.
[2]A = 16% CP vs. 19% CP; B = linear effect of DCAD; C = quadratic effect of DCAD; D = interaction between CP concentration and linear effect of DCAD; E = interaction between CP concentration and quadratic effect of DCAD.
[3]NS = $P > 0.10$.

4% increase in milk protein with higher DCAD independent of CP level

Hu et al., JDS 2007

DMI responses to higher DCAD



Hu et al., 2007

Protein and DCAD Effects on Milk Components

Table 3. Dry matter intake, milk yield, milk composition, and milk component yield for cows fed diets formulated to contain a DCAD of 25 or 50 mEq (Na + K – Cl)/100 g of DM and 15 or 17% CP

11% increase in milk protein and
26% increase in milk fat yield

	15% CP		17% CP			*P*-value		
Item	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	DCAD × CP
DMI								
DM, kg/d	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NS
DM, kg/10[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NS
Milk yield, kg/d								
Milk	24.0	25.7	23.8	26.6	0.4	**	NS	NS
ECM[1]	20.5	23.4	20.6	24.1	0.4	**	NS	NS
Fat	0.60	0.76	0.61	0.77	0.01	**	NS	NS
Protein	0.70	0.76	0.71	0.79	0.01	**	NS	NS
Milk composition, %								
Fat	2.44	2.95	2.44	2.89	0.03	**	NS	NS
Protein	2.89	2.94	2.99	2.98	0.01	*	**	**

[1]ECM = 0.3246 × (kg milk) + 12.86 × (kg fat) + 7.04 × (kg protein); Tyrrell and Reid (1965).
*$P < 0.05$; **$P < 0.01$; NS: $P > 0.10$.

Wildman et al. JDS 2007

Make Use of Fatty Acids

- Data emerging demonstrating that the profile of fatty acids at different stages of lactation impact insulin signaling
- Data from Lock et al and McFadden et al labs
- Implication is the cow has a FA requirement or a certain profile of FA improves energetic efficiency by altering partitioning of energy

Altering the ratio of dietary C16:0 and cis-9 C18:1 impacts productivity

Table 2. Proportion of each fatty acid (FA) supplement for treatment blends and FA profile of FA blends

Item	Treatment[1]			
	80:10	73:17	66:24	60:30
FA supplement in treatment blends, %				
C16:0-enriched FA supplement[2]	89.0	66.5	45.5	29.0
Ca salts of palm FA supplement[3]	11.0	33.5	54.5	71.0
FA profile of each FA blend, g/100 g of FA				
C14:0	0.67	0.75	0.82	0.88
C16:0	80.7	73.6	66.3	59.7
C18:0	1.83	1.79	1.75	1.70
cis-9 C18:1	10.2	17.5	23.9	29.7
cis-9,*cis*-12 C18:2	2.95	4.23	4.45	5.55
cis-9,*cis*-12,*cis*-15 C18:3	0.11	0.15	0.19	0.23

[1]80:10 = 1.5% of FA supplement blend to provide ~80% C16:0 and 10% *cis*-9 C18:1; 73:17 = 1.5% of FA supplement blend to provide ~73% C16:0 and 17% *cis*-9 C18:1; 66:24 = 1.5% of FA supplement blend to provide ~66% C16:0 and 24% *cis*-9 C18:1; 60:30 = 1.5% of FA supplement blend to provide ~60% C16:0 and 30% *cis*-9 C18:1.

[2]Palmitic acid-enriched FA supplement (Nutracor; Wawasan Agrolipids, Johor, Malaysia). Contained (g/100 g of FA) 0.60 of C14:0, 84.5 of C16:0, 1.80 of C18:0, and 7.90 of *cis*-9 C18:1, and 98.8% total FA.

[3]Calcium salts of palm FA supplement (Nutracal; Wawasan Agrolipids). Contained (g/100 g of FA) 1.0 of C14:0, 48.1 of C16:0, 1.12 of C18:0, and 39.9 of *cis*-9 C18:1, and 83.4% total FA.

De Souza et al., 2019 JDS

Diet and Ratio of Palmitic to Oleic Acids

Table 3. Ingredient and nutrient composition of the treatment diets

Item	Treatment[1]			
	80:10	73:17	66:24	60:30
Ingredient, % of DM				
Corn silage	25.5	25.5	25.5	25.5
Alfalfa silage	16.3	16.3	16.3	16.3
Wheat straw	5.32	5.32	5.32	5.32
Ground corn	15.9	15.9	15.9	15.9
High-moisture corn	14.2	14.2	14.2	14.2
Soybean meal	12.1	12.1	12.1	12.1
Soyhulls	4.82	4.76	4.70	4.65
Protein supplement[2]	1.09	1.09	1.09	1.09
C16:0-enriched FA supplement[3]	1.37	1.06	0.76	0.48
Ca salts of palm FA supplement[4]	0.17	0.54	0.90	1.23
Mineral and vitamin mix[5]	3.23	3.23	3.23	3.23
Nutrient composition,[6] % of DM				
NDF	29.0	29.0	29.0	29.0
CP	16.5	16.5	16.5	16.5
Starch	28.8	28.8	28.8	28.8
FA	4.00	3.98	4.00	3.98
16:0	1.58	1.44	1.33	1.26
18:0	0.05	0.04	0.04	0.04
cis-9 18:1	0.68	0.78	0.88	0.98
cis-9,*cis*-12 18:2	1.25	1.25	1.27	1.29
cis-9,*cis*-12,*cis*-15 18:3	0.20	0.20	0.20	0.20

De Souza et al., 2019 JDS

Effect of Ratio of Palmitic to Oleic on Productivity

Table 5. Milk yield, milk composition, BW, and BCS of cows fed the treatment diets (n = 36)

5.6% increase in protein yield as ratio achieved about 1.5:1

~7% increase in lactose yield at same ratio

Suggests cows were AA limiting

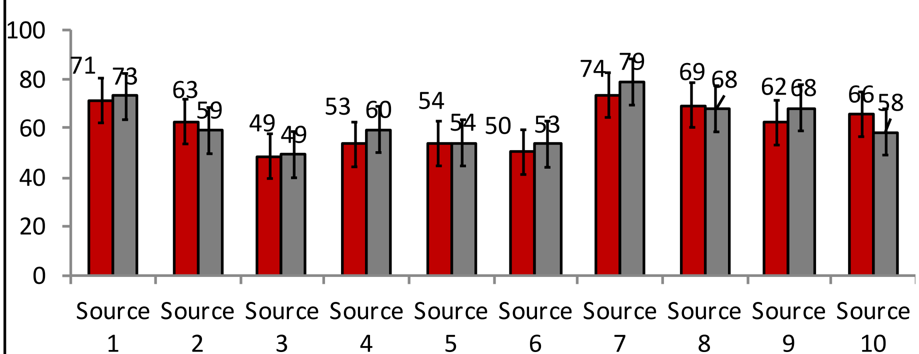
	Treatment[1]					P-value[2]		
Fat, %	3.71	3.57	3.57	3.48	0.09	0.04	0.27	0.47
Protein, kg/d	1.53	1.58	1.58	1.62	0.05	0.07	<0.01	0.03
Protein, %	3.18	3.21	3.21	3.24	0.05	0.47	0.02	0.42
Lactose, kg/d	2.15	2.24	2.25	2.30	0.06	0.05	<0.01	0.05
Lactose, %	4.47	4.54	4.55	4.57	0.03	0.05	0.05	0.08
FCM/DMI	1.71	1.71	1.72	1.73	0.03	0.95	<0.01	0.04
BW, kg	710	705	704	709	10.2	0.25	0.06	0.66
BW change, kg/d	0.50	0.84	0.96	0.84	0.09	0.01	0.74	0.61
BCS	3.31	3.36	3.38	3.35	0.05	0.63	0.14	0.13
BCS change	0.08	0.15	0.22	0.28	0.04	<0.01	0.25	0.76

De Souza et al., 2019 JDS

Pay Attention To Digestibility

Mobile Bag vs Ross, dRUP

Hydrolyzed feathermeal

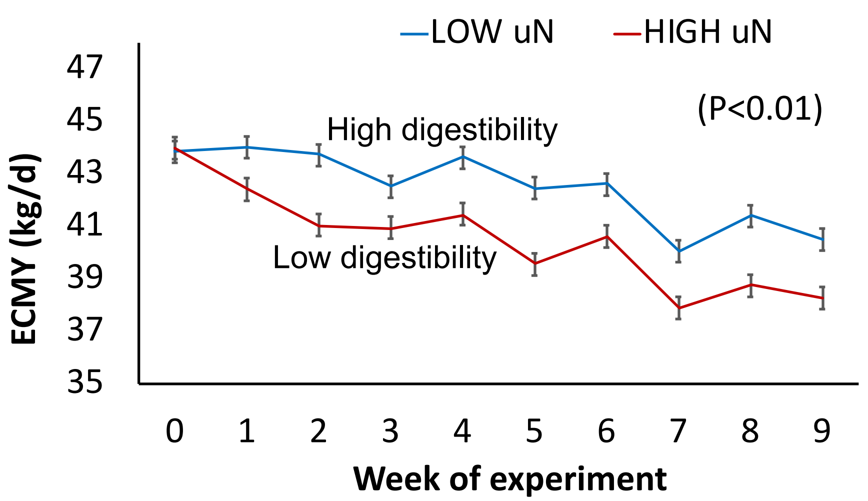


(Buse et al., 2019)

Chemical Composition of Diets Fed

	Treatment[1]	
Item,	LOW uN	HIGH uN
DM, % as fed	50.0	50.5
CP, % DM	15.2	15.2
NDF, % DM	31.9	32.3
ADF, % DM	21.3	20.5
EE, % DM	4.3	3.9
Starch, % DM	30.4	31.2
Sugar, % DM	3.6	3.3
Ca, % DM	0.65	0.60
P, % DM	0.43	0.43
ME*, Mcal/kg DM	1.8	1.7
Lys:Met*, % MP	3.21	2.89

Energy Corrected Milk (LS Means)

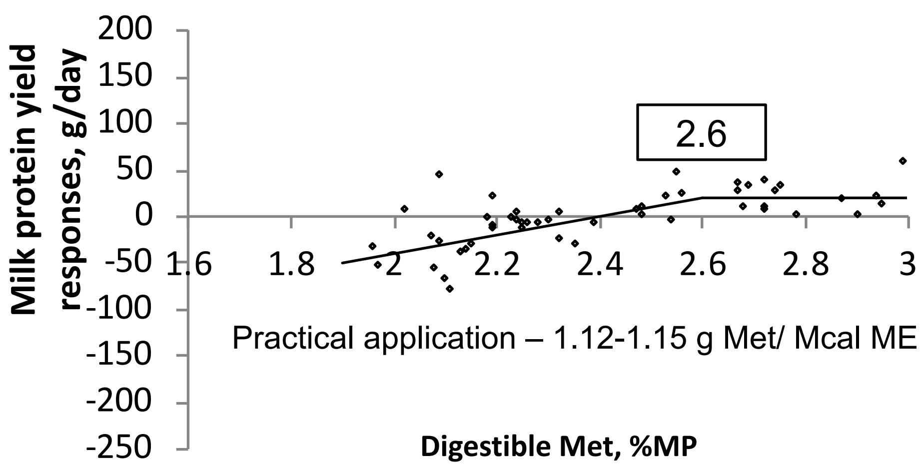


Results

Item[1]	Treatment		SEM	P-value
	LOW uN	HIGH uN		
DMI, lb	60	60	1.34	0.75
N Intake, g	671	664	14.8	0.77
Milk production				
Milk, lb	93	89	0.68	<0.01
ECM, lb	92	88	0.71	<0.01
Fat, lb	3.33	3.13	0.04	<0.01
Protein, lb	2.78	2.71	0.02	0.03
Milk composition				
Fat, %	3.6	3.5	0.03	<0.03
Protein, %	3.03	3.06	0.02	0.20
Lactose, %	4.9	4.86	0.02	0.18
MUN, mg/dl	9.4	8	0.18	<0.01

[1] DMI: dry matter intake, ECM: energy corrected milk (Tyrrell and Reid, 1965), MUN: milk urea nitrogen

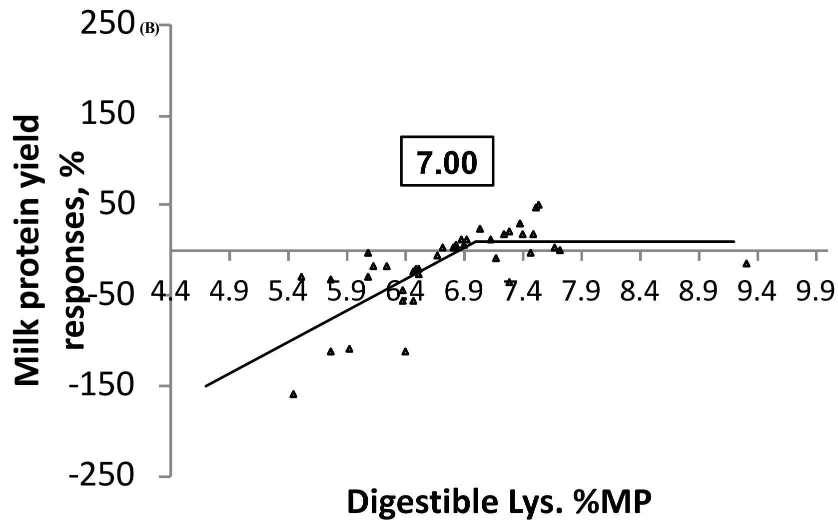
BALANCING FOR MET – UPDATED AA PROFILES – MILK PROTEIN YIELD v6.5



Practical application – 1.12-1.15 g Met/ Mcal ME

Source: Van Amburgh et al., JDS 2015

BALANCING FOR LYS – UPDATED AA PROFILES – MILK PROTEIN YIELD V6.5



Van Amburgh et al., JDS 2015

Optimum Supply Of Each EAA Relative To Metabolizable Energy – CNCPS v7.0

AA	R^2	Efficiency from our evaluation	Lapierre et al. (2007)	g AA/ Mcal ME	% EAA
Arg	0.81	0.61	0.58	2.04	10.2%
His	0.84	0.77	0.76	0.91	4.5%
Ile	0.74	0.67	0.67	2.16	10.8%
Leu	0.81	0.73	0.61	3.42	17.0%
Lys	0.75	0.67	0.69	3.03	15.1%
Met	0.79	0.57	0.66	1.14	5.7%
Phe	0.75	0.58	0.57	2.15	10.7%
Thr	0.75	0.59	0.66	2.14	10.7%
Trp	0.71	0.65	N/A	0.59	2.9%
Val	0.79	0.68	0.66	2.48	12.4%

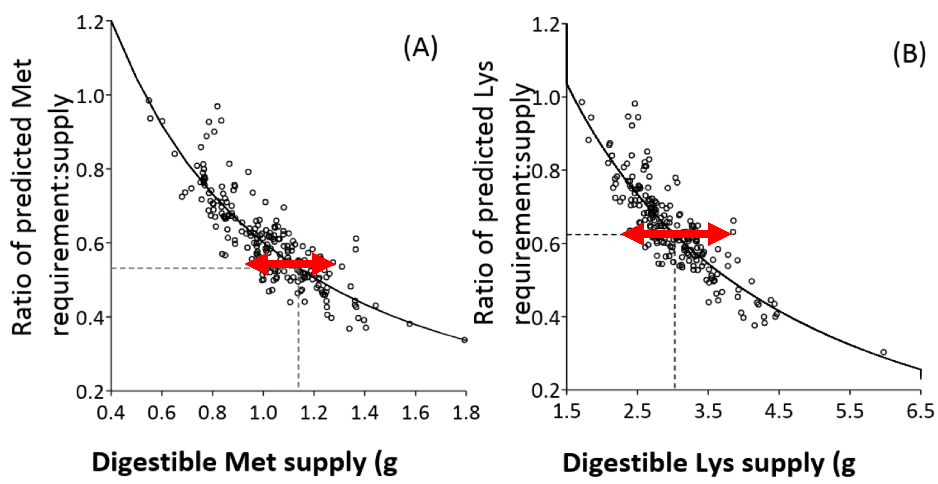
Lys and Met requirements 14.9%, 5.1% - Schwab (1996) 2.9:1

Lys and Met requirements 14.7%, 5.3% - Rulquin et al. (1993) 2.77:1

EXP 778-Experimental Design

Conducted as a pen study
- Three pens per treatment; 16 cows per pen
  (144 total cows used)
- Primi- (no more than 25% of pens) and Multiparious cows will be used
- Days in milk upon enrollment will range between 60 and 120 days
- Cows blocked by parity, body weight, previous milk production

A.LaPierre et al., 2019



Dashed lines represent AA supply at the optimum ratio of model predicted

Diets

Ingredient, % DM	Negative	Neutral	Positive
Corn silage	51.49	51.49	50.40
High moisture ear corn	9.43	9.46	9.93
Triticale	7.25	7.25	7.98
Corn grain	6.38	6.42	5.95
Soybean meal	8.16	5.55	2.72
Soybean hulls	9.25	3.84	2.83
SoyPLUS	.	0.91	3.59
Canola	1.81	9.17	6.31
Urea	0.62	0.51	0.51
Rumen Protected Met	.	0.04	0.05
Rumen Protected Lys	.	.	0.07
Blood meal	.	.	3.08
Energy Booster	0.73	0.73	0.91
Dextrose	1.63	1.63	2.18
Minerals and Vitamins	3.26	2.90	3.15

Chemical Component, % DM	Negative	Neutral	Positive
Dry Matter, %	44.7	44.5	44.2
Crude Protein	14.0	14.7	16.0
ADICP, % CP	5.70	5.90	5.50
NDICP, % CP	15.0	15.5	18.7
aNDFom	32.4	31.0	31.4
Lignin	2.61	3.00	2.70
Sugar	3.95	4.10	3.90
Starch	29.8	29.3	29.3
Fat	3.50	3.60	3.80
Ash	6.60	6.90	6.60
NH3	0.80	0.90	0.80
RUP, % CP	28.5	29.9	31.3
ME Mcal/kg	2.58	2.60	2.61

A.LaPierre et al., 2019

EAA, grams	Negative	Neutral	Positive
Arginine	143.14	161.04	164.43
Histidine	62.78	70.42	83.81
Isoleucine	147.85	162.37	160.56
Leucine	229.92	253.31	286.27
Lysine	201.70	222.12	250.07
Methionine	71.44	78.30	92.67
Phenylalanine	153.00	164.71	181.63
Threonine	144.43	161.78	171.85
Tryptophan	45.92	48.93	44.66
Valine	161.01	179.55	197.46

A.LaPierre et al., 2019

Intake & milk production, lb/d	Negative	Neutral	Positive	SEM
Dry matter intake	60.4	62.2	62.8	0.6
Milk yield	82.7[a]	88.4[bx]	91.2[by]	1.0
Energy correct milk yield	90.4[a]	96.3[bx]	99.4[by]	1.2
True protein yield	2.56[a]	2.78[b]	2.84[b]	0.02
Fat yield	3.39[a]	3.53[ab]	3.64[b]	0.07
Lactose yield	3.97[a]	4.23[b]	4.34[b]	0.07
Milk composition, %				
True protein	3.08[a]	3.15[b]	3.13[b]	0.02
Fat	4.14	4.08	4.09	0.06
Lactose	4.78	4.80	4.80	0.01

[a,b] Denote significant differences ($P < 0.05$) [x,y] Denote trends ($P < 0.10$)

A.LaPierre et al., 2019

Methionine and Lysine Feeding Levels

- The diets for this experiment were developed in CNCPS v7 and were reanalyzed in v6.55 post study.
- The optimum methionine level for v6.55 was 1.19 g MP Met per Mcal ME (CNCPS v6.55)
- This is a little higher than v7 (1.14 vs 1.19) and reflects differences in protozoa and endogenous protein
- As in both versions, need to maintain a Lys:Met of ~ 2.7:1 – make sure you have adequate digestible Lysine

Methionine and Lysine and Relative to Energy using CNCPS v6.55

60 Mcals ME, then (60 mcal*1.19 g/Mcal) = 71.4 g Met

The lysine requirement should be (7/2.6 =2.7 x Met)

Therefore 2.7 (Lys:Met) *71.4 g = 193 g Lys

Always calculated Met first – what the gram/energy relationship was derived from

Then calculate lysine otherwise the ratio will provide incorrect values

Thank you for your attention