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**LEAST COST BALANCED DAIRY RATIONS  
FOR THREE FORAGE BASES AND  
FOUR ANNUAL MILK PRODUCTION RATES**

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INTRODUCTION

When planning feeding and corresponding cropping programs, dairy farmers need information on how alternative forage bases and annual milk production rates impact on ration composition. Impact on total ration cost is also important, especially for those purchasing all feeds for their herd. The purpose of this paper is to provide dairy cow rations for alternative forage bases and milk production rates for use by dairy farmers in planning feeding programs and others interested in use of this information for research and extension purposes. The rations are based on results of a least cost balanced dairy ration computer program.<sup>1</sup> This effort is a part of a larger project to develop dairy cow and heifer enterprise budgets.

COW, LACTATION CURVE AND RATION CHARACTERISTICS

Production Levels and Animal Weights

Least cost balanced dairy rations were calculated for mature cows producing milk with 3.5 percent butterfat test at four production rates and corresponding cow body weights (Table 1).

Table 1. Annual Milk Production Per Cow and Corresponding Cow Body Weight\*

<u>Pounds of Milk Produced Per Year</u>	<u>Cow Body Weight, Pounds</u>
21,000	1,500
18,000	1,400
15,000	1,300
12,000	1,200

\*Annual milk production represents average production over 365 days.

<sup>1</sup>Milligan, R.A., L.E. Chase, C.J. Sniffen, W.A. Knoblauch, Least-Cost Balanced Dairy Rations NEWPLAN Program 31, Form 6 A.E. Ext. 81-24, A.S. Mimeo 54, Department of Agricultural Economics and Department of Animal Science, Cornell University, October 1981.

### Lactation Curve Division

The calving interval is specified to be 13 months, comprised of 336 days in milk and 60 days dry. Four groups are specified to be in the feeding program, three production groups and a dry group. The lactation curve divisions used are 112 days for each production group; high, medium, and low. The pounds of milk produced in each division were calculated using an unpublished 'Lotus 123' microcomputer template called "Ration I".<sup>2</sup> The lactation curves in this template are derived utilizing the "Woods Equation" commonly used for lactation curve analysis. The "Ration I" program calculates the cumulative pounds of milk produced over each division of the lactation curve based on total milk production and days in milk.

### Lead Factors

Lead factors were specified to formulate a production level sufficiently above the average for each group to avoid underfeeding all cows producing above the average while minimizing overfeeding of the remaining cows in the group. The lead factors used are as follows:

<u>Production Group</u>	<u>Lead Factor</u>
High	1.08
Medium	1.10
Low	1.10

### Daily Milk Production

The following table shows the calculation of daily milk production for the high, medium, and low production groups at each rate (Table 2). The average daily milk production is determined by dividing each groups total production by the days producing milk, 112 days. The milk per day is then multiplied by the lead factor to formulate a daily production level upon which dry matter intake and the nutrient requirements are based.

<sup>2</sup>Lazarus, Sheryl, Ration I, Unpublished, Department of Agricultural Economics, Cornell University.

Table 2. Calculation of Daily Milk Production for Ration Balancing

<u>Milk Production/Group</u>	<u>Pounds Produced</u>		<u>Days</u>		<u>Average Milk/Day</u>		<u>Lead Factor</u>		<u>Ration Balanced For Daily Production</u>
<u>21,000</u>									
HIGH	9,657	+	112	=	86	x	1.08	=	93
MED	7,951	+	112	=	71	x	1.10	=	78
LOW	5,175	+	112	=	46	x	1.10	=	51
<u>18,000</u>									
HIGH	8,278	+	112	=	74	x	1.08	=	80
MED	6,816	+	112	=	61	x	1.10	=	67
LOW	4,436	+	112	=	40	x	1.10	=	44
<u>15,000</u>									
HIGH	6,898	+	112	=	62	x	1.08	=	67
MED	5,679	+	112	=	51	x	1.10	=	56
LOW	3,697	+	112	=	33	x	1.10	=	37
<u>12,000</u>									
HIGH	5,518	+	112	=	49	x	1.08	=	54
MED	4,544	+	112	=	41	x	1.10	=	45
LOW	2,957	+	112	=	26	x	1.10	=	29

#### Forage Bases

Separate feed budgets were formulated for three forage bases at each production level. The forage bases were selected to represent the range in possible systems used by dairy farmers. They are:

1. Corn silage (CS) based, limiting mixed mainly legume (MML) hay crop silage to 20 percent of the forage on a dry matter basis.
2. 50 percent corn silage and 50 percent MML hay crop silage on a dry matter basis.
3. All MML hay crop silage, no corn silage in the ration.

#### Feeds and Nutrient Requirements

The conventional feeding option in the model of roughages and concentrates fed separately was used for both milking and dry cows. Nutrient composition of feeds is from Milligan, et al.<sup>3</sup> which is based on NRC 1978.<sup>4</sup>

<sup>3</sup>Milligan, R.A., L.E. Chase, C.J. Sniffen, W.A. Knoblauch, Least-Cost Balanced Dairy Rations NEWPLAN Program 31, Form 6 A.E. Ext. 81-24, A.S. Mimeo 54, Department of Agricultural Economics and Department of Animal Science, Cornell University, October 1981.

<sup>4</sup>Nutrient Requirements of Dairy Cattle, National Research Council, Fifth Revised Edition, 1978.

Dry matter, nutrient content, fiber content, discount factor and cost of the forages, and all other feeds are shown in Table 3.

Table 3. Feed Characteristics Used in Ration Formulation

<u>Feeds</u>	<u>Dry Matter</u> %	<u>Adj. Crude Protein</u> % of DM	<u>Soluble Protein</u> % of Protein	<u>Acid Detergent Fiber</u> % of DM	<u>Net Energy*</u> Mcal/lb DM	<u>Disc. Factor**</u>	<u>Cost</u>
<u>Forage/Concentrate</u>							
Corn silage (CS)	35	8.5	45	28	0.79	5.3	\$24.00/ton
Hay crop silage (MMLHCS)	45	14.5	52	38	0.65	4.0	\$39.40/ton.
Ground shelled corn (GSC)	89	10.0	12	3	1.01	3.3	\$5.70/cwt.
Soybean oil meal (SOM)	90	48.9	18	10	0.92	5.1	\$12.00/cwt.
<u>Minerals</u>							
Trace mineral salt	99	0	0	0	0	--	\$6.00/cwt
Calcium sulfate	99	0	0	0	0	--	\$6.00/cwt.
Dicalcium phosphate	99	0	0	0	0	--	\$17.00/cwt.
Limestone	99	0	0	0	0	--	\$2.00/cwt
Magnesium oxide	99	0	0	0	0	--	\$20.00/cwt.
Magnesium sulfate	99	0	0	0	0	--	\$11.00/cwt
Monosodium phosphate	99	0	0	0	0	--	\$26.25/cwt.
Magnesium potassium sulfate	99	0	0	0	0	--	\$9.00/cwt.
Vitamin premix	99	0	0	0	0	--	\$65.00/cwt.

\*1 x maintenance

\*\*Percent the net energy value is discounted per increment of maintenance.

#### Modification of Nutrient Constraints

The forage was fed on a 100 percent dry matter basis to eliminate the moisture depressant equation in the model which would have reduced dry matter intake as the moisture content of the ration increased as long as all nutrients including soluble protein are balanced correctly.<sup>5</sup> The maximum protein solubility constraint was set at 35 percent maximum protein

<sup>5</sup>This means that the rations formulated in most instances can also be used when feeding dry hay.

solubility for the high group, 40 percent for the medium group, and 50 percent for the low and dry groups.<sup>6</sup>

### RATIONS

The resulting rations for the four milk production rates and three forage bases are presented in Table 4. Detailed ration composition by production and dry group is contained in Appendix Tables A1-A4 for forages and concentrates and Appendix Tables B1-B4 for minerals. The values in Table 4 for both physical quantities and costs are or are based on quantity consumed. That is, they do not include harvest, feeding or storage losses. When planning feeding programs to determine the total amount to be placed in storage, these values need to be increased by the losses which occur on the specific farm being analyzed. These losses could range from as low as 10 percent to 30 percent or higher.

By examining section A or B of Table 4 it is apparent that with increased milk production, increased quantities of feed are also required. When moving from 12,000 to 21,000 pounds of milk produced per year with the high corn silage forage base, the tons of forage dry matter per cow increases from 4.3 to 5.6. Pounds of corn grain and soybean meal show similar increases as milk production increases.

The 50/50 hay crop silage/corn silage forage base contains the highest forage dry matter content, followed by the 80 percent corn silage. As would be expected, the ration with the lowest forage dry matter content, the all hay crop silage ration, has the highest content of concentrates. Approximately 3/4 ton more concentrate per cow is required with the all hay crop silage forage base than with the 50/50 or 80 percent corn silage forage base.

<sup>6</sup>Modified from Sniffen, C.J. "An Update on Protein Solubility and Degradability in Dairy Nutrition" contained in 1985 Winter Dairy Management School, Cornell Recommends, No. 84, Department of Animal Science, January 1985.

Table 4. Quantities Consumed Over the Calving Interval, Year and Cost for Four Production Levels and Three Forage Bases

A. Physical Quantities Consumed Per Cow For The 396 Day Calving Interval

Pounds of Milk	Forage Base											
	80% CS				50/50 HCS/Corn Silage				All-HCS			
	MML	Corn Silage	GSC 89%	SOM 90%	MML	Corn Silage	GSC 89%	SOM 90%	MML	Corn Silage	GSC 89%	SOM 90%
21,000	1.1	4.5	1.60	1.33	3.0	3.0	1.88	.96	5.1	3.21	3.21	.56
18,000	1.1	4.2	1.15	1.14	2.9	2.9	1.31	.77	4.9	2.65	2.65	.39
15,000	1.0	3.9	.76	.95	2.8	2.8	.76	.57	4.4	2.26	2.26	.29
12,000	.9	3.4	.59	.77	2.5	2.5	.55	.43	3.7	1.98	1.98	.22

B. Physical Quantities Consumed Per Cow For a Year, 365 Days

Pounds of Milk	Forage Base											
	80% CS				50/50 HCS/Corn Silage				All-HCS			
	MML	Corn Silage	GSC 89%	SOM 90%	MML	Corn Silage	GSC 89%	SOM 90%	MML	Corn Silage	GSC 89%	SOM 90%
21,000	1.0	4.1	1.47	1.23	2.8	2.8	1.73	.88	4.7	2.96	2.96	.52
18,000	1.0	3.9	1.06	1.05	2.7	2.7	1.21	.71	4.5	2.44	2.44	.36
15,000	.9	3.6	.70	.88	2.6	2.6	.70	.53	4.1	2.08	2.08	.27
12,000	.8	3.1	.54	.71	2.3	2.3	.51	.40	3.4	1.83	1.83	.20

C. Cost of Ration Per Cow Including Minerals

Pounds of Milk	80% Corn Silage		50/50 HCS/Corn Silage		All-HCS	
	Per Day	Per Year	Per Day	Per Year	Per Day	Per Year
21,000	\$2.38	\$868	\$2.37	\$865	\$2.46	\$897
18,000	2.07	756	2.05	748	2.15	783
15,000	1.76	643	1.73	631	1.85	674
12,000	1.48	540	1.44	526	1.56	569



The daily dry matter intake per cow for all forage bases and production rates decreases when moving from the high group to the dry group (Table 5). The percent forage increases when moving from the high group to the low group for all forage bases and production rates. The only situation where percent forage does not increase is with the all hay crop silage base when moving from the low group to the dry group.



## RETURNS OVER FEED COSTS

The highest returns over feed cost occurred at 21,000 pounds production per cow and were lower at each lower level of production (Table 6, see also Appendix Table C for detail on ration cost). Return over feed cost at 21,000 pounds annual production is almost twice that of 12,000 pounds annual production.

Table 6. Annual Return Over Feed Cost for Three Forage Bases and Four Annual Rates of Milk Production Per Cow, 396 Day Calving Interval.\*

	Forage Base		
	80% CS	50/50	ALL HCS
<u>12,000 Pounds Production</u>			
Value of Milk	\$1,410	\$1,410	\$1,410
<u>Feed Cost</u>	<u>540</u>	<u>526</u>	<u>569</u>
Return Over Feed Cost	\$ 870	\$ 884	\$ 841
<u>15,000 Pounds Production</u>			
Value of Milk	\$1,763	\$1,763	\$1,763
<u>Feed Cost</u>	<u>643</u>	<u>631</u>	<u>674</u>
Return Over Feed Cost	\$1,120	\$1,132	\$1,089
<u>18,000 Pounds Production</u>			
Value of Milk	\$2,115	\$2,115	\$2,115
<u>Feed Cost</u>	<u>756</u>	<u>748</u>	<u>783</u>
Return Over Feed Cost	\$1,359	\$1,367	\$1,332
<u>21,000 Pounds Production</u>			
Value of Milk	\$2,468	\$2,468	\$2,468
<u>Feed Cost</u>	<u>868</u>	<u>865</u>	<u>897</u>
Return Over Feed Cost	\$1,600	\$1,603	\$1,571

\*Value of milk is \$11.75 per hundredweight and all costs and returns are on an annual basis.

In considering the three forage bases at each milk production rate, the highest returns over feed cost occurred when feeding a forage of 50 percent corn silage and 50 percent hay crop silage on a dry matter basis (Table 7).

The 80 percent corn silage base was a close second particularly at the 21,000 production level where there was only a \$3 difference. Returns using all hay crop silage as the forage base came in a poor third with the largest difference at the 15,000 pound production level showing a \$43 per cow difference.

Table 7. Return Over Feed Cost Comparisons\*

Forage Bases**	Production Rate, Pounds Per Cow Per Year			
	12,000	15,000	18,000	21,000
50/50 vs. All HCS	+\$43	+\$43	+\$35	+\$32
50/50 vs. 80% CS	+14	+12	+8	+3
80% CS vs. All HCS	+29	+31	+27	+29

\*Calculated as value of milk purchased minus feed costs. Milk was valued at \$11.75 per hundredweight.

\*\*First forage system listed is the higher return over feed cost system. Thus, for example, the 50/50 system has a \$43 per cow per year advantage at the 12,000 pound production level over the all hay system.

Care should be exercised when extrapolating this comparison to situations in which the relative costs between hay and corn silage, and corn grain and soybean are different than those specified in this analysis. As the cost of corn silage increases relative to hay, systems using corn silage will have their current advantage reduced and if the price increase is large, the advantage may totally disappear. A similar observation can be made in regard to corn grain and soybean costs. If the cost of corn grain increases relative to soybean meal, those forage systems using larger amounts of corn grain will see their current return over feed cost situation deteriorate.

Storage and feeding losses also need to be considered when making a final comparison. For example, if the storage losses on hay crop silage were very large, that could result in a deterioration of the position of those forage bases containing large amounts of hay crop silage. The milk price will impact the magnitude of return above feed cost, but will not change the relative ranking of systems.

These may appear to be small savings for one forage system over another. However, for a 100 cow dairy the differences between systems are therefore multiplied by 100. For example, the 50/50 vs. All HCS at 18,000 pounds of milk per cow represents a \$3,500 difference in the cost of the ration. This is not a small amount in comparison to net farm income on many farms.

Before a decision to change forage systems is made, the cost of producing the farm grown forages and grain; harvest, storage and feeding losses as well as any capital costs for new field equipment, storage structures, and feeding equipment must be included. These factors could overshadow the cost savings from any change in the ration composition.



**APPENDIX**

APPENDIX TABLE A1. Composition and Cost of Least Cost Rations for Three Forage Bases by Production Group and by Feedstuff, 21,000 Pounds Annual Production per Cow, 396 Day Calving Interval.\*

	80% Corn Silage			50/50 Corn Silage/Hay Crop Silage			All Hay Crop Silage							
	MML HCS	CS	SOM	MML HCS	CS	SOM	MML HCS	GSC	SOM					
	100% DM	100% 89% DM	90% DM	100% DM	100% 89% DM	90% DM	100% DM	89% DM	90% DM					
	COST			COST			COST							
<u>High Group</u>														
Pounds	639.5	2557.0	1937.6	1501.9	1501.9	2339.7	956.5	2727.2	2914.2	726.9				
Cost	\$27.98	\$87.71	\$110.44	\$134.27	\$360.40	\$65.71	\$51.52	\$133.36	\$114.78	\$365.37	\$119.32	\$166.11	\$87.23	\$372.66
<u>Med Group</u>														
Pounds	799.7	3197.6	748.2	875.8	1911.8	1911.8	1219.7	661.9	3408.2	2002.6	379.7			
Cost	34.99	109.68	42.65	105.10	292.42	83.64	65.57	69.52	79.43	298.16	149.11	114.15	45.56	308.82
<u>Low Group</u>														
Pounds	618.2	2471.8	448.0	583.5	1951.0	1951.0	194.9	295.7	3483.2	1024.8	0.0			
Cost	27.05	84.78	25.54	70.02	207.39	85.36	66.92	11.11	35.48	198.87	152.39	58.41	0.0	210.80
<u>Dry Group</u>														
Pounds	187.2	749.4	54.6	84.0	577.8	577.8	0.0	0.0	622.8	475.8	0.0			
Cost	8.19	25.70	3.11	10.08	47.08	25.28	19.82	0.0	45.10	27.25	27.12	0.0	54.37	
Total Lbs.	2244.6	8975.8	3188.4	2662.2	5942.5	5942.5	3754.3	1914.1	10241.4	6417.4	1106.6			
Total Tn/Cwt.	1.1T	4.5T	31.9CWT	26.6CWT	3.0T	3.0T	37.5CWT	19.1CWT	5.1T	64.2CWT	11.1CWT			
Total Cost					\$907.29				\$907.50				\$946.65	

\*Not including mineral supplements. See Appendix Table B1 for mineral composition and cost.



APPENDIX TABLE A2. Composition and Cost of Least Cost Rations for Three Forage Bases by Production Group and by Feedstuff, 18,000 Pounds Annual Production per Cow, 396 Day Calving Interval.\*

	80% Corn Silage				50/50 Corn Silage/Hay Crop Silage				All Hay Crop Silage			
	MML HCS	CS	GSC	SOM	MML HCS	CS	GSC	SOM	MML HCS	GSC	SOM	COST
	100% DM	100%	89%	90%	100% DM	100%	89%	90%	100% DM	89%	90%	
	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	DM	COST
<u>High Group</u>												
Pounds	672.0	2690.2	1262.2	937.4	1572.5	1572.5	1701.3	768.3	2837.0	2320.6	529.8	
Cost	\$29.40	\$92.27	\$71.95	\$112.49	\$306.11	\$68.80	\$53.94	\$96.97	\$311.91	\$124.12	\$63.58	\$319.97
<u>Med Group</u>												
Pounds	716.8	2867.2	594.7	757.1	1913.0	1913.0	759.4	514.8	3360.0	1578.1	241.9	
Cost	31.36	98.35	33.90	90.85	254.46	83.69	65.62	43.39	61.78	254.38	147.00	265.98
<u>Low Group</u>												
Pounds	556.6	2226.6	384.2	505.1	1758.4	1758.4	156.8	245.3	3041.9	959.8	0.0	
Cost	24.35	76.37	21.90	60.61	183.23	76.93	60.31	8.94	29.44	175.62	133.09	187.80
<u>Dry Group</u>												
Pounds	176.4	706.2	54.0	81.0	546.6	546.6	0.0	0.6	595.2	445.8	0.0	
Cost	7.72	24.22	3.08	9.72	44.74	23.91	18.75	0.0	0.07	42.73	26.04	51.45
Total Lbs.	2121.8	8490.2	2295.1	2280.6	5790.5	5790.5	2617.5	1529.0	9834.1	5304.3	771.7	
Total Tn/Gwt	1.1T	4.2T	23.0CWT	22.8CWT	2.9T	2.9T	26.2CWT	15.3CWT	4.9T	53.0CWT	7.7CWT	
Total Cost					\$788.54				\$784.64			\$824.90

\*Not including mineral supplements. See Appendix Table B2 for mineral composition and cost.

APPENDIX TABLE A3. Composition and Cost of Least Cost Rations for Three Forage Bases by Production Group and by Feedstuff, 15,000 Pounds Annual Production per Cow, 396 Day Calving Interval.\*

	80% Corn Silage				50/50 Corn Silage/Hay Crop Silage				All Hay Crop Silage			
	MML HCS	CS	GSC	SOM	MML HCS	CS	GSC	SOM	MML HCS	GSC	SOM	COST
	100% DM	100% DM	89% DM	90% DM	100% DM	100% DM	89% DM	90% DM	100% DM	89% DM	90% DM	
<u>High Group</u>												
Pounds	688.8	2754.1	657.4	760.5	1631.8	1631.8	1086.4	580.2	2710.4	1859.2	383.1	
Cost	\$30.14	\$94.47	\$37.47	\$91.26	\$253.34	\$71.39	\$55.97	\$61.92	\$258.90	\$118.58	\$45.97	\$270.52
<u>Med Group</u>												
Pounds	621.6	2486.4	500.6	640.6	1900.6	1900.6	325.9	367.4	2950.1	1347.4	182.6	
Cost	27.20	85.28	28.53	76.87	217.88	83.15	18.58	44.09	211.01	129.07	76.80	227.78
<u>Low Group</u>												
Pounds	490.6	1963.4	310.2	414.4	1551.2	1551.2	108.6	184.8	2535.7	899.4	0.0	
Cost	21.46	67.34	17.68	49.73	156.21	67.87	6.19	22.18	149.45	110.94	51.27	162.21
<u>Dry Group</u>												
Pounds	165.6	663.0	52.8	78.0	514.8	514.8	2.4	0.0	568.2	416.4	0.0	
Cost	7.25	22.74	3.01	9.36	42.36	22.52	17.66	0.0	40.32	24.86	23.73	48.59
<u>Total lbs.</u>	1966.6	7866.9	1521.0	1893.5	5598.4	5598.4	1523.3	1132.4	8764.4	4522.4	565.7	
<u>Total tn/cwt</u>	1.0T	3.9T	15.2CWT	18.9CWT	2.8T	2.8T	15.2CWT	11.3CWT	4.4T	45.2CWT	5.7CWT	
<u>Total Cost</u>					\$669.79				\$659.28			\$709.10

\*Not including mineral supplements. See Appendix Tables B3 for mineral composition and cost.

APPENDIX TABLE A4. Composition and Cost of Least Cost Rations for Three Forage Bases by Production Group and by Feedstuff, 12,000 Pounds Annual Production per Cow, 396 Day Calving Interval.\*

	80% Corn Silage			50/50 Corn Silage/Hay Crop Silage			All Hay Crop Silage			
	MML HCS	CS	GSC	MML HCS	CS	GSC	MML HCS	GSC	SOM	
	100% DM	100%	89% DM	100% DM	100%	89% DM	100% DM	89% DM	90% DM	
	COST			COST			COST			
<u>High Group</u>										
Pounds	585.8	2343.0	476.0	1454.9	1454.9	759.4	436.8	2219.8	1560.2	303.5
Cost	\$25.63	\$80.36	\$27.13	\$72.98	\$63.66	\$49.91	\$52.42	\$209.28	\$97.12	\$88.93
<u>Med Group</u>										
Pounds	529.8	2121.3	403.2	1610.6	1610.6	269.9	290.1	2457.3	1167.0	141.0
Cost	23.18	72.76	22.98	62.50	181.42	70.46	55.24	15.38	34.81	175.89
<u>Low Group</u>										
Pounds	432.3	1729.3	244.2	332.6	1368.6	1368.6	66.1	129.9	844.5	0.0
Cost	18.92	59.32	13.92	39.91	132.07	59.88	46.94	3.77	15.59	126.18
<u>DIY Group</u>										
Pounds	154.8	619.8	51.6	75.0	483.6	483.6	0.0	3.6	540.6	387.0
Cost	6.77	21.26	2.94	9.00	39.97	21.16	16.59	0.0	.43	38.28
Total lbs.	1702.7	6813.4	1175.0	1536.6	4917.7	4917.7	1095.4	860.4	7354.4	3958.7
Total tn/cwt	.9T	3.4T	11.8CWT	15.4CWT	2.5T	2.5T	11.0CWT	8.6CWT	3.7T	39.6CWT
Total Cost					\$559.56				\$549.63	\$598.61

\*Not including mineral supplements. See Appendix Tables B4 for mineral composition and cost.

APPENDIX TABLE B1. Mineral Composition and Cost of Least Cost Rations for Three Forage Bases, 21,000 Pounds Annual Production Per Cow, 396 Day Calving Interval.

<u>Mineral</u>	<u>Forage Base</u>		
	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
		pounds	
Trace mineral salt	27.80	27.66	27.31
Calcium sulfate	1.92	--	--
Dicalcium phosphate	29.4	28.89	27.88
Limestone	51.33	34.54	8.95
Magnesium oxide	6.51	5.78	4.74
Vitamin premix	<u>2.80</u>	<u>2.81</u>	<u>2.80</u>
Cost	\$11.20	\$10.08	\$8.96
 <u>MEDIUM GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	25.21	24.97	15.33
Calcium sulfate	--	0.29	--
Dicalcium phosphate	28.59	27.84	--
Limestone	58.04	7.25	--
Magnesium oxide	5.54	5.18	4.01
Magnesium sulfate	3.03	--	--
Monosodium phosphate	--	--	19.27
Vitamin premix	<u>2.78</u>	<u>2.79</u>	<u>2.83</u>
Cost	\$11.20	\$8.96	\$8.69
 <u>LOW GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	18.73	19.55	11.37
Dicalcium phosphate	22.18	23.18	--
Limestone	76.54	41.69	--
Magnesium oxide	4.16	3.39	2.97
Magnesium sulfate	3.28	1.81	--
Monosodium phosphate	--	--	15.37
Vitamin premix	<u>2.80</u>	<u>2.79</u>	<u>2.77</u>
Cost	\$8.96	\$8.96	\$6.72
 <u>DRY GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	2.59	--	--
Dicalcium phosphate	8.62	1.48	0.73
Limestone	13.13	--	--
Magnesium oxide	0.99	0.80	0.60
Magnesium sulfate	0.16	--	--
Monosodium phosphate	--	5.23	4.95
Vitamin premix	<u>1.50</u>	<u>1.49</u>	<u>1.52</u>
Cost	\$3.00	\$3.00	\$2.40
Total Mineral Cost	\$34.36	\$31.00	\$27.04

APPENDIX TABLE B2. Mineral Composition and Cost of Least Cost Rations for Three Forage Bases, 18,000 Pounds Annual Production Per Cow, 396 Day Calving Interval.

<u>Mineral</u>	<u>Forage Base</u>		
	<u>80% CS</u>	<u>50/50</u> pounds	<u>ALL HCS</u>
<u>HIGH GROUP</u>			
Trace mineral salt	24.82	24.64	20.89
Calcium sulfate	2.45	--	--
Dicalcium phosphate	27.29	26.56	15.71
Limestone	37.73	20.57	--
Magnesium oxide	5.89	5.13	4.09
Magnesium potassium sulfate	--	--	--
Monosodium phosphate	--	--	7.09
Vitamin premix	<u>2.62</u>	<u>2.62</u>	<u>2.62</u>
Cost	\$10.08		\$8.96      \$7.84
<u>MEDIUM GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	22.51	20.76	13.50
Dicalcium phosphate	25.68	21.38	--
Limestone	94.42	--	--
Magnesium oxide	5.01	4.50	3.49
Magnesium potassium sulfate	3.23	0.52	--
Monosodium phosphate	--	2.90	17.36
Vitamin premix	<u>2.62</u>	<u>2.59</u>	<u>2.62</u>
Cost	\$10.08		\$7.84      \$7.84
<u>LOW GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	16.81	17.60	10.16
Dicalcium phosphate	19.98	20.92	--
Limestone	67.96	36.39	--
Magnesium oxide	3.74	3.54	2.71
Magnesium potassium sulfate	3.12	1.80	--
Monosodium phosphate	--	--	13.66
Vitamin premix	<u>2.63</u>	<u>2.63</u>	<u>2.60</u>
Cost	\$8.96		\$7.84      \$6.72
<u>DRY GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	2.44	--	--
Dicalcium phosphate	7.95	1.26	0.52
Limestone	12.35	--	--
Magnesium oxide	0.93	0.76	0.56
Magnesium potassium sulfate	0.13	--	--
Monosodium phosphate	--	3.56	4.70
Vitamin premix	<u>1.40</u>	<u>1.40</u>	<u>1.42</u>
Cost	\$3.00		\$2.40      \$2.40
Total Mineral Cost	\$32.12		\$27.04      \$24.80

APPENDIX TABLE B3. Mineral Composition and Cost of Least Cost Rations for Three Forage Bases, 15,000 Pounds Annual Production Per Cow, 396 Day Calving Interval.

<u>Mineral</u>	<u>Forage Base</u>		
	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
		pounds	
<u>HIGH GROUP</u>			
Trace mineral salt	21.80	21.46	12.86
Calcium sulfate	--	0.21	--
Dicalcium phosphate	24.81	23.93	--
Limestone	43.36	5.60	--
Magnesium oxide	4.78	4.46	3.42
Magnesium potassium sulfate	2.52	--	--
Monosodium phosphate	--	--	16.05
Vitamin premix	<u>2.42</u>	<u>2.41</u>	<u>2.40</u>
Cost	\$8.96	\$7.84	\$7.84
<u>MEDIUM GROUP</u>			
Trace mineral salt	19.35	14.90	11.72
Dicalcium phosphate	22.38	9.80	--
Limestone	80.81	--	--
Magnesium oxide	4.30	3.92	3.07
Magnesium potassium sulfate	2.91	0.84	--
Monosodium phosphate	--	9.58	15.24
Vitamin premix	<u>2.43</u>	<u>2.41</u>	<u>2.45</u>
Cost	\$8.96	\$7.84	\$6.72
<u>LOW GROUP</u>			
Trace mineral salt	14.45	15.27	8.94
Dicalcium phosphate	17.23	18.21	--
Limestone	57.16	29.74	--
Magnesium oxide	3.20	3.07	2.46
Magnesium potassium sulfate	2.97	1.83	--
Monosodium phosphate	--	--	11.89
Vitamin premix	<u>2.42</u>	<u>2.44</u>	<u>2.46</u>
Cost	\$7.84	\$6.72	\$5.60
<u>DRY GROUP</u>			
Trace mineral salt	2.30	--	--
Dicalcium phosphate	7.28	1.01	0.31
Limestone	11.56	--	--
Magnesium oxide	0.87	0.72	0.53
Magnesium potassium sulfate	0.10	--	--
Monosodium phosphate	--	4.75	4.45
Vitamin premix	<u>1.30</u>	<u>1.31</u>	<u>1.32</u>
Cost	\$2.40	\$2.40	\$2.40
Total Mineral Cost	\$28.16	\$24.80	\$22.56

APPENDIX TABLE B4. Mineral Composition and Cost of Least Cost Rations for Three Forage Bases, 12,000 Pounds Annual Production Per Cow, 396 Day Calving Interval.

<u>Mineral</u>	<u>Forage Base</u>		
	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
		pounds	
Trace mineral salt	18.20	17.94	10.57
Dicalcium phosphate	20.99	20.51	--
Limestone	76.16	1.16	--
Magnesium oxide	4.04	3.66	2.89
Magnesium potassium sulfate	2.70	0.40	--
Monosodium phosphate	--	--	13.44
Vitamin premix	<u>2.24</u>	<u>2.23</u>	<u>2.22</u>
Cost	\$8.96	\$6.72	\$6.72
<u>MEDIUM GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	16.25	9.64	9.58
Dicalcium phosphate	19.03	0.57	--
Limestone	67.08	--	--
Magnesium oxide	3.62	3.28	2.58
Magnesium potassium sulfate	2.68	0.87	--
Monosodium phosphate	--	13.65	12.52
Vitamin premix	<u>2.24</u>	<u>2.22</u>	<u>2.21</u>
Cost	\$7.84	\$6.72	\$5.60
<u>LOW GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	12.42	13.17	7.76
Dicalcium phosphate	14.81	15.70	--
Limestone	47.84	23.76	--
Magnesium oxide	2.76	2.64	2.21
Magnesium potassium sulfate	2.84	1.85	--
Monosodium phosphate	--	--	10.14
Vitamin premix	<u>2.23</u>	<u>2.25</u>	<u>2.30</u>
Cost	\$6.72	\$5.60	\$4.48
<u>DRY GROUP</u>			
<u>Mineral</u>	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
Trace mineral salt	2.14	--	--
Dicalcium phosphate	6.61	0.76	0.10
Limestone	10.77	--	--
Magnesium oxide	0.82	0.68	0.49
Magnesium potassium sulfate	0.07	--	--
Monosodium phosphate	--	4.53	4.19
Vitamin premix	<u>2.40</u>	<u>1.23</u>	<u>1.22</u>
Cost	\$2.40	\$2.40	\$1.80
Total Mineral Cost	\$24.92	\$21.44	\$18.60

APPENDIX TABLE C. Forage and Concentrate and Mineral Costs for Three Forage Bases and Four Annual Milk Production Rates Per Cow, 396 Day Calving Interval.\*

	Forage Base		
	<u>80% CS</u>	<u>50/50</u>	<u>ALL HCS</u>
<u>21,000 Pounds Production, 1,500 Pound Cow</u>			
Forages and concentrates	\$907.29	\$907.50	\$946.65
Minerals	<u>34.36</u>	<u>31.00</u>	<u>27.04</u>
	\$941.65	\$938.50	\$973.69
<u>18,000 Pounds Production, 1,400 Pound Cow</u>			
Forages and concentrates	\$788.54	\$784.64	\$824.90
Minerals	<u>32.12</u>	<u>27.04</u>	<u>24.80</u>
	\$820.66	\$811.68	\$849.70
<u>15,000 Pounds Production, 1,300 Pound Cow</u>			
Forages and concentrates	\$669.79	\$659.28	\$709.10
Minerals	<u>28.16</u>	<u>24.80</u>	<u>22.56</u>
	\$697.95	\$684.08	\$731.66
<u>12,000 Pounds Production, 1,200 Pound Cow</u>			
Forages and concentrates	\$559.56	\$549.63	\$598.61
Minerals	<u>24.92</u>	<u>21.44</u>	<u>18.60</u>
	\$584.48	\$571.07	\$617.21

\*Costs are for the total 396 day calving interval.