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Abstract

Relationships involving forage appetite and frequency of feeding forage were studied with high–producing Holstein cows, including 60 complete cow lactations and 49 records of the dry period. Significant correlation ($r = .59$) was obtained between forage dry matter intake and 4% FCM yield in the lactation period. Patterns of forage DM intake were affected strongly by different stages of the lactation and dry periods. Infrequent periods of hot summer weather decreased intake and milk yield by about 10%. Individual cow differences, however, were the most important source of variation in forage DM intake. Age, body weight changes, body condition, and stage of gestation showed little relationship to forage DM intake; neither did body weight, either taken by itself or expressed to the powers of 0.84 or 0.73.

There were no significant differences in milk yield or forage intake due to frequency of feeding, either in the dry period or when total lactation performance was studied. There was a period during mid–lactation, however, when the more frequently fed group consumed less forage ($P<.05$) than did those fed only once a day.

It is known from previous investigations that voluntary forage intake of dairy cattle is related to certain factors of management and environment, as well as to the physiology of the individual cow, but no complete explanation of the apparently complex and interrelated determinants of appetite for forage has yet been advanced. Two recent review articles offer excellent discussions of the various theories of intake control that have evolved to date (1, 26).

Management effects. One of the important external factors affecting the cow is forage quality. For example, stage of maturity of herbage out for hay or silage and the subsequent voluntary intake of the preserved forage are closely correlated (23). Digestibility and rate of passage in the gut have been related to intake in a number of experiments, (6, 7, 9, 12, 13). The observed higher intake of ground hay and pelleted hay (provided the ration contains a high proportion of the pelleted hay and very little of the concentrates) has also been associated with a faster rate of passage (1).

The level of concentrates in the ration has been shown to affect forage intake, with a decline in forage dry matter intake of 0.24 unit for each additional unit of concentrates consumed (16).

Frequency of feeding forage has not often been tested in ad libitum situations. However, in experiments where effects on voluntary intake were measurable, it was found that varying the frequency of offering forage had little effect on the total consumption (2, 11).

Climatic effects. It is well known that rising air temperatures are accompanied by a decline in total feed consumption. Brody (3) has summarized the series of experiments at the Missouri station that demonstrated this phenomenon. For example, in an experiment with Holsteins, Jerseys, and Brown Swiss, the consumption of total digestible nutrients (TDN) at 35 and 37.8 C was, respectively, one-half ond one-third of the level consumed at 21.1 C (18). Part of this decline must certainly reflect reduced appetite for forages.

Exposure to extreme cold likewise influences forage intake. Canadian experiments showed an average difference of 2.4 kg in daily hay intake when cows were subjected to moderate (daily minimum of 4.4 C) or very cold (daily minimum of −17.8 C) temperatures (17). The colder the weather, the greater was the appetite for forage; at the same time, gross efficiency of feed utilization declined by 10%.

Relative humidity, wind velocity, and solar radiation have contributory effects on appetite regulation, mainly in situations of heat stress. In general, any action of these climatic factors that adds to an animal's heat load will cause a

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lowering of the critical temperature at which feed consumption begins to decline, and any action that tends to subtract from the heat load will cause this critical temperature to rise (4, 5, 19).

Factors related to individual cow variation. Individual cows display widely differing appetites for forage, even under controlled conditions. Stone et al. (23), in an analysis involving 175 Holsteins, found that only 25% of the total variation in forage intake could be accounted for by the measurable variables of milk production, body weight, and weight changes. It is notable that individual cows in the experiments reported by Stone tended to keep the same ranking with respect to appetite when offered different forages (early–cut hay, late–cut hay, and hay–crop silage) or when observed over the lactation period. The repeatability of weekly forage dry matter intake was 0.70 on a within–forage–treatment, within–year basis.

Previous reports on the relationship between milk yield and forage appetite are not in agreement. In one study of 17 cows of four breeds, these two variables were virtually independent, even when forage was ingested at a high level (14). Another report, however, describes these variables as being significantly correlated ($r = 0.61$) in an experiment with 138 Guernseys (25). Conrad et al. (7) suggest that when the ration is highly digestible, milk yield is a determinant of intake, whereas with a poorly digestible ration the direction of cause and effect is reversed.

An experiment with sheep demonstrated that lactating ewes consumed more forage on pasture than did their nonlactating flock-mates (8). For dairy cows, however, information is lacking about comparative effects of different stages of lactation and nonlactation on forage appetite.

The effect of gestation on forage intake also has not been adequately studied, although Mather (15) hypothesizes that the additional nutrient requirement for fetal growth may cause increased maternal appetite. Taylor (24), on the other hand, suggests that encroachment of fetal growth on rumen space may decrease food intake (24).

Intake is commonly expressed in terms of body weight (BW) or metabolic body size ($BW^{.73}$ or $BW^{.75}$). However, the correlation between body weight and intake is generally reported to be low (14, 25). Furthermore, correcting intake data simply by dividing by body weight may unrealistically favor small cows (10, 15). At least one report, however, indicates that $BW^{.75}$ is not better than $BW^{1.0}$ as a correction factor (25). Some workers have proposed $BW^{.84}$, or a similar factor, as possibly better than those mentioned above, but at the moment this question is unresolved.

The investigation reported here was undertaken to study further the interrelationships involving milk production, body weight and weight changes, frequency of feeding, and voluntary forage intake. These variables were studied during the entire lactation and part of the subsequent dry period to better assess the effects of stage of lactation and gestation.

Experimental Procedure

The 3-year experiment included a total of 60 cow–lactations from Holstein–Friesian cows of the Cornell University dairy herd. During each of the first 2 yr (1960-61 and 1961-62) 24 cows were used; during the third year (1962-63) 12 cows were used. All cows had completed at least one lactation before they were placed on the experiment. Their average age at time of freshening for their respective experimental lactation periods was 60.6 months. A period of varying length (about 2 wk) before parturition served as an adjustment period. It was intended to have each cow on the experiment for 365 days from the day after calving, including a 308-day (44-wk) lactation period and an 8-wk dry period. An estimated correction was added to the total milk yield of ten cows that could not stay in milk for the full 308 days because of accident or because they conceived on first service 70 days after parturition and were due to calve again in less than 1 yr. No yield adjustments were made for cows that did not milk for 308 days when they had an opportunity to do so. For two cows that left the experiment early, estimates of feed intake were made for the brief periods remaining up to 308 days. For all other cows, actual intake data were available for the full lactation period. In 49 instances information was available for the following dry period, the length of which varied from 2.5 to 13 wk.

Cows were assigned to groups of four on the basis of similarities in previous records, season of calving, and age. Within each group the four cows were assigned to one of the following experimental treatments:

1. Forced–air–finished hay (dried without heat) and corn silage, each fed once a day.
2. Forced–hot–air–finished hay and corn silage, each fed once a day.
3. Forced–air–finished hay fed five times and corn silage fed twice a day.

4. Forced–hot–air–finished hay fed five times and corn silage fed twice a day.

Assignment of cows to treatment was done randomly, except that the 15 cows which appeared on the experiment during more than 1 yr were assigned to the opposite treatment for the second lactation period. Once assigned, cows remained on a given treatment continuously for the lactation and following dry period. Eight cows, or two groups, started on the experiment within each of three seasons (fall, winter, and spring) for the first 2 yr; four cows, or one group, were assigned during each season of the 3rd yr. Each cow-lactation was considered as a separate experimental unit.

Feed offerings, feed refusals, and milk yields were recorded daily. Night and morning composite milk samples were taken once a week for fat, protein, and solids-not-fat analyses. Body weights were recorded once a week, except that three consecutive daily weights were recorded at the beginning and end of the experiment and at the end of the lactation period. Once a month three persons made independent visual ratings for body condition, according to a six-point numerical scale ranging from very fat (1) to very thin (6).

All cows were fed a mixed clover–alfalfa–timothy hay cut between June 13 and 28 in 1960 (cutting was delayed due to very unfavorable weather, but most of the hay was cut between June 18 and 27), June 15 and 20 in 1961 and June 18 and 21 in 1962. The average TDN value was estimated using the following formula [derived from two formulae of Reid (20, 21)]:

Estimated % TDN = 82.5 − .45 (no. of days from April 30 to date of cutting)

The TDN content of the hay was thus estimated to be 58.8% (dry matter basis) in 1960, 60.6% in 1961, and 59.7% in 1962.

The amount of hay offered was adjusted periodically to a level about 15% higher than the amount voluntarily consumed by each cow. Refused hay was weighed daily and composited proportionally into weekly samples for dry matter determination. Corn silage was fed at the constant rate of 11.3 kg per cow per day. Concentrates were fed in two equal portions each day. Each cow received 2.7 kg of grain per day before calving and after being dried off. After calving, the grain was increased daily according to a prescribed schedule, until the maximum allowance was reached 10 or 12 days postpartum. The maximum given all four cows in each group was either 8.2 or 9.1 kg per cow per day, depending on average previous production records of the group. Maximum grain intake was maintained for 60 days, after which the daily rate was decreased by 0.136 kg each week until the end of lactation. Compensation for occasional grain refusals (due to ketosis or other causes) was made by later additions to the scheduled ration.

Several multiple linear regression equations were computed from the data, with total dry matter (DM) intake from hay plus silage as the dependent variable in each case. Milk yield was expressed as 4% fat–corrected milk (FCM) for these analyses. Grain intake was expressed on a dry matter basis. A cow's age was expressed to the closest month at date of calving. When a single figure for body weight was used to represent the entire lactation period, it was taken as the average of observations during the 5th through 8th wk post–partum, when there was most uniformity in body condition.

Results and Discussion

The average performance of all animals included in the study is shown in Table 1. The mean 308-day forage DM intake for the 60 cow–lactations was 3,773 kg, about three–fourths of which came from ad libitum hay consumption and the remainder from the fixed amount of silage. Individual forage DM intakes ranged from 2,769 to 5,049 kg in 308 days; the standard deviation was 477 kg.

Average milk yield for 60 cow lactations was 6,486 kg FCM. The average body weight during the second month (5th to 8th wk) of lactation was 618 kg, with observations ranging between 508 and 767 kg. The average net gain in weight over the lactation period was 43.5 kg. Average intake of grain was 1885 kg DM; the

TABLE 1
Average daily milk yield, feed intake, and weight gain, and average condition rating for 60 lactation and 49 dry period records from Holstein cows

Observation	Lactation period			Dry period
	Wk 1-15	Wk 16-44	Total	
4% FCM (kilograms/day)	29.7	16.6	21.1	—
Forage DM intake (kilograms/day)	11.2	12.8	12.2	11.6
Grain DM intake (kilograms/day)	7.61	5.35	6.12	2.43
Weight gain (kilograms/day)	−0.36	0.40	0.14	0.82
Condition rating[a]	3.5	3.3	3.3	2.50

[a] Visual ratings for body condition according to a six–point numerical scale ranging from very fat (1) to very thin (6).

concentrate mix contained 90.1% dry matter and 74.1% TDN (estimated from Morrison's tables).

Treatment effects. No significant differences in performance of the animals, including their voluntary forage DM intake, could be related to the different drying methods of the hay (heated or nonheated forced air).

The same was true for frequency of feeding forage, except during the 7th through 26th wk of lactation. Preliminary analysis of variance, using weekly observations of intake from 48 cows for this period (weeks 7-26), indicated that the difference between daily voluntary hay intake of cows fed forage several times a day (8.4 kg) and those fed only once a day (9.3 kg) was significant at the 5% level of probability. Later analysis of variance of the data from all cows for the entire lactation period showed no significant differences due to frequency of feeding. These two conflicting results indicated a possible interaction between stage of lactation and frequency of feeding, as they affect intake; this conclusion was confirmed by comparing average hay DM intakes for the two groups at weekly intervals after parturition. Patterns of intake for both groups were closely parallel for the first 6 and the last 20 wk of the lactation period, but for the 18 wk immediately following the peak of lactation the group given forage once a day consumed about 10% more dry matter from hay than did the group fed several times a day (9.4 versus 8.6 kg). Meanwhile, both groups had comparable milk yields (25.1 kg per day during this period), resulting in a higher apparent efficiency of feed utilization during these 18 wk for the cows fed more frequently.

The dry period. Data from 49 cows were used for study of the dry period. All cows included had at least 19 days of observations available; the maximum length of the period observed was 91 days, the average, 51. In most instances the period observed did not extend to subsequent parturition. During the dry period, daily DM intake from hay and silage declined to an average of 11.6 kg per day, compared to 12.2 kg per day for all cows while lactating. It is significant that the repeatability of forage DM intake between the lactation and dry periods was high ($r = 0.73$) for the 49 cows. This means that reasonably accurate predictions of a cow's intake during the dry period can be made on the basis of her mid-lactation consumption, and supplemental feeding can be planned accordingly.

Relationships involving forage intake. Specific relationships among forage intake, milk yield, body weight and weight changes, age, condition rating, and stages of lactation and gestation were studied by computing several series of multiple linear regression equations.

a) *Comparisons among cows for the lactation period.* The first series of equations were computed from data representing total performances of all cows during the lactation period. Since treatment effects had been shown to be nonsignificant, they were ignored in this analysis. The first equation of this series was

$$Y_1 = 3{,}648 + .372\,X_1 + 1.52\,X_2 + 2.12\,X_3 - 1.83\,X_4 + 2.13\,X_5 \quad [1]$$

where Y_1 = predicted 308-day total DM intake from hay and silage (kg), X_1 = 308-day FCM (kg), X_2 = body weight (kg), X_3 = net gain in weight (kg), X_4 = 308-day grain DM intake (kg), and X_5 = age in months at date of calving. A multiple correlation coefficient (R) of .73 was obtained; the coefficient of determination (R^2) was .54, indicating that the five independent variables here considered can explain slightly more than half (54%) of the total variation in forage DM intake (the dependent variable) in this situation. The standard error of estimate (S.E.) of Y_1 was 339 kg; this is a measure of the residual variation in forage DM intake after the observations were corrected for the effects of the five independent variables, and can be compared with the standard deviation of 477 kg for the unadjusted data.

The technique of dropping one variable at a time and recomputing the regression equation, as described by Steel and Torrie (22), was used to assess the importance of each variable in the analysis. Using the same notation as above, the resulting equations were

$$Y_1' = 3{,}485 + .366\,X_1 + 1.85\,X_2 + 1.99\,X_3 - 1.76\,X_4 \quad [2]$$

$$Y_1'' = 1{,}061 + .266\,X_1 + 1.48\,X_2 + 1.65\,X_3 \quad [3]$$

$$Y_1''' = 1{,}578 + .225\,X_1 + 1.19\,X_2 \quad [4]$$

$$Y_1'''' = 2{,}366 + .217\,X_1 \quad [5]$$

For these four equations R was .73, .63, .61. and .59, respectively; R^2 was, therefore, .53, .39, .37, and .35.

It was concluded from this analysis that age is of no value in predicting forage DM intake. This conclusion followed from the very small differences in R^2 values (.537 and .532) between Equation [1], which included age (X_5), and Equation [2], which omitted X_5. Likewise, gain in body weight and body weight itself contributed very little information to such a prediction. Grain DM intake was more important in its association with forage DM intake, since R^2 dropped from .53 when it was included (Equation [2]) to .39 when it was omitted (Equation [3]). This fact is of little significance, however, due to the arbitrary method of assigning grain to the cows in this experiment and the resulting discontinuous pattern of variation among cows. The above conclusions regarding four of the five independent variables were confirmed by examining the correlation coefficients in Table 2. Here it can be seen that the correlations between forage DM intake and body weight, gain in weight, grain DM intake, or age were all very low.

There was, however, an important degree of association between milk yield (FCM) and forage DM intake in this analysis. The correlation between these two factors was .59, and the R^2 value for Equation [5] indicates that roughly one-third of the total variation in Y_1 was associated with variation in X_1. As the regression coefficient indicates, an average increase of 22 kg in forage DM intake accompanied each 100 kg of increase in total FCM yield.

Equation [6] (below) is a simple regression of FCM yield on forage DM intake, the dependent and independent variables in Equation [5] being reversed. The regression coefficient computed in this manner indicates an average increase of 160 kg in FCM yield for each 100-kg increase in voluntary forage consumption.

$$X_1 = 450 + 1.60\,Y_1 \qquad [6]$$

b) *Within-cow analysis, considering stage of lactation.* A second set of multiple linear regression equations was computed, ignoring individual cow effects and using weekly observations within the lactation period as the unit of analysis. Previous examination of the data had revealed two distinctly separate patterns within the lactation period with respect to voluntary forage intake (see Figure 1). Hence, the first 15 wk were analyzed separately from the last 29.

The average forage intake was 78 kg of DM per week (11.2 kg per day) for Weeks 1-15, and 89 kg DM per week (12.8 kg per day) for Weeks 16-44. The cows produced 208 kg FCM per week (29.7 kg per day) and 116 kg per week (16.6 kg per day), respectively, for the two periods. Loss of body weight averaged 2.5 kg per week in the first 15 wk, but the cows gained back an average of 2.8 kg per week in the last 29 wk. The average condition rating was similar for both periods (3.50 and 3.25). Average stage of gestation for all cows during the second portion of lactation was 13.3 wk post-conception.

Some of the equations for the first 15 wk were

$$Y_2 = 47 + .08\,X_6 + .09\,X_7 + 1.08\,X_8 + 1.46\,X_9 \qquad [7]$$

$$Y_2' = 53 + .01\,X_6 + .14\,X_7 + 6.9\,X_8 \qquad [8]$$

$$Y_2'' = 68 + 1.30\,X_9 \qquad [9]$$

where Y_2 = predicted DM intake from hay and silage (kilograms per week), X_6 = FCM yield (kilograms per week), X_7 = gain in weight (kilograms) from the previous week, X_8 = numerical rating for body condition, and X_9 = week number of the lactation period. R and R^2 values for these three equations were, respectively, .60 and .36; .40 and .16; and .54 and .29.

One of the equations for the last 29 wk was

$$Y_2''' = 102 + .05\,X_6' + .07\,X_7' - 5.0\,X_8' - .12\,X_{10} \qquad [10]$$

Stage of lactation (X_9) was not included, since graphic analysis (see Figure 1) showed that average intake was quite constant throughout this portion of lactation. Instead, the stage of gestation (X_{10} = number of weeks since apparent date of conception) was included, to test for possible effects of pregnancy on intake. R and R^2 for Equation [10] were .23 and .05, respectively.

Equation [7] gave the best fit for the data covered, but even so it left unaccounted for nearly two-thirds (100 − R^2 = 64% = the coefficient of nondetermination) of the variation in forage DM intake. Of the four independent

TABLE 2
Coefficients of correlation between all pairs of variables in analysis of total lactation performance (308 days) for 60 Holstein cows

Variable	Body weight	Gain in weight	Grain DM intake	Age	Body weight$^{.84}$	Body weight$^{.73}$	Forage DM intake
4% FCM	−.14	−.57	.54	−.03	−.14	−.14	.59
Body weight		−.10	.01	.51	1.00	1.00	.06
Gain in weight			−.27	−.17	−.10	−.10	−.24
Grain DM intake				.16	.01	.01	.03
Age					.51	.51	.03
Body weight$^{.84}$						1.00	.06
Body weight$^{.73}$							.06

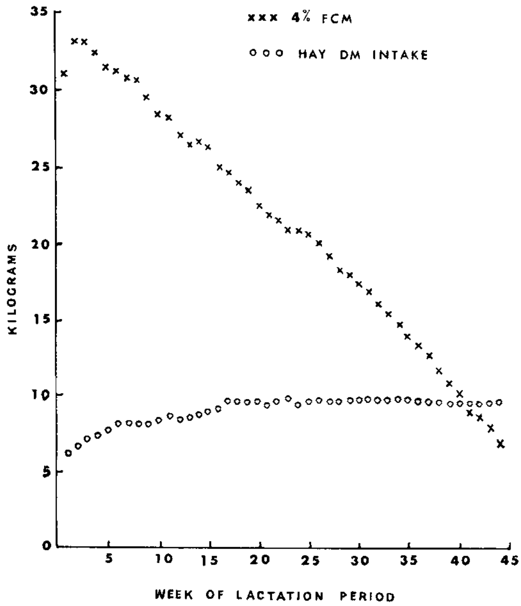

FIG. 1. Average daily 4% FCM yield and hay DM intake for 60 Holstein cows during each week of the lactation period.

variables in Equation [7], X_9 (stage of lactation) was the most important in its association with Y_2, as noted by the decline in R^2 from .36 for Equation [7] to .16 for Equation [8], which omitted X_9. Equation [9], which considered only stage of lactation in a simple linear relationship with forage DM intake, gave nearly as good a fit as Equation [7].

The low R^2 value for Equation [8] indicates that FCM yield, body weight change, and body condition had little relationship with forage DM intake in the first one-third of the lactation period. The same conclusion applies for all variables under consideration in the analysis of the last 29 wks, as evidenced by the insignificant R^2 value for Equation [10]. The low correlation coefficients between these variables and forage DM intake are further evidence of this point (see Table 3, last column).

c) *Comparisons among cows for the dry period.* Two series of equations were computed for the dry period. The first series dealt with possible sources of variation among cows for the whole period studied. Average forage DM intake (kilograms per day) was taken as the dependent variable (Y_3) for these equations. X_{11} = stage of gestation at the midpoint of the period studied, expressed as the number of weeks since apparent date of conception; X_{12} = average weight gain (kilograms per day); X_{13} = average body weight (kilograms) for the period; and X_{14} = average condition rating. Average values for these variables for 49 cows were, respectively: 11.6 kg of forage DM intake, 31.4 wk of gestation, 0.82 kg of weight gained per day, 708 kg of body weight, and condition rating of 2.5. One prediction equation from this series was

$$Y_3 = 7.7 - .10\,X_{11} + 1.96\,X_{12} + .001\,X_{13} + 0.74\,X_{14} \quad [11]$$

for which R and R^2 were .47 and .23, respectively. It is clear that this equation did not fit the data well. Coefficients of correlation between daily forage DM intake and independent variables were, respectively, .05, .41, −.22, and .32. A fair degree of correlation existed between forage intake and body weight gain, which was expected since, on the average, nearly 80% of the TDN consumed in the dry period came from forage.

The second set of equations covering the dry period ignored individual cow effects; the unit of analysis was weekly observations of forage intake and accompanying body weight. For these equations, Y_4 = predicted forage DM intake (kilograms per day); X_{15} = the week number of the dry period, a measure of both stage of gestation and time elapsed since the

TABLE 3

Coefficients of correlation between all pairs of variables in analysis of weekly observations within the 308-day lactation period of 60 Holstein cows, with individual-cow effect ignored

Variable	Weight gain	Condition rating	Stage of gestation	Stage of lactation	Forage DM intake
A. Wk 1-15 of lactation period					
4% FCM	−.09	−.30	....	−.51	−.08
Weight gain		.25	....	.28	.29
Condition rating			....	.56	.34
Stage of lactation					.54
B. Wk 16-44 of lactation period					
4% FCM	−.10	.64	−.88	−.89	.15
Weight gain		−.05	.09	.10	.06
Condition rating			−.67	−.69	−.03
Stage of gestation				.94	−.13
Stage of lactation					.05

previous lactation ended; and X_{16} = body weight (kilograms). The prediction equations were

$$Y_4 = .027 - .307\,X_{15} + .0175\,X_{16} \quad [12]$$
$$Y_4' = 12.3 - .20\,X_{15} \quad [13]$$
$$Y_4'' = 25.4 - .0191\,X_{16} \quad [14]$$

R and R^2 for Equation [12] were .39 and .15. The correlation coefficient between forage DM intake and stage of dry period was −.37; between forage DM intake and body weight $r = -.26$. Implications of these results are discussed below.

Effects of hot weather. There was evidence of reduced voluntary intake during the hot weather that occurred during brief periods in two of the three summers of the experiment. Parallel reductions of similar magnitude occurred in milk yield (corrected for normal lactational decline). For example, during the first 2 wk of September, 1961, when the mean daily temperature rose as high as 26.7 C (8.3 degrees above seasonal normal), total daily DM intake per cow was reduced to as much as 10% below normal. This decline was manifested as reduced voluntary consumption of hay. Similar responses occurred on four separate occasions in 1961 and 1963.

Differences in response to hot weather due to stage of lactation were noted, but trends were not clear-cut. There was some evidence that cows at the peak of lactation were affected more by heat stress than cows in later stages of lactation. During one five-day interval of abnormally hot weather (June 29-July 3, 1963) four spring-freshening cows declined in average production from 36 to 27 kg per day. Their feed consumption dropped about 20% over the same period. This observation gives additional reason for the recommendation to farmers in the Northeast to breed for fall freshening.

Conclusions

Forage intake and lactation. Three important areas of consideration have been suggested from this study with respect to the relationship between lactation and voluntary forage intake. They are: 1) intake differences among cows, a portion of which might be associated with inherent capacity for milk production; 2) differences in intake apparent at different stages of lactation; and 3) intake differences that might be related to whether a cow is lactating or dry.

Results showed clearly that the high-producing cows voluntarily consumed more forage than their lower-producing herd-mates; which was cause and which effect, however, is still unknown. The assumption that forage intake depended on milk yield was made for convenience of analysis, but remains unproved. The important finding is that the two variables were interdependent, to the extent that the coefficient of correlation between them approached 0.6. The economic advantage of this relationship is obvious for most situations.

When stage of lactation was considered, level of milk yield became of secondary importance in predicting forage DM intake. In this case, when the unit of observation was the performance of a single cow in a single week, these two variables showed considerably less association with each other ($r = -.08$ and .15, from Table 3). Of much more importance was the pattern of variation within lactation periods due to stage of lactation. This effect is demonstrated in Figure 1 and Equation [9]. The latter shows that an average increase in voluntary forage DM intake amounting to 1.3 kg per week (or .19 kg per day, each week) occurred over the first 15 wk. Hay DM intake increased more than 50% during the first one-third of lactation, rising from 6.4 kg per day after parturition to 9.5 kg per day by the 17th wk.

It is notable that the increase in forage consumption continued throughout the early part of lactation while the cows were receiving maximum allowances of concentrates, in spite of previous reports that high-grain feeding depresses forage intake (16). Apparently, the moderate levels of grain in this experiment, with a maximum of 9 kg per day, were not sufficient to inhibit the tendency for increased forage appetite.

The fact that voluntary forage intake was at its lowest level in the weeks immediately following parturition underscores the particular need for adequate concentrate supplementation at this time.

As diagrammatically shown in Figure 1, appetite for forage remained quite constant during the latter part of the lactation period. It was after drying-off that levels of voluntary intake of forage began to decline. Over the portion of the dry period studied, the average decline in forage DM intake was at the rate of 0.20 kg per day each week (Equation [13]). As reported above, the correlation between stage of dry period and forage DM intake was negative, but only moderately close ($r = .-37$).

The reason appetite changes might be related to stage of lactation or dry period is open to speculation. It is possible that changing nutrient requirements due to onset or cessation of lactation may have some effect, although if such a reaction occurs from onset of lactation it apparently has delayed effects.

Forage intake and gestation. Differences in appetite among cows were not closely related to different stages of gestation, as evidenced in Equation [11], computed with data from dry cows in all stages of advanced gestation. The correlation between average stage of gestation and average forage DM intake was negligible ($r = .05$).

Likewise, gestational effects did not contribute to differences in weekly intake observations for individual cows during the latter part of the lactation period (Equation [10]). As would be expected for such early stages of gestation, the correlation between weekly observations of forage DM intake and stage of gestation during this period was quite low ($r = -.13$, Table 3).

The observed reduction in intake as the dry period progressed is discussed above. It is possible that this phenomenon was a gestation effect. Reduced gut capacity due to the growing fetus could be a contributing factor. Whether advancing stage of gestation was a real reason for reduced intake is still open to question, but it is safe to conclude from this study that suggestions of increased appetite accompanying pregnancy in dairy cattle are entirely unfounded.

Forage intake and body weight. These two variables were wholly unrelated in the analysis of data from the lactation period ($r = .06$). In the dry period there was a slight negative correlation ($r = -.22$), but body weight was an unimportant variable in regression Equations [11], [12], and [14], computed for the dry period. Changes in body weight, either gains or losses, and the visual rating for body condition likewise showed little relationship to intake differences.

When body weight figures for the lactation period were raised to the powers of 0.84 and 0.73, the correlation with forage DM intake remained negligible (see Table 2). These results cast doubt on the value of the present common practice of reporting feed consumption of dairy cattle in terms of body weight or metabolic body size and of using body weight as an indicator for predicting forage intake, at least when all animals being considered are mature and of the same breed.

Individual differences in forage intake. It is apparent that highly significant differences existed among individual cows with respect to forage appetite, as measured by forage DM intake. This was true even when intake observations were corrected for concomitant variation in FCM yield, body weight, weight changes, grain intake, age, body condition, and stage of lactation or gestation. Of all the equations computed in this study, Equation [1], computed from lactation totals, best fitted the data, but even so it left nearly one–half of the total variation in forage DM intake unaccounted for. This was only slightly better than the results of Stone et al. (23), whose study included a multiple regression equation incorporating the same variables as Equation [3]. R^2 for the equation of Stone et al. was 25%, compared with nearly 40% for Equation [3] and 54% for Equation [1] in the present study.

This study has demonstrated a relationship between milk–producing ability and forage appetite, which accounted for a significant portion of the individual variation in intake. It also demonstrated a relationship between stage of lactation and intake differences within lactation periods for individual cows. The approach used, however, gave no insight into the mechanisms whereby these relationships are mediated, nor did it add to our knowledge on the whole question of appetite control. These are questions to which studies of the basic physiology of appetite control must be applied.

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