RELATIVE VALUES OF ROUGHAGE AND CONCENTRATE FOR MILK PRODUCTION

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INTRODUCTION

It has long been known that supplementation of the ration of dairy cows with concentrates was necessary if maximum milk production was to be attained. The feeding of roughage as the entire ration usually resulted in low levels of milk production. The feeding of concentrates concurrently with good roughages -- whether hay, pasture or silage -- resulted in greatly improved production. This improved production due to concentrate feeding was explained on the basis of increased intake of total digestible nutrients.

More recently experiments have been performed in which roughage was compared with concentrate on the basis of total digestible nutrient content. Replacement of a portion of the roughage ration of a cow with the same amount of total digestible nutrients in the form of grain resulted in higher level milk production. Attempts have been made to explain this on the basis of insufficiency of the "total digestible nutrient" system for the evaluation of feeds with concurrent attempts to substitute the "calculated net energy" system of feed evaluation to account for variation in milk production in the cases of ration change. Neither system of feed evaluation seems to hold the answer to the question since there obviously are complementary effects amoung certain feedstuffs which affect the "balance of the ration."

This investigation was initiated in an attempt to evaluate mathematically the value of total digestible nutrients in the form of concentrates relative to the value of total digestible nutrients in the form of roughages.

REVIEW OF LITERATURE

Factors known to affect milk production are easily divided into 2 categories -- inherent and environmental. The inherent factors affect milk production through efficiency of feed conversion and level of maximum productive capacity. The environmental factors may be classed as climatic, geographical and managerial.

Climatic variations are uncontrollable and influence milk production through variations in quality and quantity of feed available for consumption as well as the comfort of the animals. The geographical variations can not be separated from climatic variations because the latter are an essential causative agent in both. Variables such as plane of nutrition, season of calving, age at calving, length of dry period are managerial in nature and may be controlled.

Several investigators have not agreed on the effect of season on milk production. Ragsdale and Brody (1922) attributed responsibility for seasonal fluctuations to temperature variations. High temperature greatly reduced milk production. Cannon (1933) working with data from 68000 Iowa Cow Testing Association records found that cows calving in November produced more milk than those calving in June. Woodward (1945) analyzing 15442 Dairy Herd Improvement Association records essentially agreed with Cannon differing only in the low month -- July in this case. Contrary to the findings of Cannon and of Woodward, Wylie (1925) using 2900

Register of Merit records made in one year found that cows calving in June had the highest production. Woodward explained this inconsistancy on the basis of conditions under which the records were made. All of Wylie's data came from records made by cows on unusually high planes of nutrition and concentrate consumption. Arnold and Becker (1935) working with 319 records made in Florida found no significant differences in season of calving. They attributed the lack of significant variation in season to small changes in climatic conditions throughout the entire year. Dloufa and Jones (1948) in a study of 2690 records made in western Oregon found no significant differences in season of calving.

The effect of age at first calving was shown by Reed et al. (1924) to affect milk production. Heifers calving at 2 years of age produced less milk than heifers with similar inherent abilities and environmental conditions calving at 2 1/2 years of age.

Length of gestation during a lactation has been shown to exert a decided effect on production. Gavin (1913) found that lactation curves started dropping off very slightly from normal 4 months after conception. The maximum decline was reached during the fifth and sixth months following conception. Brody et al. (1923) found that cows in America took more time to reach the same point in decline than those in England. They noted that gestation exerted its maximum effect during the latter part of the fifth and

the sixth months. Gowen (1924) stated that the amount of energy needed by the developing fetus was equivalent to 400 to 600 pounds of milk. He also found that gestation exerted the greatest drain on the dam's energy as she approached 5 years of age. Lower nutritive requirements attributable to gestation were found as the cow aged beyond this point.

Another variable which can be controlled to some extent by management is dry period. Klein and Woodward (1943) reported that a 55-day dry period was optimum for cows calving at 12-month intervals. Longer period had much less effect on production. Hammond and Sanders (1923) in earlier work found 80 to 119 days to be the optimum interval. They reported a 13 per cent reduction in milk production following a 0 to 39-day dry period; 2.5 per cent reduction for 40 to 70 days; and over 120-day dry period resulted in a 2 per cent increase in milk production over that of their optimum.

Rations fed to dairy animals vary from an all roughage regime to one nearly devoid of roughage. In the heavily populated sections of the United States heavy concentrate feeding is practiced while in the western section of the country all roughage feeding programs are used by many farmers. Reed et al. (1924) reported that heifers raised on roughage alone were slower maturing than heifers raised on a combination of roughage and concentrates. Such heifers not only matured later but produced less milk in subsequent lactations.

Numerous investigators have worked with rations

composed entirely of roughages. Willard (1934) reported cows fed only roughage declined from peak production faster than cows fed some concentrates. In an experiment with high quality roughages, alfalfa hay and irrigated pastures, Woodward (1945) found production equivalent to that of cows fed concentrates at the rate of 2 to 12 pounds per day. Haag et al. (1929) studying the physiological effect of an all alfalfa ration noted that cows produced only half as much milk as expected. These workers attributed this to a probable insufficiency of total digestible nutrients. Lindsey and Archibald (1932) comparing low roughage rations with high roughage rations found greater consumption of total digestible nutrients on the former. The low roughage group produced more milk and were in better general physical condition. Efficiency of production was in favor of the low roughage group. Graves et al. (1938) working with an all alfalfa ration and with a full-feed ration found that the alfalfa fed group produced only 57 per cent as much milk and 60 per cent as much butterfat as when fed under a full-feed program. Cows fed alfalfa for 2 consecutive lactations produced 10 per cent less the second lactation than was produced during the first lactation. They found little difference in the efficiency between the 2 rations but that little difference was in favor of the alfalfa. Reed (1937) reported essentially the same results. Cows on roughage produced only 67 per cent as much milk and 62 per cent as much butterfat as when they were fed grain in addition

to roughage. Jensen et al. (1942) in a report compiled from 10 cooperating experiment station herds in a feeding program found that cows fed roughage alone produced only 80 per cent as much milk as comparable cows fed grain at the rate of one pound to 6 pounds of milk. This study in covering 10 states eliminated sectional variations. Graves et al. (1940) experimenting with 4 different rations found that full grain feeding produced approximately 16 per cent more milk than a ration in which barley was the sole concentrate. The barley ration was superior to an all roughage ration. Jones et al. (1934) reported that cows on a low-grain ration had very low production while similar cows on a similar ration but with more grain consumed more total digestible nutrients with greater efficiency of production and with less gain in weight. Smith et al. (1945) at the same station found that replacement of 13 to 25 per cent of the alfalfa total digestible nutrients with concentrate allowed cows to produce normally. Woll (1918) working with alfalfa as a sole feed for dairy cattle found that cows produced 45 per cent more butterfat on a mixed ration during the first lactation and 23 per cent more butterfat during the second lactation than when fed an all-alfalfa ration.

Haag (1931) reported that alfalfa crude protein was deficient in cystine. Huffman and Duncan (1942, 1944, 1947, 1949, 1950) in a series of experiments indicated that cystine was not a limiting factor in alfalfa for milk

production. They found in nearly all instances that concentrate in addition to alfalfa increased milk production. To compare different feeding stuffs cows were depleted on alfalfa until milk production leveled off. The feedstuff in question was then added to the ration. They found that cystine corn starch and sugar were all inactive in this regard since these feedstuffs did not increase production of 4 per cent fat corrected milk but iso-caloric amounts of corn and wheat increased milk production significantly. Davis and Kemmerer (1948) in paired feeding experiments found that milk production could be maintained when near iso-caloric amounts of dried citrus pulp were substituted for corn.

Headley (1930) indicated that alfalfa hay and grain were equally efficient for butterfat production on the basis of total digestible nutrient content. Redman (1952) concluded that roughages and concentrates are not freely substitutable but are complimentary. Milk was produced more efficiently when some grain was fed. He agreed with Jensen et al. (1942) that milk production was a curvilinear function of feed consumed. Increasing increments of feed were required to produce the same amount of four per cent fat corrected milk at higher levels of production. Headley (1943) indicated that a logarithmic function existed between total digestible nutrients and 4 per cent fat corrected milk. Baker and Tomhave (1944) found a straight-line relationship between total digestible nutrient intake and milk production. Borland et al. (1942) found that the milk yield per pound of grain

decreased as the amount of grain increased. Tennant and Fowler (1941) noted that annual production of 4 per cent fat corrected milk increased approximately 90 pounds for each 100 pounds increase in grain. Autrey (1941) reported significant differences in milk production when cows were fed roughage alone, limited grain and full grain. Saarinen et al. (1951) reviewed work of other investigators and found that isocaloric amounts of grain substituted for roughage were not equivalent "calculated net energy" values. They designed an experiment using "calculated net energy" as the basis for substitution of concentrates for roughages. Results of their experiment indicated corn was not superior to roughage on the "calculated net energy" basis for milk production. Moore et al. (1952) studied the relationship between the "total digestible nutrient" system and "calculated net energy" system for feed evaluation. They found that the difference between the two systems became progressively greater as the feedstuff total digestible nutrient value lowered and that variations "up to 100 % difference in the energy value of 1 lb. of TDN, depending on the feed" could be expected.

Huffman and Duncan (1952), in rebuttal to the proponents of the "calculated net energy" system of feed evaluation for the solution of this problem, showed that the inclusion of abnormally large amounts of indigestible organic matter, "ballast", in the ration did not cause a depression

in milk production as long as the balance of the ration was maintained. This group of workers (Huffman et al., 1952a) further substantiated their position by demonstrating that the inclusion of oakwood meal, wheat straw or peanut hulls in a balanced ration did not depress milk production. They demonstrated further that immature alfalfa and timothy hays had milk producing power not accounted for on the basis of coefficients of digestibility, starch equivalent, total digestible nutrient, or calculated net energy content (Huffman et al. 1952b). These workers indicated that the values of feeds were not necessarily additive in all cases, especially in the case of grain supplementation of a hay ration.

Davis et al. (1953) indicated there are no unidentified factors in concentrates for milk production. They explained the increased production on increases in productive energy consumed and "balance of the ration."

PROCEDURE

The data used in this study were those accumulated from 1934 to 1953 in the Michigan State College Experiment Station dairy nutrition herd. The study was made on 323 lactation records from 78 cows; 285 records made by 63 Holsteins, 26 by 6 Jerseys, and 12 by 9 scrubs.

Lactations of less than 250 days were not included in this study and those of more than 305 days were terminated at the 305-day point. The monthly fat test used was an average of 3-day composite tests for the month. Four per cent fat corrected milk was computed for each month by the use of Gaines' (1928) formula. The records were neither corrected for age of cow at calving nor for length if less than 305 days in duration.

June 1 to May 31 was selected as the feeding year. The year was divided into the seasons suggested by Cranek (1952). These were December, January and February in Group 1; March, April and May in Group 2; June, July and August in Group 3; and September, October and November in Group 4.

Lactations were grouped for age-at-calving analysis by 6-month intervals. The first group included all cows which calved prior to 2 years of age. Cows 12 years old and over were grouped in the last group. The procedure of dropping 15 days or less and adding a month to the age for 16 days or more was followed.

Weight changes were calculated for each lactation

of each cow. Three patterns were followed for obtaining cow weights during the time covered by this study. For periods when cows were weighed on three consecutive days each month, the first such weighing after calving was taken as the initial weight. The final weight was the weighing closest to the end of the lactation period. In cases where daily weighings were made, the initial weight was an average of the weights for the first month after calving and the final weight of the weighings for the last month of the lactation period. For records where weighings were made every third day, the fourth, fifth and sixth weighings after calving were averaged and used as the initial weight. The final weight was an average of the last 3 weighings before the end of the lactation.

Daily feed records were totaled for each lactation. The total digestible nutrient values for feed consumed were calculated using the values for each feed listed in the Appendix Table 2. The table was compiled from data compiled by Huffman (1953), Morrison (1948) and Schnieder (1947). Corn silage was separated into roughage equivalent and concentrate equivalent by using $\frac{\text{lbs. corn silage}}{8} \times 80.1$ for total digestible nutrients of corn grain and corn silage total digestible nutrients minus corn total digestible nutrients for hay value of the corn stalk-portion of the silage.

Bartlett's test of homogeneity of variance (1937) indicated that the data were sufficiently homogenous to be

analyzed. Statistical analyses for the effect of pasture, age at calving, season of calving, year of lactation and length of dry period were carried out according to patterns set forth by Snedecor (1946). Analysis of variance for each variable with 4 per cent fat corrected milk production was run without taking into account any other variable.

Correlation coefficients and regression equations were calculated for:

1. FCM vs. total TDN
2. FCM vs. Roughage TDN and Concentrate TDN
3. FCM vs. Roughage TDN, Concentrate TDN and Weight Change.

Since it was necessary to know the entire total digestible nutrient consumption during each lactation, 42 lactations during which the cows were on pasture for 2 or more days were eliminated from the analysis.

RESULTS

Three hundred-twenty-three records made by 78 cows were analyzed. The average number of lactations per cow was 4.14. The mean lactation, the 3.69th, indicated a predominance of first lactations as well as cows with unusually large numbers of lactations. First lactations comprised 22.3 per cent of the total. Seventy-five per cent of the lactations were 300 days or more in length with the average being 298 days. Individual records ranged from less than 4000 pounds to more than 15000 pounds of 4 per cent fat corrected milk. Bartlett's test was employed and indicated that the population was homogenous.

An analysis of variance for the effect of pasture on milk production (Table 1) indicated no significant difference between the averages of the 2 groups.

The analysis of variance for the effect of age at calving on milk production may be found in Table 2. The F test indicated significance at the 5 per cent level of probability.

The analysis of variance for the effect of the season of calving on milk production is recorded in Table 3. The seasonal differences were significant at the 5 per cent level of probability. The season of calving for maximum milk production was September, October, and November.

The year in which the lactation took place had a highly significant effect on the milk production level

(Table 4). The F value of 4.281 was highly significant at the one per cent level of probability. The average yearly production was significantly larger during the early years of this study.

The analysis of variance for the effect of length of previous dry period on milk production did not approach significance in this study (Table 5). The dry periods ranged in length from one day to nearly a year. Only 2 lactations were preceded by dry periods of 30 days or less.

The amount of concentrate total digestible nutrients received by cows in this study ranged from one to more than 6000 pounds. Roughage total digestible nutrient intake ranged from approximately 2000 pounds to approximately 7000 pounds. The total digestible nutrient intake ranged from approximately 4000 pounds to approximately 9000 pounds.

Age at calving, season of calving and year of lactation, variables which exerted barely significant effects on 4 per cent fat corrected milk production, lost their identity with redistribution of data and were not included as variables in the correlation analyses.

Necessarily lactations during which the cows were on pasture were not included in these analyses, leaving 281 lactations available with complete feed data.

The correlation coefficient, 0.817 ± 0.020, between 4 per cent fat corrected milk and total digestible nutrients was highly significant. The predicting equation for the

relationship between these two variables was found to be

FCM = 1.716 TDN - 2272 ± 1316 pounds.

The multiple correlation coefficient, 0.843 ± 0.017, between fat corrected milk and roughage total digestible nutrients and concentrate total digestible nutrients was highly significant. The predicting equation for this relationship was found to be

FCM = 1.783 conc. TDN + 0.838 rough. TDN +
1358 ± 905 pounds.

An analysis of variance in the regression showed that both regression coefficients were highly significant as well as being highly significantly different from each other.

The multiple correlation coefficient, 0.844 ± 0.017, between 4 per cent fat corrected milk and roughage total digestible nutrients, concentrate total digestible nutrients and weight change was highly significant. Since the inclusion of the fourth variable, weight change, had practically no effect on the multiple correlation coefficient it was assumed that any relationship between weight change and 4 per cent fat corrected milk was not significant.

TABLE 1

Pasture vs. No Pasture for Milk Production

A. Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F
Groups	1	2340796	2340796	0.414
Individuals	321	1702101451	5302497	
Total	322	1704442247		

B. Comparison of Groups

Groups	Cows	Records	Average
	(no.)	(no.)	(lb.)
Pasture	23	42	7176
No Pasture	65	281	7483

Standard Deviation = 2302 pounds of 4% FCM.

TABLE 2

Effect of Age at Calving on Milk Production

A. Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F
Groups	21	191324662	9110698	1.812*
Individuals	301	1513117585	5026968	
Totals	322	1704442247		

B. Averages for Each Age Group

Age Group (yr.)	Records (no.)	Average (lb.)	Age Group (yr.)	Records (no.)	Average (lb.)
under 2	5	5425	7-7 1/2	18	7153
2-2 1/2	35	6782	7 1/2-8	15	8627
2 1/2-3	28	6532	8-8 1/2	9	7808
3-3 1/2	22	7748	8 1/2-9	13	8475
3 1/2-4	29	7233	9-9 1/2	4	7095
4-4 1/2	21	8119	9 1/2-10	10	7205
4 1/2-5	21	7283	10-10 1/2	5	7297
5-5 1/2	17	8198	10 1/2-11	3	9377
5 1/2-6	20	8260	11-11 1/2	7	6524
6-6 1/2	16	7744	11 1/2-12	4	6290
6 1/2-7	12	8194	12 and over	9	5730

*Significant at the 5 per cent level of probability.

Standard Deviation = 2242 pounds of 4 per cent FCM.

TABLE 3

Effect of Season of Calving on Milk Production

A. Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F
Seasons	3	58995789	19665263	3.813*
Individuals	319	1645446458	5158139	
Total	322	1704442247		

B. Season Averages for Production

Season	Average (lb.)
Dec., Jan., Feb.	7585
Mar., Apr., May	7323
June, July, Aug.	6852
Sept., Oct., Nov.	8120

*Significant at the 5 per cent level of probability.

Standard Deviation = 2271 pounds of 4 per cent FCM.

TABLE 4

Effect of Year of Lactation on Milk Production

A. Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F
Years	18	360745018	20041390	4.5342**
Individuals	304	1343697229	4420057	
Total	322	1704442247		

B. Average Lactation by Years

Year	Records	Average	Year	Records	Average
	(no.)	(lb.)		(no.)	(lb.)
1934	8	8733	1944	18	8181
1935	7	10030	1945	19	7799
1936	5	10821	1946	22	8025
1937	11	6601	1947	26	6113
1938	11	7892	1948	25	6695
1939	17	9653	1949	17	6598
1940	15	7963	1950	25	6272
1941	23	7131	1951	20	6729
1942	27	7144	1952	6	7130
1943	21	7865			

**Significant at the 1 per cent level of probability.

Standard Deviation = 2106 pounds of 4 per cent FCM.

TABLE 5

Effect of Length of Dry Period on Milk Production

A. Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F
Periods	4	15733773	3933443	0.695
Individuals	247	1397109229	5656312	
Total	251	1412843002		

B. Averages for Dry Period Length

Period	Records	Average
(day)	(no.)	(lb.)
0-59	71	7828
60-89	101	7510
90-119	51	8125
120-149	15	6835
150 and over	13	7281

Standard Deviation = 2378 pounds of 4 per cent FCM.

DISCUSSION

In the process of evaluating the effect of total digestible nutrients in the form of concentrate separate from that of total digestible nutrients in the form of roughage it was necessary to establish that the data were homogenous in nature. The use of Bartlett's test established this point and opened the way for further analysis of the data.

It was deemed necessary to determine significant environmental sources of variation in milk production other than those connected with feed intake in the barn. Lack of significant variance due to the effect of pasture and to length of dry period eliminated these as factors to be considered. Variance due to age at calving and season of calving was barely significant. The year in which the lactation was made exerted a highly significant effect on milk production with the early years of the study having the higher level of milk production. Inspection of the feed intake data indicated that this effect was largely due to the level of concentrate intake during those early years and would be included in the analysis of nutrient intake.

Separation of the total digestible nutrient intake into 2 catagories, roughage and concentrate, increased the correlation coefficient between nutrient intake and milk production from 0.817 to 0.843. This indicated that roughage and concentrate total digestible nutrients did not exert equal effects on milk production in the group of lactations

studied since a greater portion of the variance was accounted for by regression when the nutrient intake was separated into the 2 categories. The addition of a fourth variable, weight change, to the analysis resulted in no increase in the correlation coefficient indicating the insignificance of weight change as a factor affecting milk production in this study.

The simple regression equation calculated from the data indicated that when the total digestible nutrient intake was used as a single criterion that a pound of total digestible nutrients would produce 1.716 pounds of 4 per cent fat corrected milk after the constant for the equation was satisfied. Since no attempt was made to correct the feed intake for it, the maintenance nutrient requirement appeared in the form of the constant, -2272 ± 1316 pounds of 4 per cent fat corrected milk or its equivalent in total digestible nutrients. This indicated theoritically that the cow had to eat nutrients equivalent to this amount of milk before milk could be produced. It is entirely possible that the relationship might be more curvilinear if zero milk production were approached. Insufficient data were available in this study in the very low levels of production to make any definite prediction regarding the maintenance total digestible nutrient requirement of the cows.

The relationship between nutrient intake and milk production has been reported to be curvilinear (Headley, 1943: Jensen et al., 1942: and Redman, 1952). The data used in

this study were not analyzed for curvilinearity. However, it is highly improbable that the relationship is more than slightly curvilinear since 66 per cent of the variance is accounted for by linear regression. The range of points from which this regression equation for these 2 variates was calculated was so narrow that curvilinearity might well be masked.

The multiple regression equation showing the relationship between 4 per cent fat corrected milk and the separated categories of total digestible nutrients, roughage and concentrate, indicated that total digestible nutrients in the form of concentrate were approximately twice as efficient for milk production as were those in the form of roughage. It is probable that roughage total digestible nutrients were penalized for milk production by the maintenance requirement of the cows. The fact remains, however, that the regression coefficients for roughage nutrients and concentrate nutrients were highly significantly different from each other, 0.838 and 1.783, respectively.

The results of this study, that concentrate total digestible nutrients are more efficient for milk production than are roughage total digestible nutrients, are in agreement with those of Huffman and Duncan (1947, 1949, 1950, 1952, 1952a), Lindsey and Archibald (1932) and Smith et al. (1945). All of these studies were made with the roughage concentrate ratio greater than 1/1. In each investigation the substitution of concentrate for roughage on the basis

of total digestible nutrients resulted in more efficient milk production. It is entirely possible that this relationship might not continue to hold if the above ratio were much smaller than 1/1. It is well known that cows are unable to tolerate very small roughage/concentrate ratios, very little roughage and the remainder of the nutrients as concentrate.

Redman (1952) has attempted to explain the apparent inconsistencies in the results obtained from the feeding of equal amounts of total digestible nutrients from different nutrient sources with varying results in lactation experiments. His explanation recognizes the need for a "balanced ration" including optimum quantities of all nutrients for maximum production and proposes that "roughages and grain are not perfect substitutes for each other, but possess a degree of complementarity." Davis et al. (1953) attributed the increased productivity of rations after the addition of grain on better "balance" in the ration and on greater intake of "productive energy". The need for concentrate to complement or balance roughage is indicated by the results of this study and agrees with the results of Huffman and coworkers (Huffman and Duncan, 1952; Huffman et al., 1952a).

SUMMARY

A study was made on 323 lactation records accumulated from 1934 to 1953 made by 78 cows predominantly of the Holstein breed.

Variance of 4 per cent fat corrected milk due to the effect of pasture, length of dry period, age at calving, season of calving and the year in which the lactation was made was insignificant, insignificant, significant, significant, and highly significant, respectively. Inspection of feed intake data indicated that the significance of the year in which the lactation was made was largely due to the level of concentrate intake during the early years of the study.

The 231 lactation records with complete feed data (no pasture) were subjected to correlation and regression analyses. The correlation between 4 per cent fat corrected milk production and total digestible nutrient intake was 0.817 with the corresponding regression equation FCM = 1.716 TDN - 2272 ± 1316 pounds. The correlation coefficient between 4 per cent fat corrected milk production and roughage total digestible nutrients was 0.843, indicating advantage in the separation of the 2 categories of nutrients for the analysis. The regression equation for this relationship was FCM = 1.783 conc. TDN + 0.838 rough. TDN + 1358 ± 905 pounds. An analysis of variance of the regression indicated that both coefficients of regression were highly significant as well as being highly significantly different from each other. This

equation indicated that total digestible nutrients in the form of concentrate were more efficiently used for milk production than were those in the form of roughage. The possibility that roughage total digestible nutrients were penalized by the maintenance nutrient requirement of the cows was discussed. The addition of a fourth variable, weight change, added nothing to the multiple correlation.

The need for a "balanced ration" for milk production and the complementarity of concentrate and roughage were discussed.

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APPENDIX

APPENDIX TABLE 1

Individual Data by Lactations

Cow / Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
66													
2	297	6431	5.1	330	7517	3823	1927	5750	10-21-41	67	3-10	30	0
3	300	6204	5.1	317	7017	2608	2461	5069	11-2-42	79	4-11	-59	0
5	305	5354	4.6	244	5806	3407	973	4380	5-4-45	322	7-5	-25	0
76													
1	305	5851	4.5	266	6326	3170	1352	4522	12-19-37	0	2-6	-26	0
2	305	7888	4.6	362	8591	3428	2117	5545	2-19-39	104	3-8	-37	0
3	304	5646	4.4	238	5824	3907	463	4370	5-30-40	101	5-0	-4	0
4	305	9095	4.6	422	9543	3391	2916	6307	6-11-41	71	6-0	65	0
5	302	5383	4.3	233	5679	3145	773	3918	6-21-42	65	7-0	-29	0
6	305	7263	4.3	311	7559	3073	2250	5323	5-22-43	33	7-11	-54	0
77													
1	263	4488	4.9	218	5066	3285	857	4142	12-11-37	0	2-5	2	0
2	304	6519	5.1	335	7627	3076	1946	5022	12-1-38	91	3-5	-10	0
3	305	5278	5.3	280	6311	3982	276	4258	12-9-39	69	4-5	-13	0
4	305	7818	5.2	405	9183	2615	3190	5805	3-12-41	57	5-8	17	0
5	278	4311	4.9	211	4883	3097	702	3799	3-9-42	50	6-8	10	0
6	305	5313	4.9	243	5749	2904	2076	4980	3-4-43	82	7-8	32	0
78													
1	305	5974	4.5	270	6435	3411	1725	5136	12-14-37	0	2-3	25	0
2	305	9794	4.5	439	10509	4173	3044	7217	10-17-39	345	4-1	50	0
3	294	5443	4.6	250	5927	4474	303	4777	10-20-40	57	5-1	-159	0
4	305	7820	4.6	362	8552	4039	2531	6570	9-29-41	49	6-1	132	0
5	305	5055	4.6	235	5521	4027	899	4926	9-19-42	49	7-0	-37	0
6	305	9050	4.4	398	9575	3640	5207	8847	12-2-43	65	8-3	0	0
7	305	4580	4.5	205	4907	2849	1501	4350	5-6-45	67	9-8	17	0

0 First lactation.

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
266													
1	305	6205	3.2	201	5016	5362	212	5574	4-3-38	0	2-7	79	0
2	274	7402	3.6	268	6983	5436	243	5679	8-30-39	133	4-0	85	0
3	305	8694	3.4	299	7800	6027	55	6082	7-24-40	53	4-11	33	0
4	305	8792	3.6	316	8232	6036	485	6521	9-25-41	112	6-1	48	0
5	300	7432	3.5	258	6941	5873	742	6615	12-22-42	119	7-2	76	0
6	270	6409	3.1	201	5576	5272	1	5273	2-10-44	113	8-5	29	0
7	250	10820	3.5	378	10001	2788	3143	5931	2-20-45	103	9-6	0	0
8	258	10871	3.4	372	9932	3927	2769	6696	2-27-46	118	10-6	71	0
9	305	10679	3.7	400	10167	4050	2671	6721	2-25-47	103	11-6	-134	0
267													
1	305	5948	3.7	221	5694	4132	1084	5216	12-30-37	0	2-3	53	0
2	305	6567	3.4	221	5957	3788	1	3789	3-4-39	147	3-5	7	0
3	305	6936	3.4	235	6299	5470	1	5471	9-6-40	62	4-11	-4	0
4	305	6060	3.7	224	5604	5399	204	5603	12-22-41	94	6-2	80	0
5	305	8543	3.3	281	7646	4270	1890	6160	12-31-42	53	7-3	78	0
6	305	9887	3.0	300	8464	3883	1962	5845	3-21-44	35	8-5	59	0
284													
1	305	12338	3.4	426	11316	2740	4266	7006	10-7-39	0	2-5	216	0
2	305	13798	3.3	462	12388	2994	4868	7862	5-21-41	68	4-0	94	0
285													
1	305	11568	4.2	483	11866	2661	4285	6946	11-5-39	0	2-6	43	0
2	301	9882	3.6	359	9283	3136	3203	6339	9-6-41	46	4-4	166	0
3	305	9018	3.6	325	8411	3948	2434	6382	10-12-42	100	5-5	-18	20
4	305	14232	3.5	499	13145	3392	4721	8113	12-14-43	68	6-7	-248	0
5	300	9403	3.4	317	8515	4778	1283	6061	12-2-44	38	7-7	-37	0
6	305	8190	3.2	217	7201	4492	391	4883	1-21-46	82	8-8	54	0
7	237	0	0	0	0	0	0	0	0	0*	0	0	0
8	208	0	0	0	0	0	0	0	0	0*	0	0	0
9	273	4300	3.3	143	3858	4109	449	4558	3-7-49	157	11-10	189	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
288													
2	160	0	0	0	0	0	0	0	4-23-41	0*	0-0	0	0
3	304	6175	3.3	202	5487	4911	526	5437	4-2-42	94	4-8	164	0
4	305	17618	3.3	578	15641	2645	6038	8683	4-17-46	75	8-8	-19	0
289													
1	305	11869	4.0	481	11968	3334	3100	6434	2-12-40	0	2-4	63	0
408													
1	301	10616	3.4	360	9591	2120	2166	4286	1-1-43	0	3-3	-33	163
2	289	6240	3.1	194	5390	5123	171	5294	1-14-44	77	4-3	-48	0
412													
1	305	7595	3.3	263	7111	5179	1436	6615	12-19-42	0	2-10	29	0
2	305	9020	3.4	307	8186	3577	1494	5071	12-7-43	36	3-9	-72	0
3	305	8728	3.5	306	8073	3320	1685	5005	4-16-45	93	5-1	-84	0
4	303	7899	3.4	269	7203	4541	1172	5713	6-21-46	105	6-4	92	0
5	305	5301	3.6	189	4961	4428	675	5103	7-17-47	85	7-5	-7	0
6	283	7844	3.4	269	7161	2861	639	3500	12-18-48	81	8-10	-114	27
419													
1	305	5911	3.2	187	5107	4379	1	4380	2-7-43	0	2-3	-25	0
2	305	6177	3.0	187	5287	4078	99	4177	3-10-44	87	3-4	48	0
3	305	4528	3.2	147	4021	4012	1	4013	6-26-45	64	4-7	132	0
4	305	7690	3.1	240	6673	4772	1088	5860	8-16-46	79	5-9	-63	0
5	305	6529	3.1	204	5678	3783	524	4307	9-8-47	74	6-10	-11	58
6	305	9495	3.3	313	8890	4006	995	5001	10-23-48	85	7-11	-79	0
7	293	6623	3.3	213	5840	4621	328	4949	12-6-49	57	9-1	37	20
8	305	9635	3.3	323	8696	3768	1846	5614	11-21-50	53	10-0	63	0
9	255	5918	3.4	203	5407	4153	213	4366	1-17-52	82	11-2	-80	0

* Incomplete lactation.

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow	Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
		(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
426														
	5	268	4362	3.5	151	4014	4056	443	4499	8-24-47	137	6-5	24	0
	6	305	8331	3.8	317	8091	3843	1709	5552	8-18-48	121	7-5	-95	15
	7	264	4666	3.7	172	4443	3157	372	3529	12-10-50	109	9-8	71	31
442														
	3	305	9593	3.4	260	6941	5887	804	6691	9-19-46	92	4-4	149	0
	4	305	12207	3.4	420	11189	3579	2450	6029	11-19-47	69	5-6	59	85
	5	275	6188	3.7	229	5906	4591	58	4649	12-27-48	61	6-7	-78	0
	6	290	5636	3.5	198	5231	4740	488	5228	12-10-49	70	7-7	93	9
	7	305	8435	3.4	287	7682	5323	189	5512	12-1-50	63	8-6	95	0
	8	300	7585	3.5	264	6994	5311	251	5562	1-3-52	77	9-8	5	0
461														
	1	305	6590	3.2	213	5825	4050	612	4662	8-18-46	0	2-6	51	0
	2	305	7078	3.4	238	6400	4005	0	4005	10-13-47	54	3-8	13	85
	3	305	6887	3.4	237	6304	4624	585	5209	1-29-49	74	4-11	45	0
	4	304	6838	3.2	251	6504	4429	668	5097	6-27-50	118	6-4	91	0
485														
	1	305	9480	3.2	300	8288	3985	2168	6153	5-6-48	0	2-9	127	0
	2	291	10049	3.1	312	8697	4209	2034	6243	6-13-49	51	3-10	160	0
499														
	1	305	9068	3.6	329	8560	4145	1894	6039	3-22-49	0	2-5	159	0
	2	299	5759	3.8	219	5591	3666	737	4403	3-28-50	33	3-5	58	0
	3	305	8377	3.6	302	7873	6053	1	6054	6-1-51	128	4-8	-40	0
A-4														
	2	304	9986	2.9	293	8394	5268	1599	6867	2-25-35	114	2-11	177	0
	3	302	12491	3.1	391	10867	4720	2769	7489	2-3-36	37	3-10	107	0
	4	279	8691	2.8	247	7173	5212	1647	6859	2-25-37	84	5-0	213	0
	5	256	6701	3.0	200	5571	4408	860	5268	3-22-38	112	6-0	160	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-5													
1	305	10112	3.2	321	8811	4669	1279	5948	4-2-34	0	2-0	27	0
2	305	11133	3.1	346	9614	5497	1576	7073	4-15-35	56	3-0	51	0
3	305	14100	2.8	401	11643	4741	3270	8011	2-12-37	88	4-10	189	0
4	305	11461	3.2	365	10053	5590	1273	6863	2-7-38	55	5-10	58	0
5	305	18997	2.9	543	15745	4265	4525	8790	10-11-39	105	7-6	62	0
6	305	8904	3.3	298	8026	6065	23	6088	11-1-40	61	8-7	13	0
7	305	8194	3.4	279	7463	5255	281	5536	11-14-41	65	9-7	-60	0
8	305	11923	2.9	344	10135	3730	3068	6798	3-23-43	54	11-0	15	0
9	282	7234	3.3	237	6423	4837	1026	5863	12-13-44	121	12-8	-24	0
10	281	9454	3.2	308	8395	2667	2886	5553	12-22-45	91	13-9	-44	0
A-6													
1	305	9106	2.7	252	7452	4312	1104	5416	6-24-34	0	2-3	-8	0
2	305	13814	2.9	405	11636	4488	3130	7618	1-25-36	75	3-10	101	0
3	305	9272	2.8	262	7573	5184	525	5709	6-16-37	126	5-3	136	0
4	305	12738	2.8	359	10486	4793	2717	7510	6-29-38	89	6-3	234	0
5	305	18788	3.0	558	15890	4683	4303	8986	7-31-39	92	7-4	24	0
6	299	16633	3.0	493	14054	3815	4616	8431	12-6-41	250	9-8	-25	0
A-7													
1	305	9225	2.9	265	7670	4350	1319	5669	6-22-34	0	2-2	-52	0
2	305	9631	3.2	308	8473	4534	1524	6058	10-19-35	133	3-6	-2	0
3	305	10733	2.9	315	9069	5421	1934	7355	12-26-36	126	4-8	176	0
4	305	8827	3.1	271	7644	4891	746	5637	1-23-38	68	5-9	15	0
5	269	6966	3.1	220	6079	4637	584	5221	3-22-39	101	6-11	106	0
6	292	11702	3.1	362	10164	4106	2579	6685	3-1-40	74	7-10	-34	0
A-8													
1	305	8273	5.0	413	9512	2741	2784	5429	8-23-34	0	2-3	27	0
2	305	8806	5.2	461	10489	3311	3231	6542	9-18-35	49	3-4	102	0
3	305	9902	4.8	463	10896	3723	3238	6961	9-16-36	57	4-4	60	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-9													
1	303	10597	2.9	304	8662	3322	2598	5920	9-18-34	0	2-3	138	0
2	280	9041	2.9	266	7581	4460	1912	6372	8-26-35	39	3-2	194	0
3	110	0	0	0	0	0	0	0		0*	0-0	0	0
A-13													
1	305	6115	4.4	268	6477	4174	1107	5281	6-29-35	0	2-9	64	0
2	132	0	0	0	0	0	0	0		0*	0-0	0	0
A-14													
1	305	13277	2.9	388	9747	3744	3112	6856	10-30-34	0	2-1	151	0
2	305	17096	3.0	519	14689	4929	3764	8693	3-5-36	70	3-5	75	0
3	305	17516	3.2	556	15324	4982	4234	9216	5-6-37	119	4-7	154	0
4	305	16137	3.0	485	13752	5133	2327	7460	7-21-38	105	5-11	246	0
5	305	8601	3.2	275	7566	5945	124	6069	9-30-39	91	7-0	130	0
6	305	13167	3.1	414	11453	4305	3103	7408	1-10-41	70	8-3	-165	0
A-15													
1	298	8143	3.3	272	7347	3539	1561	5100	12-7-37	0	2-6	71	0
2	305	7711	3.4	263	7038	5793	185	5978	12-25-38	55	3-7	75	0
3	305	8142	3.4	279	7447	4634	119	4753	4-10-40	76	4-11	60	0
4	305	10824	3.5	376	9992	4814	2639	7453	4-15-41	59	5-11	77	0
5	305	7500	3.6	268	6977	4603	773	5376	6-7-42	60	7-0	-23	0
6	305	12363	3.7	459	11804	4433	3127	7560	11-11-43	83	8-6	-2	0
7	305	7695	3.4	265	6994	5123	788	5911	3-5-45	73	9-9	-51	0
8	305	10004	3.4	341	9082	4739	569	5308	6-2-46	89	11-0	82	0
9	285	5569	3.5	195	5150	4617	439	5056	7-10-47	77	12-2	-27	0
10	305	4291	3.7	160	4098	4117	362	4479	6-13-48	53	13-1	84	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-17													
1	305	11782	2.9	342	8549	3989	2542	6531	9-11-38	0	3-3	157	0
2	305	14573	2.9	421	12208	3862	4144	8006	10-23-39	52	4-4	112	0
A-18													
1	305	6583	3.3	217	5887	4554	918	5472	4-1-38	0	2-5	126	0
2	305	7192	3.3	235	6438	5149	110	5259	5-27-39	97	3-7	29	0
3	305	7618	3.4	261	6950	6175	108	6283	8-8-40	53	4-10	102	0
4	305	7736	3.5	274	7200	5717	281	5998	8-28-41	36	5-10	77	0
5	305	9938	3.5	352	9282	4621	2304	6925	11-4-42	75	7-1	34	0
A-21													
1	305	6693	3.3	224	6043	2489	1411	4400	4-6-39	0	3-0	132	0
2	305	7360	3.3	242	6633	2115	624	2739	6-12-40	61	4-3	179	128
3	305	10029	2.9	293	8405	2672	656	3328	6-24-41	54	5-3	225	118
4	305	8479	3.1	264	7362	2276	1001	3277	7-11-42	58	6-4	114	101
5	305	9823	3.1	306	8484	2358	1014	3372	9-5-43	67	7-5	76	102
6	305	15281	2.9	447	12785	2008	2559	4567	11-19-44	56	8-8	36	145
7	305	7735	3.2	244	6762	4519	1094	5613	1-29-46	120	9-10	21	0
8	252	11006	3.0	336	9446	4641	2341	6982	3-4-47	73	10-11	-47	0
9	305	6899	3.1	212	5937	3512	1021	4514	3-6-48	64	11-11	132	96
10	250	4697	2.9	137	3928	2773	346	3119	5-25-49	113	13-2	78	43
A-22													
1	305	8085	3.0	250	6248	3889	1349	5238	12-1-38	0	2-6	153	0
2	303	9960	3.3	325	8857	4491	1998	6489	1-24-40	49	3-7	179	0
3	305	6323	3.3	207	5678	5466	16	5482	1-20-41	55	4-7	20	0
4	305	7524	3.3	245	6695	5404	738	6142	1-31-42	59	5-7	95	0
5	305	12204	3.1	379	10519	4427	3057	7484	2-8-43	63	6-8	203	0
6	305	11640	3.0	346	10002	4281	2399	6680	3-6-44	82	7-9	96	0
7	300	7108	3.1	218	6116	4133	624	4757	3-19-45	46	8-9	96	0
8	207	0	0	0	0	0	0	0	3-6-46	0	0-0	0	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-23													
1	305	6916	3.7	257	6611	2470	749	3219	4-22-40	0	3-6	-3	157
A-24													
1	305	8775	3.7	322	8347	2528	830	3357	10-3-39	0	2-5	-3	81
2	305	10168	3.2	330	9066	2686	1113	3799	11-4-40	64	3-6	-5	113
3	305	9320	3.3	299	7797	1523	849	2372	2-11-42	46	4-9	181	170
4	305	10763	3.4	364	9746	2045	575	2620	2-9-43	58	5-9	41	151
5	305	9056	3.3	295	8904	2339	29	2368	2-21-44	68	6-9	-60	174
6	305	18091	3.1	561	15653	1881	1196	3077	4-29-45	98	7-11	52	170
7	305	12090	3.2	384	10591	6405	586	6991	6-25-46	50	9-2	70	0
8	54	0	0	0	0	0	0	0		0*	0-0	0	0
A-25													
1	303	7193	3.3	241	6492	3889	465	4354	4-1-40	0	2-8	44	0
2	295	6817	3.2	219	6017	3992	766	4758	3-15-41	42	3-7	14	0
3	281	6376	3.3	210	5704	3946	865	4811	3-1-42	52	4-7	110	0
4	305	8348	3.3	279	7531	4408	1048	5456	2-15-43	69	5-6	95	0
5	305	8207	3.4	278	7470	3342	1395	4737	3-1-44	63	6-7	-38	0
6	305	12196	3.2	389	10717	2457	3766	6223	4-23-45	55	7-9	61	0
7	305	8971	3.4	304	8143	6040	471	6511	7-7-46	77	8-11	-41	0
8	283	4041	3.2	128	3541	4261	497	4758	8-6-47	72	10-0	153	0
9	289	6388	3.5	226	5939	2338	848	3186	7-27-48	70	11-0	96	0
10	305	8446	3.3	280	7573	3438	1843	5281	8-6-49	85	12-0	76	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-26													
1	305	7641	3.7	280	7255	3907	1163	5070	8-9-40	0	2-11	5	0
2	305	7934	3.5	279	7324	5150	751	5901	10-4-41	66	4-1	-1	0
3	305	9224	3.5	322	8515	4526	1108	5634	12-2-42	118	5-3	41	0
4	305	9415	3.6	337	8808	3558	1770	5328	4-18-44	97	6-7	42	0
5	275	9604	3.5	336	8875	2843	3476	6319	5-11-45	40	7-8	165	0
6	280	6197	3.5	217	5728	4497	529	5026	5-7-46	85	8-8	53	0
7	297	6035	3.4	202	5606	4634	862	5496	6-3-47	78	9-9	55	0
8	305	9525	3.5	330	8754	4300	2204	6504	5-27-48	57	10-8	44	0
9	280	5730	3.4	194	5200	4545	198	4743	7-5-49	74	11-10	147	0
A-27													
1	305	7525	3.3	249	6743	3907	1130	5037	10-9-40	0	2-9	-3	0
2	305	7443	3.1	233	6481	4445	744	5189	10-28-41	48	3-9	28	0
3	301	7803	3.2	252	6911	4254	1091	5345	11-25-42	87	4-10	179	0
4	305	9578	3.1	301	8333	3670	1590	5260	11-14-43	51	5-10	123	0
5	305	14428	3.2	465	12752	3423	3649	7072	12-28-44	77	6-11	14	0
6	292	12260	3.3	401	11213	3742	3044	6786	3-9-46	108	8-2	62	0
7	265	7802	3.3	260	7019	3994	1751	5745	3-22-47	84	9-2	-61	0
8	239	0	0	0	0	0	0	0		0*	0-0	0	0
9	294	5922	3.4	200	5375	3382	484	3866	2-28-49	117	11-1	87	0
10	265	5928	3.3	198	5342	4197	458	4655	3-8-50	77	12-1	62	0
11	305	6831	3.3	223	6077	3412	1100	4512	3-12-51	101	13-2	144	13
12	305	5198	3.2	166	4572	3657	684	4341	4-13-52	86	14-3	55	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN			Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
						Rough.	Conc.	Total					
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-29													
1	305	7355	3.0	222	6266	4237	1738	5975	7-1-41	0	3-4	77	0
2	301	8300	3.3	266	7256	1464	1849	3313	4-6-43	297	5-1	21	160
3	305	8536	3.1	263	7345	1423	1156	2579	4-13-44	69	6-1	-124	156
4	305	6021	3.1	188	5222	4201	1599	5800	8-13-45	73	7-5	46	0
5	305	8246	3.3	270	7352	4770	777	5547	10-28-46	105	8-8	28	0
6	267	6990	3.2	223	6143	2880	1485	4365	5-25-48	102	10-2	-47	0
A-30													
1	305	7408	3.0	223	6317	4534	1	4535	6-11-41	0	2-9	108	0
2	305	7183	3.1	219	6126	6150	1	6151	1-16-43	186	4-4	153	0
3	305	7489	3.0	226	6379	6031	1	6032	1-31-44	65	5-5	35	0
A-31													
1	305	5926	3.4	202	5401	4398	173	4571	9-1-41	0	2-4	32	0
2	305	5304	3.5	186	4914	4503	1	4504	11-11-42	60	3-6	73	0
3	305	5630	3.4	190	5095	4724	41	4765	12-7-43	46	4-7	13	0
4	305	6607	3.3	220	5941	4888	219	5107	1-15-45	80	5-8	13	0
5	305	6948	3.4	240	6477	4645	205	4850	1-18-46	58	6-8	161	0
6	282	6175	3.5	219	5750	4207	545	4752	3-14-47	87	7-10	85	0
7	272	5259	3.4	181	4972	3279	0	3279	2-14-48	50	8-9	81	85
8	276	5137	3.6	185	4826	3356	182	3538	2-28-49	72	9-9	127	43
A-32													
1	305	6049	3.4	209	5547	1378	602	1980	2-27-42	0	2-6	211	171
2	256	5502	3.4	187	4982	1123	543	1666	4-27-43	116	3-8	165	151
3	236	0	0	0	0	0	0	0	4-14-44	0*	0-0	0	0
4	226	0	0	0	0	0	0	0	4-23-45	0*	0-0	0	0
5	262	8469	3.4	290	7710	3537	2211	5748	4-17-46	132	6-8	77	0
6	24	0	0	0	0	0	0	0	5-7-47	0*	0-0	0	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-33													
1	305	4995	3.5	173	4589	4521	1	4522	5-23-42	0	2-4	23	0
2	305	5669	3.6	206	5353	5253	80	5333	9-5-43	94	3-7	85	0
3	305	5619	3.3	186	5017	5212	1	5213	11-12-44	72	4-10	-1	0
4	305	6741	3.5	233	6196	6056	1	6057	12-13-45	84	5-11	103	0
5	300	7606	3.4	260	6945	4690	288	4978	2-26-47	125	7-1	65	0
6	305	4849	3.4	165	4411	5346	84	5430	3-16-48	81	8-2	66	0
7	297	5432	3.4	184	4930	4778	183	4961	4-28-49	61	9-3	100	0
8	305	9957	3.5	344	9117	4013	2141	6154	5-2-50	69	10-3	136	0
9	305	5996	3.5	208	5515	5666	101	5767	6-13-51	73	11-5	72	0
A-34													
1	305	4081	3.4	139	3670	4286	1	4287	9-2-42	0	2-7	38	0
A-35													
1	291	6023	3.5	214	5661	1292	431	1723	2-21-42	0	1-10	118	169
2	305	7265	3.7	271	6967	1798	765	2563	2-8-43	59	2-10	131	150
A-37													
1	305	6318	3.3	210	5669	4324	1124	5448	8-18-42	0	2-2	119	0
2	305	8869	3.3	289	7890	3532	1509	5041	12-27-43	59	3-7	-84	0
3	305	8209	3.5	284	7542	4956	442	5398	5-4-46	287	5-11	-120	0
4	305	4685	3.0	142	4023	5248	523	5771	6-20-47	102	7-1	135	0
5	280	7685	3.2	249	6804	3094	1005	4099	8-3-48	76	8-2	64	0
6	179	0	0	0	0	0	0	0	9-8-49	0*	0-0	0	0
7	264	4713	3.3	154	4218	3884	816	4700	8-31-51	177	11-3	254	0
A-39													
1	305	5220	3.8	201	5076	2475	2193	4668	9-28-43	0	2-1	79	0
2	305	4424	3.5	156	4112	2051	2736	4787	2-24-45	194	3-6	299	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN			Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
						Rough.	Conc.	Total					
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-40													
1	305	9244	3.5	324	8609	2824	2908	5732	12-1-43	0	2-1	112	0
2	305	9134	3.3	300	8177	4311	2463	6774	11-8-44	24	3-0	-23	0
3	300	12159	3.2	384	10263	5439	2988	8427	1-3-46	94	4-2	47	0
4	287	11248	3.4	385	10279	4140	2897	7037	1-24-47	84	5-3	80	0
5	305	11474	3.3	376	10231	3502	3453	6955	3-9-48	118	6-4	42	84
6	266	3953	3.3	129	3515	4384	311	4695	8-21-49	124	7-10	160	0
7	120	0	0	0	0	0	0	0	8-6-50	0*	0-0	0	0
A-42													
1	305	6959	3.4	236	6393	2945	2603	5548	7-5-44	0	2-4	97	0
2	305	8478	3.3	278	7545	4536	2060	6596	8-29-45	94	3-6	161	0
3	295	8096	3.3	269	7266	3292	2143	5435	8-23-46	38	4-6	20	0
4	271	3932	3.6	141	3712	4450	348	4798	8-19-47	63	5-6	187	0
5	305	9058	3.6	323	8464	4204	1972	6176	7-30-48	73	6-5	58	0
6	290	6261	3.5	220	5801	4598	683	5281	2-11-50	122	7-11	154	0
7	305	8024	3.6	290	7566	4841	246	5087	2-6-51	66	8-11	8	0
8	305	9612	3.6	343	8988	4587	1942	6529	5-17-52	95	10-3	122	0
A-46													
1	305	8741	3.0	264	7451	3718	2296	6014	8-1-45	0	2-2	118	0
2	305	9213	3.2	293	8088	4823	1989	6812	11-2-46	109	3-5	121	0
3	300	7684	3.2	248	6771	4968	1194	6162	12-27-47	111	4-6	104	0
4	305	10830	3.3	355	9659	4854	1961	6815	12-11-48	49	5-6	125	0
5													
6	305	7852	3.5	273	7237	5126	276	5402	2-24-51	31	7-8	48	0
A-47													
1	305	7885	2.9	231	6621	3579	2168	5747	7-24-45	0	1-11	155	0
2	305	10919	2.9	317	9130	4075	2634	6709	8-31-46	42	3-0	95	0
3	305	8662	3.0	256	7311	4647	1322	5969	9-29-47	86	4-1	18	0
4	305	11448	2.9	338	9649	4501	2022	6523	11-1-48	90	5-2	114	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN			Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
						Rough.	Conc.	Total					
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-48													
1	305	10981	3.4	371	9955	3812	2831	6643	8-1-46	0	2-9	46	15
2	305	9457	3.4	323	8628	4591	2183	6774	10-29-47	108	4-0	86	0
3	295	9006	3.6	325	8473	4689	1981	6670	12-3-48	41	5-1	148	0
4	305	9240	3.9	358	9099	4594	1136	5730	11-23-49	60	6-0	31	0
5	305	6244	3.9	246	6189	4639	388	5027	2-21-51	72	7-3	104	0
A-49													
1	276	7343	3.4	249	6668	3654	2079	5733	5-23-46	0	2-6	177	0
2	305	8364	3.5	292	7721	5313	1388	6701	5-29-47	89	3-6	-77	0
3	276	8679	3.6	312	8157	3912	1876	5788	12-30-48	140	5-1	252	0
4	305	8051	3.7	299	7703	4410	1039	5449	11-17-49	44	5-11	-237	0
5	280	6078	3.8	232	5913	4158	86	4244	3-18-51	138	7-3	81	0
6	293	6197	3.6	225	5847	4099	1148	5247	3-5-52	69	8-3	-28	0
A-50													
1	305	8417	3.2	269	7400	4392	1882	6274	7-17-46	0	2-6	22	0
2	250	5563	3.2	180	4931	3771	875	4646	9-8-47	55	3-8	93	0
A-53													
1	305	9073	2.9	265	7604	4576	1839	6415	5-11-46	0	2-2	206	0
2	298	9172	2.9	268	7683	5245	1229	6474	5-13-47	58	3-2	168	0
3	305	10239	3.0	311	8757	5894	1827	7721	5-16-48	69	4-2	102	0
4	305	12132	3.0	366	10348	4925	2029	6954	5-10-49	53	5-2	148	0
5	305	9219	3.2	297	8135	4316	1610	5926	4-23-50	38	6-2	117	0
6	305	8409	3.4	283	7620	4324	1217	5541	5-29-51	79	7-3	103	0
7	291	8007	3.1	248	6928	5178	534	5712	8-10-52	81	8-5	184	0
A-54													
1	296	9021	3.2	287	7906	4688	1851	6539	4-23-47	0	2-5	75	0
2	260	7348	3.4	249	6674	3752	2127	5879	3-29-48	37	3-4	182	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-55													
1	305	5920	3.2	189	5209	4283	1257	5540	8-12-47	0	2-9	219	0
2	305	7132	3.4	240	6454	4529	528	5057	1-10-49	75	4-2	29	0
3	305	7789	3.3	260	7020	4026	1715	5741	8-15-50	235	5-9	149	0
A-60													
1	305	7702	3.4	262	7018	4314	1451	5765	7-4-48	0	2-10	32	0
2	272	7350	3.5	259	6818	4085	1363	5448	7-17-49	54	3-11	100	0
A-61													
1	278	5021	3.3	164	4465	2675	261	2936	2-26-48	0	2-1	82	85
2	296	5927	3.3	198	5343	4619	34	4653	2-7-49	67	3-1	161	0
3	305	5287	3.5	187	4914	4212	557	4769	1-23-50	54	4-0	121	9
4	305	10380	3.5	365	9621	3260	2763	6023	2-20-51	84	5-1	88	0
A-62													
1	305	3620	3.2	116	3187	2578	291	2869	4-26-48	0	2-3	53	86
A-66													
1	305	6296	3.3	210	5674	4500	145	4645	7-20-50	0	2-11	119	4
A-67													
1	305	5162	3.5	183	4810	4513	1346	5859	6-3-48	0	1-11	14	0
2	288	6494	3.9	252	6378	3408	1684	5092	9-13-49	41	3-2	99	0
3	304	9160	3.8	346	8907	3462	1896	5358	10-11-50	102	4-3	133	0
4	305	9799	3.7	358	9295	3918	1676	5594	9-22-51	43	5-2	130	0
5	253	7831	3.7	291	7493	2814	2335	5149	9-19-52	52	6-2	51	0
A-68													
1	305	4404	3.9	171	4330	4556	1171	5727	6-28-48	0	1-11	133	0
A-69													
1	305	8028	3.3	267	7222	4956	300	5256	10-4-49	0	3-1	-64	0
2	305	8168	3.4	280	7473	6092	1	6093	6-14-51	273	4-9	-69	0
3	301	10801	3.2	341	9441	5030	1705	6735	8-1-52	71	5-9	29	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN Rough.	TDN Conc.	TDN Total	Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
A-71													
1	189	0	0	0	0	0	0	0	12-21-49	0*	0-0	0	0
2	305	7009	3.5	245	6482	3790	698	4488	12-16-50	168	3-2	64	0
3	305	9269	3.3	308	8334	4078	1641	5719	1-25-52	65	4-3	117	0
A-72													
1	305	6597	3.4	227	6040	3578	1156	4734	6-18-50	0	2-4	88	0
A-73													
1	305	5689	3.4	194	5173	3504	413	3917	8-1-50	0	2-5	76	0
2	305	7833	3.4	268	7153	3673	1825	5498	9-17-51	78	3-6	112	0
A-76													
1	305	5868	3.7	216	5590	3337	1103	4440	7-14-50	0	2-2	180	0
2	305	10789	3.6	392	10195	4407	2014	6421	2-21-52	218	3-9	69	0
A-78													
1	304	5462	3.6	196	5125	3577	326	3903	11-6-50	0	2-5	108	0
2	305	6264	3.5	220	5794	5068	198	5266	12-7-51	89	3-6	70	0
A-79													
2	266	6240	3.7	230	5949	3210	755	3965	8-5-52	0	4-2	125	0
A-80													
1	305	5227	3.6	186	4877	3022	452	3474	8-5-50	0	2-0	120	0
2	305	8515	3.6	306	8001	3256	1866	5122	10-4-51	95	3-0	42	0
T-1													
1	305	6201	3.7	220	5704	2617	1173	3790	5-16-51	0	1-9	48	5
2	299	4488	3.6	163	4248	2882	1271	4153	5-16-52	2	2-9	147	0
T-3													
1	305	6857	3.7	250	6554	2883	1874	4757	4-23-52	0	2-2	-111	0
T-4													
1	268	6592	3.8	251	6405	3233	1089	4322	8-2-52	0	2-6	3	0

APPENDIX TABLE 1 (continued)

Individual Data by Lactations

Cow Lact.	In Milk	Milk	Fat Test	Fat	FCM	TDN			Date Calved	Dry Period	Age of Cow	Weight Change	Pasture
						Rough.	Conc.	Total					
	(days)	(lb.)	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)		(days)	(yr.-mo.)	(lb.)	(days)
T-5													
1	305	6059	4.6	276	6566	3033	1377	4410	6-4-52	0	2-5	56	3
T-6													
1	305	5498	4.7	258	6063	2832	1254	4086	4-14-52	0	2-3	67	33
T-7													
1	297	4904	3.8	184	4724	3390	1	3391	4-3-51	0	2-6	137	0
2	282	7469	3.6	272	7071	3028	1839	4867	3-28-52	59	3-6	66	0
T-8													
1	305	5664	3.8	217	5494	2764	1228	3992	4-5-51	0	2-6	95	0
T-9													
1	285	4926	3.1	150	4225	2924	1178	4102	7-30-51	0	1-9	187	0
2	268	5200	3.0	155	4401	2749	954	3703	9-2-52	113	2-10	91	0
T-10													
1	305	5732	2.9	168	4804	3239	1481	4720	8-29-51	0	2-2	99	0

APPENDIX TABLE 2

Total Digestible Nutrient Values for Feeding Stuffs

Feeding Stuff	TDN (%)	Reference
A7's grain	75.0	H
Barley	77.7	M
Beets, sugar	9.8	S
Beet tops, sugar	50.9	S
Beet pulp	67.8	M
Bran, wheat	67.2	M
Butter oil	214.0	H
Buttermilk powder	85.3	S
Casein	87.0	S
Chickery	57.0	H
Corn	80.1	M
Corn and cobmeal	73.2	M
Corn Gluten meal	80.2	M
Corn Starch	87.6	M
Corn cobs	45.7	M
Corn oil	214.0	H
Corn and shavings	38.0	H
Corn and peanut hulls	46.0	H
Corn gluten meal and peanut hulls	46.0	H
Complex No. 2	75.0	H
Cottonseed oil meal	70.6	M
Dried Molasses	54.0	H
Linseed Oil	214.0	H
Linseed oil meal	77.2	M
Liver meal	96.7	M
Meat Scrap	69.6	M
Molasses	54.0	M
Oats	70.1	M
Palm Kernel oil meal	76.5	M
Peanut hull mix	46.0	H
Rye malt	70.1	H
Ration no. 1	76.3	H
Ration no. 2	74.4	H
Semi-synthetic concentrate	46.0	H
Skim milk	8.8	S
Special mix	46.0	H
Solubles mix	46.0	H
Soybeans	87.6	M
Soybean oil	214.0	H

APPENDIX TABLE 2 (continued)

Total Digestible Nutrient Values for Feeding Stuffs

Feeding Stuff	TDN (%)	Reference
Soybean oil meal	78.5	M
Sugar	90.0	H
Synthetic Corn	46.0	H
Synthetic Corn and Corn Gluten Meal	46.0	H
Velvet beans	81.7	M
Wheat	80.0	M
Yeast	70.5	M
Hay		
1934	51.88	H
1935	49.52	H
1936	48.55	H
1937	48.33	H
1938	48.17	H
1939	46.77	H
1940	49.08	H
1941	50.86	H
1942	49.24	H
1943	49.60	H
1944	50.77	H
1945	50.40	H
1946	51.31	H
1947	49.84	H
1948	49.73	H
1949	50.61	H
1950	44.21	H
1951	53.78	H
1952	50.71	H
Ladino Clover	57.50	H
Corn Silage		
1934	18.21	H
1935	15.79	H
1936	15.38	H
1937	17.37	H
1938	15.83	H
1939	20.49	H
1940	18.29	H
1941	18.40	H[1]
1942	17.70	H
1943	17.52	H

APPENDIX TABLE 2 (continued)

Total Digestible Nutrient Values for Feeding Stuffs

Feeding Stuff	TDN (%)	Reference
Corn Silage (continued)		
1944	16.20	H
1945	19.44	H(Ohio M-15)[2]
1945	11.80	H(Eureka)
1946	21.16	H
1947	20.88	H
1948	19.13	H
1949	17.26	H
1950	19.06	H
1951	18.88	H
1952	21.27	H
Alfalfa-brome silage		
1937	8.8	H[3]
1938	16.8	H
1939	12.4	H
1940	15.5	H
1941	17.3	H
1942	17.4	H
1950	22.0	H
All analyses	15.7[4]	H
Clover-timothy silage	16.7	H
Ladino clover silage	17.9	M
Alfalfa-pea silage	17.0	H
Oat-pea silage	16.8	H
Green oats	16.9	M
Stalk silage	13.1	M
Sudan grass silage	14.7	M

H Huffman (1953)
M Morrison (1948)
S Schneider (1947)

1 No corn silage analyses were made in 1941. The value used for 1941 is an average of analyses for these data.

2. Two different corn varieties were ensiled. Ohio M-15 was an early maturing variety with a relatively large number of ears. Eureka was a later maturing variety with unusually large stalks and relatively few ears.

3 The alfalfa-brome silage had an unusually high butyric acid content.