

Table 1. Cooperator farms and diet ingredient and chemical composition information at the initiation of the study

Item	Average	SD	Minimum	Maximum
Arable land, ac	240	386	6	1255
Number of lactating cows	157	155.6	39	550
Milk production, kg/d	32	4.9	24	40
Milk fat, %	3.75	0.234	3.43	4.14
Milk true protein, %	3.08	0.106	2.87	3.29
Milk lactose, %	4.80	0.062	4.68	4.88
MUN, mg/dL	14.0	0.99	12.9	16.2
TMR DM intake, kg/d				
Formulated	23	1.3	21	24
Actually fed <sup>1</sup>	21	1.8	18	24
Diet ingredient composition, % of DM				
Corn silage	33	8.7	17	46
Legume haylage <sup>2</sup>	23	10.5	0	38
Hay (legume or grass)	2.7	3.90	0	10
Corn grain	10	9.9	0	23
High-moisture corn grain	6.6	8.68	0	26
SBM or roasted SB <sup>3</sup>	3.3	3.41	0	9.2
Energy/protein premix <sup>4</sup>	18	5.07	11	30
Analyzed diet composition, % of DM				
NDF	35	2.8	31	40
ADF	22	2.3	18	25
NFC	41	1.8	39	44
NE <sub>L</sub> , Mcal/kg	1.66	0.050	1.57	1.75
Ca	0.87	0.104	0.66	0.98
P	0.39	0.023	0.34	0.42

<sup>1</sup> Estimated based on farm data.

<sup>2</sup> One farm fed triticale silage at 7% of dietary DMI.

<sup>3</sup> Soybean meal or whole, roasted soybeans.

<sup>4</sup> Commercial premixes with various compositions.

Table 2. Analyzed dietary crude protein (CP) content before and after implementing the low-protein diets (n = 11) and an example of feed ingredient changes implemented on one farm

Item	HighCP <sup>1</sup>	LowCP
	(Fall 2009 – Spring 2010)	(Fall 2010 – Spring 2011)
Average dietary CP, % DM	16.5	15.4
SD	0.59	0.67
Minimum	15.7	13.6
Maximum	17.6	15.9
SEM		0.18
<i>P</i> -value <sup>2</sup>		< 0.001
Example diets from one cooperator farm, ingredients are % of dietary DM <sup>3</sup>		
Corn silage	38.0	41.0
Legume haylage	18.5	7.56
Rye silage	-	6.32
Corn grain, ground	15.2	1.54
High-moisture corn grain	-	12.6
SBM, 48% CP	9.24	4.49
Whole cottonseed, with lint	-	9.27
Soybean hulls	4.68	-
Distillers grain	3.79	2.89
Bakery by-product	-	3.92
Proprietary protein supplement	2.79	3.75
Wheat middlings	-	0.93
Proprietary energy supplement	2.04	1.54
Cottonseed hulls	0.94	-
Animal fat	0.52	-
Molasses (cane)	0.31	0.36
Mineral, vitamins, and other minor ingredients	3.99	3.83
Formulated CP, % DM	17.0	16.0

<sup>1</sup>HighCP and LowCP represent high- and low-dietary CP periods of the study.

<sup>2</sup>*P*-value for the main effect (dietary CP concentration).

<sup>3</sup>Both diets were formulated (proprietary formulation program) for a 614 kg BW cow, with 36 kg/d milk production, 3.60% milk fat, and 3.00% milk CP at 21.8 (HighCP) and 21.6 (LowCP) kg DMI/d. HighCP and LowCP represent high- and low-dietary CP periods of the study.

Table 3. Gaseous emissions from manure before and after implementing the low-protein diets

Item	HighCP <sup>1</sup>	LowCP	SEM	P-value <sup>2</sup>
Barn floor emissions, mg/m <sup>2</sup> per h (n = 7; averaged across manure systems)				
Ammonia	445	186	51.5	< 0.001
Nitrous oxide	0.74	0.84	0.256	0.42
Methane	682	313	212.1	0.007
Carbon dioxide	5,307	3,823	1,226.6	0.05
Ambient temperature, °C	13.6	6.4	1.15	< 0.001
Relative humidity, %	56.8	58.0	3.73	0.81
Manure temperature, °C	13.0	8.1	1.06	< 0.001
Manure thickness, mm	164	113	60.7	0.05
Gaseous emitting potential of manure (n = 11; averaged across manure systems)				
Ammonia	378	291	15.0	< 0.001
Nitrous oxide	- <sup>3</sup>	-	-	-
Methane	32	33	1.80	0.71
Carbon dioxide	1,847	1,813	67.5	0.69

<sup>1</sup>HighCP and LowCP represent high- and low-dietary CP periods of the study.

<sup>2</sup>P-value for the main effect (dietary CP concentration).

<sup>3</sup>Not detected.

Table 4. Gaseous emissions from manure before and after implementing the low-protein diets

Item	Manure system (n = 2)			SEM	P-value <sup>2</sup>
	Flush <sup>1</sup>	G/S	G/F		
Barn floor emissions, mg/m <sup>2</sup> per h					
Ammonia	167 <sup>b</sup>	352 <sup>a</sup>	426 <sup>a</sup>	57.3	0.02
Nitrous oxide	0.23	1.40	1.03	0.36	0.09
Methane					
HighCP <sup>3</sup>	58 <sup>c</sup>	526 <sup>b</sup>	1,806 <sup>a</sup>	156.3	< 0.001
LowCP	17 <sup>b</sup>	445 <sup>a</sup>	624 <sup>a</sup>		
Carbon dioxide	2,043	6,975	5,829	2,069	0.30
Manure characteristics					
Temperature, °C	8.5	13.6	11.2	0.79	< 0.001
Thickness, mm	23	137	327	7.13	0.01

<sup>1</sup>G/S, gutter-scrape; G/F, gravity-flow.

<sup>2</sup>P-value for the main effect (manure system). Interactions dietary CP × manure system, ammonia ( $P = 0.12$ ), nitrous oxide ( $P = 0.71$ ), methane ( $P < 0.001$ ), carbon dioxide ( $P = 0.72$ ).

<sup>3</sup>HighCP and LowCP represent high- and low-dietary CP periods of the study.

Table 5. Bulk tank milk yield, milk composition, and income-over-feed-costs before and after implementing the low-protein diets

Item	HighCP <sup>1</sup>	LowCP	SEM	<i>P</i> -value <sup>2</sup>
Milk yield, kg/d	32.2	32.5	1.58	0.81
Milk composition				
Milk fat, %	3.66	3.87	0.101	0.12
Milk crude protein, %	3.08	3.08	0.032	0.72
Milk lactose, %	4.80	4.81	0.018	0.20
MUN, mg/dL	14.5	13.3	0.45	0.06
Income-over-feed costs, \$/d	6.75	7.37	0.271	0.07

<sup>1</sup>HighCP and LowCP represent high- and low-dietary CP periods of the study.

<sup>2</sup>*P*-value for the main effect (dietary CP concentration).