APPETITE STUDIES IN DAIRY CATTLE
GRASS SILAGE VS. HAY

Thesis for the Degree of Doctor of Philosophy

MICHIGAN STATE UNIVERSITY
DONALD HILLMAN

1959

This is to certify that the

thesis entitled

Appetite Studies in Dairy Cattle

Grass Silage vs. Hay

presented by

Donald Hillman

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Dairy ~~Nutrition~~

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Date 5/22/59

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Submitted to the [illegible] of
Michigan State [illegible]
Applied Science [illegible]
the requirements [illegible]

DOCTOR [illegible]

Department of [illegible]

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Approved C. A. [illegible]

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GRASS SILAGE VS. HAY

By

DONALD HILLMAN

AN ABSTRACT

Submitted to the School for Advanced Graduate Studies of
Michigan State University of Agriculture and
Applied Science in partial fulfillment of
the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Dairy

1959

Approved C A Lassiter

ABSTRACT DONALD HILLMAN

Three trials were conducted during a two-year period to determine the affects of feeding rations of all hay, all silage, and hay-silage combinations _ad libitum_ on dry matter consumption, milk production, and body weight changes of lactating dairy cows. The alfalfa hay and alfalfa silage used in each trial were harvested from the same field at the same stage of maturity.

In the first trial two equalized groups of eight milking Holstein cows were used in a 42-day reversal experiment to compare the affects of all-hay and all-silage rations. Cows fed all hay averaged consuming 34.3 pounds of dry matter daily, 3.14 pounds of dry matter per 100 pounds of body weight, gained 19.4 pounds of body weight, and averaged 28.3 pounds of milk per day. Respective values for cows fed all silage were 27.0, 2.46, -42.4, and 28.4. Differences in dry matter intake and body weight changes between rations were highly significant ($P < .01$).

Blood sugar levels of cows fed hay were significantly higher ($P < .05$) than of cows fed all silage.

In a 40-day 4 x 4 latin square feeding trial when wet hay (soaked in water to approximate the moisture of the silage) and silage that was treated with sodium hydroxide (NaOH) to increase the pH to approximately that of the hay were compared to dry hay and the alfalfa silage, neither the wet hay nor the NaOH-treated silage had any affect on dry matter consumption, body weight changes, or milk production.

When silage was fed _ad libitum_ and hay feeding was controlled to 0%, 25%, 50%, 75%, and 100% of the ration dry matter, in each case additional increments of hay to the ration resulted in an increase in average daily dry matter consumption in a 90-day continuous trial. The average daily dry matter intake and dry matter intake per 100 pounds of body weight were 26.2 and 2.44 pounds, 28.6 and 2.97 pounds, 32.8 and 2.99 pounds, 35.1 and 2.99 pounds, and 41.0 and 3.52 pounds for cows fed the 0%, 25%, 50%, 75%, and 100% hay rations, respectively.

Dry matter intake per 100 pounds of body weight was significantly greater for cows fed all hay or the 75% hay plus silage ration than for cows fed all silage or 25% hay plus silage ration ($P < .01$). Differences between other rations were not significant at the one per cent level. However, at the five per cent level, the all-hay, 75%-hay, and 50%-hay rations were significantly greater

than the all-silage ration; and the all-hay ration was significantly greater than the 75%-hay, 50%-hay, or 25%-hay rations.

Milk production of the cows fed all hay, 75% hay, and 50% hay was significantly greater ($P < .01$) than of cows fed 25% hay plus silage or all-silage rations. There were no significant differences in milk production between the all-silage and 75%-silage rations or the all-hay, 75%-hay, and 50%-hay rations at either the one per cent or the five per cent levels of significance.

The correlation between dry matter intake and milk production for all cows was $r = .572$. Changes in body weight were: all silage, -58 pounds; 75% silage, -20 pounds; 50% silage, -5 pounds; 25% silage, +51 pounds, and all hay, +23 pounds during the 90-day period. These differences were significant at the ten per cent level of probability.

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G15145
6/17/61

ACKNOWLEDGEMENTS

For their fruitful wisdom, constructive guidance, and much helpful assistance during the conduct of the research and preparation of the manuscript, the author is deeply grateful to Dr. C. A. Lassiter, Associate Professor of the Department of Dairy, and Dr. C. F. Huffman, Professor of the Department of Dairy at Michigan State University.

Gratitude is expressed to Dr. C. W. Duncan and Dr. E. J. Benne of the Department of Agricultural Chemistry who performed the chemical analyses of the feed samples and to Dr. R. S. Emery of the Department of Dairy for reading the manuscript and for many helpful suggestions throughout the course of study.

Appreciation is expressed to Dr. N. P. Ralston, formerly Head of the Department of Dairy, for making the facilities for the study available and to the people of the State of Michigan who provided the funds and facilities for the study.

Thanks and appreciation is extended to Mr. Ralph Reed, Mr. Lester Reed, and others for their assistance in feeding and caring for the cattle.

The author is deeply indebted to his wife Mary for her meticulous typing of the manuscript, to her and their son Donald for their loving faith and encouragement and for the many sacrifices that they encountered during the course of the study, and to his mother, Anna M. Hillman, for her many sacrifices and constant encouragement over the many years that made possible the privilege to conduct this study.

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INTRODUCTION

Recent trends in the development of forage harvesting equipment and self-feeding systems for managing dairy cows have created widespread interest in the use of silages as a major source of nutrients for dairy cattle. Preservation of forage crops as grass silage has been commonly recommended as a means of reducing field losses from leaf shattering and rain damage. In Michigan some dairy farmers have contemplated the use of silages as the sole source of roughage.

Since roughages are generally considered the cheapest source of nutrients for dairy cattle, a large dry matter intake from roughages is essential for maximum profits from the dairy business.

The studies reported here have attempted to measure the influence of all grass silage rations compared to all hay rations and combinations of hay and silage on dry matter intake, milk production, and body weight changes of lactating dairy cows. In addition, limited observations concerning factors affecting appetite for roughages are reported.

REVIEW OF LITERATURE

The importance of forage quality and quantity in the dairy ration has been reviewed by Huffman (1939). Recently, Hardison (1959) reviewed methods of evaluating the nutritive quality of forages and Ward (1959) reviewed the affect of soil fertility upon the yield and nutritive value of forages. A complete review of recent literature on all phases of forage preservation and evaluation is lacking but could be useful. The research cited here pertains primarily to those experiments which have dealt with feeding large amounts of silages to dairy cattle.

Hay and Silage Compared: Dry Matter Consumption, Milk Production, and Body Weight Changes

As early as 1917 Woll and Voorhies (1917) observed that cows consumed two pounds more dry matter on alfalfa hay than on milo silage when both were fed to maximum appetite. At the same time they observed a slightly higher dry matter intake on Indian corn silage and hay than on alfalfa hay alone; and approximately 1.5 pounds more dry matter was eaten as corn silage and hay plus concentrates than as sweet sorghum silage and hay plus concentrates.

Cows on immature grass hay ate 19 per cent more nutrients than their requirements, whereas those on similar grass silage ate only 3 per cent more than their nutrient requirements when no grain was fed in trials conducted by Graves et al. (1938). The grass silage group did not eat enough to meet requirements until the fourth month of lactation. The grass hay group produced slightly less milk per pound of dry matter consumed. However, the authors pointed out that this does not mean the hay dry matter was less efficiently used since all cows exceeded their TDN (total digestible nutrient) requirements. When the silage group was put on full feed with grain they consumed approximately the same TDN as the group fed hay with heavy grain. These authors concluded that "the cows on grass silage were not able to consume as much in proportion to their nutrient requirements as the cows on grass hay."

In a similar experiment conducted by Hodgson and Knott (1940) cows fed a mixed hay and grass silage ration consumed only 78 per cent as much dry matter as cows on an all alfalfa hay ration. The hay and grass silage group ate 26 pounds of dry matter (D.M.), when hay made up 58 per cent of the ration dry matter, compared to 33 pounds D.M. on the all hay ration. Dry matter consumed per 1000

pounds of body weight was 20.6 and 24.2 pounds, respectively. Average fat corrected milk production was higher for the all hay group in 168 and 140 day trials when no grain was fed. Likewise, the rate of decline was faster for the hay plus silage group.

Milk production was statistically highly significant in favor of cows fed brome grass hay in comparison to brome grass silage in 30-day trials conducted by Brundage and Sweetman (1954). Total digestible nutrient consumption was generally higher for the hay fed group; however, silage had a higher calculated TDN when fed _ad lib_. due to the lower roughage consumption. Chopped, baled, and loose hays and wilted grass silage were compared for milk production in studies by Keyes and Smith (1955). The data reveals that during a 120-day trial cows consumed about 5.5 pounds more TDN per day from roughage as loose hay than as grass silage. Roughage consumption differences between the hay fed groups were very small; however, the group fed chopped hay received more grain than other hay fed groups and thus consumed more total TDN and produced the most milk. The silage group was fed about 1,000 pounds more TDN as grain than those getting loose or baled hay, although total TDN consumption was about 4,000 pounds less than the hay fed group. The silage group was second

in milk production and was significantly higher than the groups fed baled hay and loose hay. Body weight gains for baled hay, loose hay, chopped hay, and grass silage were 67 pounds, 43 pounds, 11 pounds, and 20 pounds, respectively. Although the report indicates that all of the hay was harvested at approximately the same time, there was no mention of when the grass silage was harvested. This experiment points out a danger of feeding grain according to milk production in experiments that are intended to evaluate the milk producing power of different forages. If milk production response happens to be higher for the group receiving a particular forage early in the experiment, grain feeding will be adjusted upward. This becomes a continuous process until the cows are recieving such a large proportion of their nutrients from grain that it is impossible to distinguish whether the difference in production was due to the forage or to heavier grain feeding.

Little et al. (1953) demonstrated that the 8 per cent extra dry matter consumed by cows on baled hay produced 8 per cent more milk than the cows on grass silage harvested at the same time from the same field. Cows were depleted of milk production reserves for a 45-day period prior to this experiment.

In trials designed to measure the relative feeding value of pea and oat silage, Huffman, Dexter, and Duncan (1954) observed that cows fed an all silage ration ate less dry matter and 25-30 per cent less TDN than when hay was included in the ration. Similar results were reported when red clover was fed as hay and as silage by Huffman et al. (1954) and again when prebud alfalfa hay and alfalfa-rye-grass silage were used in milk production trials by Huffman et al. (1956). Dry matter intakes were 30.6, 27.5, and 24.7 pounds per day for the basal hay, prebud alfalfa, and alfalfa-rye-grass silage, respectively, in this experiment. These workers noted that there was generally a gain in body weight during the hay feeding periods and point out that at least part of this was undoubtedly due to greater fill of the digestive tract when more dry matter was eaten. Horwood and Wells (1936) compared second cutting alfalfa-molasses silage and alfalfa hay but found no significant difference in milk production when grain was fed according to production; however, about 7 per cent more TDN was consumed by cows while on the hay ration. The hay ration just met the average daily nutrient requirements for TDN, while the silage ration lacked 2.2 pounds of meeting the requirements. Cows on the hay ration gained somewhat more body weight, although this was probably not significant.

Blosser *et al.* (1952) noted that cows fed silage alone have a marked craving for some dry roughage in the ration. In this trial cows fed five pounds of hay ate about one pound more dry matter and produced one pound more milk daily than when fed grass silage as the only roughage. Grain was fed at the rate of one pound per four pounds of FCM.

The addition of hay at the rate of one-third, two-thirds, and one pound per 100 pounds of body weight increased dry matter consumption with each added level of hay feeding in a double change-over experiment conducted by Nicholson and Parent (1957); however, there were no significant differences in milk yield, butterfat percentage, or change in body weight between the rations.

In contrast to these results, Hill *et al.* (1954) found no difference in dry matter intake when grass silage and hay, that were harvested from the same field at the same time, were fed to appetite to milking cows. They reported higher milk production and greater body weight gains from the silage than from the hay. Similarly, Shepard *et al.* (1954) concluded that "the roughage intake (dry matter basis) and milk production of cows fed wilted alfalfa silage will equal that of cows fed alfalfa hay made from the same field at the same time." In palatability

trials conducted by these workers there was no significant difference in dry matter consumption. Although there were no significant differences in milk production, it is important to note that the experimental forages comprised only about one-half of the total ration TDN.

Trimberger et al. (1955) concluded that intake depended on the palatability of the roughages as influenced by stage of maturity when harvested. In milk production trials cows consumed equally as much dry matter from early silage as from barn dried hay and as much from late silage as from field cured hay. Grain consumption averaged 11.5 pounds per cow and about 6 pounds of dry hay was fed with silages.

There was no difference in dry matter intake when grass-legume silage was fed at two pounds hay equivalent per 100 pounds of body weight compared to an equal hay-silage combination during one trial; whereas, in a subsequent trial the hay-silage group consumed somewhat more dry matter in studies conducted by Cobble and Wildes (1956). Apparently one group of cows produced better on silage and another group produced better on the hay-silage combination when grain was fed at the rate of one pound per three pounds of milk.

In reversal experiments with Jersey cows when Lush <u>et</u> <u>al</u>. (1954) fed hay and silage that were not identical and grain according to production, the cows ate two per cent more TDN and produced slightly more milk when fed hay than when fed silage as the only roughage. When ½ hay and ½ silage were fed, cows ate 3.8 per cent less TDN but produced slightly more milk than when all silage was fed; however, they produced 5.7 per cent more milk when ¾ silage was fed than when all silage was fed.

Limited and varying amounts of grass silages and corn silage were fed with apparently satisfactory results by Fairchild and Wilbur (1925), Owen <u>et</u> <u>al</u>. (1956), Waugh <u>et</u> <u>al</u>. (1943), Williams and Cunningham (1917), Henderson and Norton (1950), Gaalas and Rogler (1955), Pratt and White (1930), Monroe and Allen (1934), Monroe and Hayden (1935), and Jamieson (1957), although the data are inadequate for relevant conclusions.

Conversely, Monroe <u>et</u> <u>al</u>. (1938) reported that cows on an alfalfa hay-corn silage ration ate about two pounds more dry matter daily and produced more milk and butterfat than cows fed a ration of soybean-corn silage plus grain. Likewise, Huffman and Duncan (1954) noted that dry matter consumption was often lower when corn silage made up a large part of the ration. Similarly, Lassiter <u>et</u> <u>al</u>. (1958)

found that cows ate significantly less dry matter when fed oat silage than when fed corn silage. Milk production was better when oat silage made up 63 per cent of the ration, but corn silage was better when used as 77 per cent of the ration dry matter.

Since this paper pertains only to grass silage no attempt was made to review all of the mass of literature concerning corn silage.

Soilage vs. Silage

Huffman *et al*. (1957) did not find a reduction in dry matter intake when immature alfalfa fed as soilage replaced a major part of the basal hay ration; however, there was consistently less dry matter consumption when the alfalfa silage replaced a part or all of the hay. There were good increases in production when either soilage or silage replaced the basal hay.

In contrast, Foreman *et al*. (1958) reported that the cows fed soilage consumed more dry matter and maintained a higher level of milk production than did those fed silage when first crop alfalfa silage was compared with second and third crop alfalfa soilage, and grain was fed at the rate of one pound per four pounds of fat corrected milk (FCM). Similarly, Boyd (1959) found that cows fed green-chopped star millet consumed six pounds

more dry matter on the average than their paired mates getting oat silage when both groups were fed five pounds of hay and the same amount of grain. During the first 28-day period the millet-fed group produced 24.3 pounds of FCM per day and those on oat silage produced 23.7 pounds per day. It appears that one group of cows produced slightly higher regardless of ration. There were no differences in butterfat content or total solids of the milk, or differences in body weight that could be attributed to the rations.

Dry Matter Consumption and Growth of Dairy Heifers Fed Silages and Hay

Bender and Tucker (1937) reported that body weight gains of Holstein and Guernsey heifers fed timothy silage alone were inferior to gains made when both hay and silage were fed. Similar results were reported by Bender (1942) when hay was limited to three pounds per day and grass silage was fed ad lib. In another study using 163 grade Guernsey and 172 grade Holstein heifers, it was noted that height normality was 95.8 and 94.4 per cent of the Ragsdale standards, respectively. Growth was definitely retarded when poor quality silage was fed.

Similarly in experiments comparing alfalfa hay and wilted silages for growing dairy heifers, Sykes et al.

(1955) found that heifers fed the all hay ration made significantly better growth and consumed more TDN than heifers fed either a limited hay-silage ration or all-silage ration. It was noted that growth rate paralleled TDN intake although the health of all heifers was generally good. These results were confirmed by Thomas, Sykes, and Moore (1959) when they reported that heifers fed alfalfa silage supplemented with either corn silage or hay gained at a slower rate (P = 0.01) than heifers fed only alfalfa hay during the 8 to 12 month of age period. Heifers fed corn and alfalfa silages had a slower rate of gain (P = 0.05) than those fed silage and hay during this period. Supplementing alfalfa silage with grain produced faster rates of gain than supplementing silage with hay, but these differences were not significant. Similar results were noted after the heifers were one year old. Dry matter intake was highest on hay, intermediate on silage plus hay, and lowest on all silage rations. Heifer calves consumed 8.3 per cent more wilted silage (32% DM) and gained 9.7 per cent more weight than their twin mates that were fed high moisture silage in trials by Newlander and Riddell (1957). Lassiter _et al_. (1958) noted that heifers fed oat silage as the sole roughage made significantly lower average daily gains than when fed either corn

silage or alfalfa hay and consumed significantly less roughage dry matter when fed either oat or corn silage than heifers fed hay.

In contrast to this, Keener et al. (1949) reported that heifers fed mow-cured or field-cured hay consumed about four pounds more dry matter daily than similar heifers fed grass silage, but the silage group made better daily gains. The favorable rate of gain for the silage fed heifers was not explainable by TDN intake. Recently, however, Keener et al. (1958) reported that there was a highly significant increase in growth when a limited amount of hay was added to rations of grass silage or grass silage plus corn silage. Energy intake of the heifers was correspondingly increased when hay was added to either the grass silage or grass silage and corn silage rations. A depression of growth was observed when corn silage was added to the grass silage ration, but the data reveal that a protein deficiency might have existed under the conditions of this ration. When a 25 per cent protein concentrate was fed with corn silage as the sole roughage and skim milk was fed to six months, Converse and Williams (1952) reported that Holstein heifers attained the Ragsdale standards and Jerseys exceeded the standards at 24 months of age. Studies by Moore et al.

(1948) indicated that wilted silage produced gains equally as good or better than the barn-dried hay and field cured hay with which it was compared when fed at equally controlled levels of intake. Similar results were reported by Porter and Kesler (1954) working with young calves.

In a summary of eight different trials with Jersey and Holstein heifers fed less than 600 pounds of grain with alfalfa, timothy, and orchard grass-ladino hay with and without corn silage, the U.S.D.A. (1957) concluded that the quality of the roughage and resulting effect on dry matter intake was more important than which roughage was fed or the amount of grain fed for normal growth. Forages fed in these trials were generally of excellent quality.

It would appear from the literature available that in general grass silage has produced less favorable results for growing dairy heifers than hay of comparable quality. This apparently is a result of lower dry matter consumption when grass silage is fed. Whether this difference is of any great economical concern for subsequent milk production or reproduction has not been fully determined.

Dry Matter Consumption of Silages Preserved by Various Methods

White and Johnson (1934) concluded that the addition of succulent roughage (corn silage or beet pulp) to a hay and grain ration did not increase dry matter intake. They noted less dry matter intake when corn silage was fed with hay and grain than when only hay and grain were fed, but that the total roughage dry matter intake of the silage group increased as the experiment progressed as a result of an increase in the dry matter content of the silage. However, cows on a hay and grain ration ate more dry matter when water was available continuously than when watered once a day.

Similarly, Shepherd *et al*. (1953) reported slightly higher dry matter intake when low moisture (46 per cent) grass silage was compared with medium moisture (64 per cent) grass silage. Dry matter intakes were 2.52 pounds and 2.34 pounds per 100 pounds body weight daily for the low moisture and medium moisture silages, respectively, when about 6.5 pounds of grain were fed. When oat silage was preserved with ground snap corn, or sodium metabisulfite, McCullough *et al*. (1958) concluded that there was no consistent difference in dry matter intake due to

method of preservation, but that the difference in silage dry matter resulted in a mean difference in dry matter intake of four pounds per cow per day in favor of the snap corn preserved silage. No statistical analysis of the results was given. Although the data reveal a higher dry matter intake from the snap corn preserved silage at the prebloom stage in 1956 and at the boot stage in 1957, they also show that the consumption of snap corn preserved silage harvested at the prebloom stage in 1957 was less than the untreated control. Similarly, dry matter consumption of both the sodium metabisulfite treated and snap corn preserved silages, harvested at boot stage in 1957, was considerably lower than shown for any other trial regardless of moisture content of the silages.

When high moisture hay crop silages of comparable moisture content were preserved with beet pulp or corn meal, Gordon et al. (1957) reported dry matter intake per 100 pounds of body weight was 2.58 pounds but only 2.0 pounds per 100 pounds of body weight when the control silage, Kylage-treated silage, or silage with seepage recirculated were fed without hay. The use of corn meal and beet pulp reduced dry matter losses in storage by about one-fourth. Cows consumed somewhat more dry matter when fed sodium metabisulfite treated prebloom alfalfa silage

than when fed molasses-urea treated silage or the untreated control in experiments conducted by Hardison et al. (1957). However, in subsequent experiments with a millet, soybean, sudan grass, and sorghum mixture there was no difference in silage consumption, dry matter intake, or milk production, although cows fed the untreated silage gained somewhat more in body weight. Later, slightly higher dry matter intake resulted from the bisulfite and Kylage treated sudan grass-soybean mixture silages than from the untreated control. In this trial milk production was significantly better on Kylage-treated and untreated silages than on the bisulfite-treated silage.

Little (1954) demonstrated that 18 to 28 month old heifers preferred sodium metabisulfite-treated silage over untreated silage which was harvested from the same field. Under free-choice feeding conditions the heifers ate 13 pounds more of the treated silage. Similar results were reported by Cowan et al. (1955). Heifers ate nearly four times as much bisulfite- and sulfur dioxide-treated silages as they did of the control high moisture silage. It was reported that the bisulfite-treated silage was more palatable than the SO_2-treated silage. In a double reversal experiment with depleted milking cows, Little (1955) found that cows fed metabisulfite-treated silage ate about

one-third more dry matter than when fed the untreated silage, but there was no significant difference in milk production, percentage of fat in the milk, or body weight gain.

Allred et al. (1955) concluded that the feeding value of unwilted silages prepared by four different treatments was very similar since there was no significant difference between them in dry matter consumed, body weight changes, four per cent fat-corrected milk, or digestibility of silage dry matter in 1952. In 1953 tests, bisulfite-treated silage was inferior to the other silages in daily intake and body weight gains. The methods of preservation studied were: no preservative, sodium metabisulfite, molasses (wet), and brewers dried grains.

Similar results were obtained by Voelker and Bartle (1957). When they compared alfalfa silage treated with bisulfite, wilted and unwilted, there was no difference in milk production or body weight changes during the eight-week trials; however, when the cows were changed to 12 pounds of hay and corn silage, they ate 13 pounds more dry matter daily, gained two pounds body weight per day, and the decline in milk production was reduced.

Preservation of high moisture legume silage with sulfur dioxide (SO_2) did not improve apparent palatability

or feed consumption over the untreated silage in trials by Dufour et al. (1954). There was no difference in body weight or milk production during 60-day trials. Similar results were reported by Knodt (1950). However, Knodt et al. (1952) reported reducing dry matter losses 50 per cent from treating timothy-red clover silage with SO_2 as compared to corn cob meal. Again there were no production differences when fed to dairy cows.

The A.I.V. (sulfuric and hydrochloric acid) method of preserving alfalfa silage resulted in 13.8 per cent greater dry matter consumption and 8 per cent more milk than on the control hay ration in trials by Hayden et al. (1945). Grain was fed at the rate of one pound per three pounds of milk with both rations. In another trial cows produced 5.5 per cent more milk and gained more weight than on the hay ration in a 46-day experiment. When silage preserved with phosphoric acid was fed by these workers, the cows produced 4.6 per cent less milk than when about the same amount of dry matter was fed as corn silage. The corn silage fed cows gained weight while the grass silage group lost body weight. In a summary of ten years of work with hay-crop silages, Hayden et al. concluded that "the dry matter content of the forage was as important if not the most important factor in determining the quality of the resulting silage regardless of the preservative used."

Dijkstra (1957) found that wilted silage gave a small gain of body weight and slightly more milk than A.I.V. silage. In similar trials Hegsted et al. (1939) found no difference between A.I.V. and molasses grass silage for milk production or body weight when one-half of the hay and one-third of the corn silage in the ration were replaced with the grass silages. The grain-milk ratio fed was 1:3. Petersen et al. (1935) reported the same result in a similar trial with A.I.V. silage; however, Fagan and Ashton (1937) found A.I.V. silage was eaten with reluctance by cattle, whereas the molasses-grass silage was very palatable.

Cows consumed 1.84 pounds of dry matter per 100 pounds of body weight when fed an unchopped forage having a pH 5.18 and 2.4 per cent butyric acid compared to 2.01 pounds of dry matter per 100 pounds of body weight when fed a chopped forage having a pH 4.77 and 1.6 per cent butyric acid during studies reported by Gordon et al. (1958). Both forages were stored in bunker silos. Comparing these results with results of the following year, the data reveal that dry matter intake of both unchopped and chopped forages was lower when the pH of the silages

was 5.88 and 5.90 and the butyric acid content was 1.6 and 1.1 per cent, respectively. There appeared to be a close relationship between chemical composition of the silages and dry matter intake. Daily dry matter intakes were 1.75 and 1.71 pounds per 100 pounds of body weight for the unchopped and chopped forages, respectively. The moisture contents of both silages were approximately the same within each year. These workers suggested that the differences in intake could have been due to different types of fermentation products.

Pratt *et al*. (1958) conducted a series of experiments to measure the relative "palatabilities" of silages. In these experiments cows were fed 12 to 16 pounds of hay plus grain at approximately one pound for each four pounds of milk produced. It is interesting to note that the relative palatability of a silage largely depended on the condition or quality of the reference silage with which it was fed. When cows had a choice between two silages, great differences in consumption often occurred but in reversal type experiments when only one silage was fed at a time, the differences in silage consumption were not as pronounced. In general it appeared that cattle preferred any of the experimental silages over the untreated control when they had a choice. Considerable differences in dry matter intake and milk production by cows on various silages was noted.

In general one could conclude from the research reviewed here that when silages were fed to cattle, no one method of preservation consistently resulted in greater dry matter consumption; however, there is some evidence to indicate that those methods of ensiling which result in a somewhat lower moisture content either by addition of dry material or wilting generally resulted in greater dry matter consumption if the resulting silage was satisfactory in quality. This is not to say that reduced dry matter consumption was a result of high moisture content of the silage *per se* but rather a result of the type of fermentation and the products of fermentation that are associated with storage of high moisture crops.

Factors Affecting Appetite for Dry Matter

The practical importance of the phenomenon of appetite as a nutritional factor affecting the rate of production and the economy of animal production has been born out in both the field and the laboratory. By and large experimental studies have indicated that those feeds which are readily eaten in large amounts by animals result in the greatest yield of animal products, provided

other nutritional factors are available (Huffman, 1939). This does not omit the quality differences in feed stuffs but includes quality as one of the desirable factors affecting feed intake.

Appetite has been defined as a natural longing or desire for food. It is associated with an agreeable sensation and is most commonly measured as dry matter intake or dry matter intake per unit of body weight (Huffman, 1939).

Appetite must not be confused with palatability. Palatability is merely a relative term which implies whether one feed stuff is better liked than another as determined in cafeteria-type feeding experiments, while appetite refers to the total amount of feed eaten.

There are many factors known to affect appetite. Huffman (1939) has classified them in a general scheme as:

A. Factors Inherent in the Animal

(1) size, (2) age, (3) exercise, (4) health, (5) psychological: group feeding, fear, excitement, habit, (6) level of production, (7) inheritance, (8) hormones--adrenals and insulin, (9) palatability of the feed.

B. Factors Inherent in the Ration

(1) balance of the ration, (2) amount of feed offered, (3) bulk, (4) environmental temperature, (5) water availability, (6) palatability of feeds--physical condition, presence of aromatics, deficiencies or excesses of chemical factors.

Gordon (1957) points out that "Food is neither palatable nor unpalatable. Palatability depends on the relationship between the food on the one hand and the animal on the other hand and is the sum of the factors which operate to determine whether, and to what degree, a food is attractive to an animal."

In recent years several theories have been advanced that may contribute to an understanding of factors affecting appetite. Carlson (1916) advanced the idea that control of food intake was based on the concept that the lowering of blood sugar which occurs between meals stimulates stomach contractions producing hunger pains which motivate the animal to eat. Bulatao and Carlson (1924) showed that hypoglycemic conditions (low blood sugar) could have some affect on the origin of hunger contractions. They found that hunger contractions were inhibited by intravenous injections of glucose and that injections of insulin strengthened hunger contractions by its depressing action on blood glucose levels. This idea of the stomach being the controlling factor on appetite was proved inadequate by Grossman (1948) when he demonstrated that cutting the nerve supply to the stomach stops hunger pains but does not abolish appetite, and complete removal of the stomach also abolishes hunger contractions but does not materially influence food intake.

Studies on the influence of bulk and dilution of the diet of rats by Adolph (1947) and Hoelzel (1930) experimenting with himself further discredit the central role of the stomach in controlling food intake. Adolph noted that dilution of the rat diet with kaolin (clay) or cellulose shavings did not reduce nutrient intake until the food was diluted to the point that it was physically impossible for the rats to consume enough. Dilution of food (milk solids) with water did not materially influence nutrient intake until the concentration of nutrients was less than 2.6 per cent. Hoelzel found that appetite persisted after he had swallowed considerable size helpings of sand, cotton-wool, cellulose, glass beads, etc.

In his review on the question of bulk in ruminant rations, Mäkela (1956) observed that the total rumen contents of cattle did not vary to a great extent whether fasted or fed, but that the dry matter part of the rumen

contents varied considerably. Mäkela studied the effects of quantities of water, dry matter, fibre, and ballast contained in the ration on the filling effects of the ration and found that dry matter quantity was the best criterion for the filling effect of a ration. He further studied the filling effect of certain foods as measured against hay. One kilogram of dry matter in concentrates was equivalent to 0.5 kg. in potatoes, 0.6 kg. in rutabagas, 0.7 kg. in fodder cellulose, 0.8 kg. in sugar-beet tops, and in sugar-beet pulp to 0.9 kg. of the dry matter of hay. A.I.V. silage made from grass, hay, and oat straw were of approximately equal filling effect per kg. of dry matter. However, Mäkela's data reveals that dry matter consumption per 100 kg. body weight with only hay *ad lib.* and 12 kg. A.I.V. silage was 1.77 kg. whereas when hay *ad lib.* and 12 kg. silage plus brewers grains and rutabagas were fed, consumption increased to 3.4 kg. per 100 kg. of weight.

Ewing and Wright (1918) observed in slaughter tests with steers that the retention of food in the reticulorumen and in the omasum was of longer duration when the steers ate silage only than in the case of a silage ration supplemented with a small amount of cottonseed meal, or when only cottonseed meal was fed.

Mäkela (1956) cited evidence which indicates that green roughages, as a rule, remain for a shorter time in the alimentary tract than the corresponding dry roughages. Similarly, finely ground feed, either concentrates or hay, pass more rapidly than courser material. However, Balch (1953) has shown with cows that the quantity of water consumed had no noticeable influence upon the retention time of food in the reticulo-rumen or in the entire alimentary tract. Conversely, the quantity of the total ration fed does affect the rate of passage from the rumen. Mäkela (1956) cited evidence that when cattle were fasted the discharge of the alimentary tract proceeds so slowly after commencement of the fast that it is necessary to assume an increased time of retention.

The importance of certain sections of the brain in controlling appetite was revealed by Hetherington and Ransom (1940) when they demonstrated that lesions in specific areas of the hypothalamus of rats caused greatly increased food intake (hyperphagia) and obesity. Lesions in other specific areas caused complete refusal of food (aphagia) and inanition. These results have been duplicated with cats by Anand and Brobeck (1951) and with sheep and goats by Larsson (1954) by using electrical stimulation of the hypothalamus. Larsson further showed

that hypothalamic stimulation sometimes produced rumination in connection with hyperphagia and concluded that it is not impossible that rumination constitutes part of the mechanism regulating food intake in ruminants.

The glucostatic theory of arterial-venous differences (delta glucose) in blood glucose concentration controlling appetite by the affect of this difference on the hypothalamus has been advanced by Mayer (1953, 1955). According to this theory the difference in the concentration of glucose in arterial and venous blood indicates the rate at which it is being used by body tissue. When delta glucose is high, hunger is absent; when delta glucose diminishes, hunger returns. It has been shown with humans on ordinary diets and is supported by studies with rats in which injected glucose reduced food intake by an amount greater than the energy of the glucose, whereas other substances such as fats and sucrose did not. In opposition to this Fryer _et al_. (1955) showed that the satiety values in reducing diets for humans do not agree with their effects on blood glucose. The highest satiety value in reducing diets studied with young men was obtained with a diet high in protein, high in fat, and low in carbohydrate. The poorest satiety was observed with a diet high in carbohydrate and low in protein. The

effects of these diets were exactly the opposite from that which would be expected from the glucostatic theory. Larsson (1954) did not find any characteristic change in blood glucose values which could be referred to the effect on hyperphagia and rumination in goats. Further, Gordon (1957) found that there was no relation between blood glucose levels and the choice of different glucose solutions when working with sheep. Bell (1959) reported that glucose solutions were accepted by goats at all concentrations offered but that goats have acceptance or rejection thresholds for quinine-HCl, NaCl, and acetic acid at different concentrations.

The sense of smell is apparently only of supplementary importance in influencing food selection of sheep. Tribe (1949) in comparing normal sheep with sheep that had the olfactory lobes removed concluded that the sense of smell is important in the initial stimulation of appetite but was of no importance in the selection of a particular grass and clover species. The sheep soon became adapted to a particular smell and it then had little influence on the feeding activity of the sheep.

Lauter (1937) observed that opposite to the feeding of hunger is repletion which determines the quantity of food that is eaten. He noted that repletion is characterized by a feeling of fullness in the stomach and pressure

in the entire trunk. This is accompanied by a feeling of bodily and mental weariness which produces a need of rest. He maintained that the absorption of nutrients lags behind the feeling of repleteness; therefore, repletion would not be due to the arrival of nutrients into the tissues.

Brobeck (1948), in his thermostatic theory, considered that food intake is regulated as a means of temperature control. It is supported in part by experiments with rats fed diets differing in fat and protein content in which the food eaten from all diets appeared to produce a relatively constant specific dynamic action, and by observation that food intake is reduced when environmental temperature rises. Further, it is known that the hypothalamus is concerned with temperature regulation through centers different than those controlling food intake, but it is hypothesized that the hypothalamus "integrates" the effects of temperature and circulating metabolites to control food intake. This theory helps to explain the effect of protein since this nutrient has a high specific dynamic action but does not account for the effects of thyroxin which increases both body temperature and food consumption.

The lipostatic theory is concerned with long-term regulation of food intake and suggests that the fat stores of animals govern their rate of food consumption. This working hypothesis of Kennedy (1952) helps to explain why there appears to be a "privileged body weight" characteristic of the animal, the environment, and the feeding program. Obviously, it does not completely account for controlling food intake, particularly in those animals that are already obese and have healthy appetites.

It appears that no one of the above theories is adequate in itself to completely describe the processes of controlling appetite; however, each of these has contributed to a more complete understanding and it is possible that they are all involved in some complex system which is not yet understood.

There have been numerous observations on the effects of certain vitamin and amino acid deficiencies on food consumption and rate of growth in other species. For instance, Cowgill (1934), when studying the vitamin B requirements of man, observed that "the outstanding characteristic of a thiamine deficiency is a decreased food intake." Scott (1946) has shown that rats were unable to balance their diets adequately from a cafeteria feeding situation. Approximately one-half of the rats failed to

grow normally; however, Scott and Quint (1946) reported that "appetites for food containing thiamine, riboflavin, or pyridoxine are developed in rats whose diets have been deficient respectively in these vitamins. These appetites are not simple preferences because they cannot be found in normal rats." In this regard Richter et al. (1938), by using self-selection techniques, were able to show with rats that a deficiency of the vitamin B complex caused an anorexia for carbohydrate and protein and a craving for fat and yeast. Considering the fat soluble vitamins, apparently in the vitamin A deficient mammal there is a decreased food intake which can be restored by feeding this vitamin (Guilbert et al., 1940). Vitamin D deficiency also decreases food intake of chicks (Baird and Green, 1935). In studies with rats the addition of vitamin D to a low phosphorus rachitic diet may decrease food intake (Schneider and Steenbock, 1939); but on a low calcium rachitic diet, the vitamin increased the food intake according to Zucker et al. (1938) and Krieger et al. (1940).

Vitamins E and K seem to have little effect on food intake (Pappenheimer, 1939, and Almquist and Stokstad, 1936). Frazier et al. (1947) have shown that each of the nine essential amino acids is important in maintaining

food intake with the rat, and Rose (1938) noted that the lack of protein in the diet reduces food intake.

Deficiencies of many of the inorganic elements have been noted to depress appetite and/or cause a craving for the element. Phosphorus, calcium, magnesium, sodium, potassium, chlorine, zinc, and manganese have been studied in this regard and reviewed by Lepkovsky (1948). Cobalt deficiency affects the appetite of ruminants only and apparently exerts its effect through the rumen bacteria (Lepkovsky, 1948).

These findings with non-ruminant animals are of doubtful significance in the case of the ruminant because of the complex biological fermentation and synthesis of nutrients in the rumen. This area has been comprehensively reviewed by Huffman (1953) and in general it will suffice to note here that the products of carbohydrate digestion appear to be the short chain fatty acids primarily acetic, propionic, and butyric. Of these it is known that acetic and butyric can be utilized directly upon absorption (Theiler, 1915) and that propionic is probably converted to glucose in the liver and used as such. The numerous works cited by Huffman (1953) reveal further that true protein, all of the amino acids and B vitamins that are known to be essential to the nutrition

of animals are synthesized in the rumen in quantities adequate for growth, production, and reproduction under normal conditions. The fact that true proteins and the nitrogen containing vitamins can be synthesized in part from non-protein nitrogen (NPN) sources such as urea and sodium nitrate as well as the many NPN compounds found in plants (i.e., amino acids, nucleic acids, purine and pyrimidine bases, choline and betaine, alkaloids, urea, nitrates, and possibly others) vastly complicate the problem of elucidating specific compounds that could possibly affect the appetite of the ruminant.

EXPERIMENTAL PROCEDURE

Three trials were conducted during a two-year period to study the effect of varying levels of hay and grass silage feeding on dry matter consumption, milk production, and body weight changes of lactating dairy cows. The alfalfa hay and alfalfa silage used in each trial were harvested from the same field at the same stage of maturity. No grain was fed during the course of any of the experiments. All cows received 50 grams of a salt-mineral mixture daily. Weighed amounts of the roughages were provided in excess (approximately ten per cent) of daily consumption, and the remaining portion was weighed back daily and deducted from the totals. All cows were fed separately in stanchions with partitional mangers.

Three-day average body weights for all cows were recorded at the beginning and end of each experimental period. An average of the beginning and final weight for each cow was used to determine dry matter intake per 100 pounds of body weight.

Cows were milked twice daily and the milk was weighed at each milking. Three-day composite samples of the milk were tested for butterfat content.

Average daily feed consumption, average daily dry matter intake, average daily dry matter intake per 100 pounds of body weight, body weight changes, and milk production were determined.

Trial I. The Effect of All-Hay vs. All-Silage Rations on Dry Matter Intake of Lactating Dairy Cows

Since the literature concerning the effect of all-silage rations on the performance of dairy cattle showed that considerable controversy exists, a preliminary experiment was conducted in the late summer of 1957 to measure dry matter intake, milk production, and body weight changes of milking cows when fed an all-hay ration compared to an all-silage ration.

Random field-plot samples and botanical composition analysis revealed the crop used to be 84 per cent alfalfa, 7 per cent grasses, and 7 per cent weeds. The crop yielded 2.68 tons of hay (90% dry matter) per acre from the one cutting. The entire crop was cut on June 4 when only a sprinkling of the alfalfa plants were in bloom. The material used for grass silage was allowed to wilt for approximately 24 to 36 hours before being put in storage, but due to persistent high humidity very little wilting occurred, and it was field-chopped and blown

into a 12' x 25' concrete stove silo at the nutrition experimental barn on June 5 and 6. Frequent sampling and dry matter analysis of the green material from the wagon indicated that the first material ensiled contained about 78 per cent moisture. Later samplings were about 74 per cent moisture as was the bulk of the material ensiled. Considerable seepage drained from the silage as it settled.

The hay that had been cut at the same time as the silage was field cured, baled, and put in storage on June 10 and 11 without weather damage. It was of excellent quality.

Two groups of eight milking Holstein cows each were balanced as well as possible for milk production, stage of lactation, and body weight and fed either hay or grass silage as the only roughage in a 42-day single-reversal experiment.

When the silo was opened for feeding on August 23, about 18 inches of spoiled material were removed from the top of the silo and discarded. Grain feeding was stopped at this time, and all cows were changed to either hay or silage. When feeding began the silage was only fair in quality, having a slightly offensive odor; but after a preliminary adjustment feeding period of three days, the

quality had improved and the experiment was begun on August 26. Most of the silage fed was very good in quality. Weekly representative samples of the silage and less frequent samples of the hay were analyzed for chemical composition by A.O.A.C. methods (1955). These results are shown in Tables 1 and 2.

Table 1

Chemical Composition and pH of Legume-Grass Silage on Subsequent Sampling Dates (Trials I and II)

Date Sampled	Dry Matter	Ash	Crude Protein	Ether Extract	Crude Fiber	NFE	pH
	%						
8-26-57	19.25	1.60	3.56	.85	6.93	6.31	4.40
9- 5-57	22.42	2.25	3.96	.96	7.97	7.28	5.30
9-26-57	28.21	2.37	5.43	1.02	9.38	10.01	4.28
10- 4-57	26.47	2.48	5.04	.92	9.04	8.99	5.12
10- 8-57	25.34	2.29	4.86	.87	9.05	8.27	5.16
10-25-57	24.97	-	-	-	-	-	5.18
11- 4-57	25.37	-	-	-	-	-	4.82
11-11-57	25.41	-	-	-	-	-	4.99
11-22-57	26.44	-	-	-	-	-	4.98
11-28-57	25.62	-	-	-	-	-	4.90
Average	24.95	2.20	4.57	.92	8.47	8.17	4.90

Table 2

Chemical Composition of Alfalfa-Grass Hay (Trials I and II)

Sample Number	Dry Matter	Ash	Crude Protein	Ether Extract	Crude Fiber	NFE	pH
			%				
1[a]	88.30	7.37	17.52	1.58	31.36	30.47	-
2	80.65	5.72	13.93	1.24	26.25	33.51	-
3	85.48	5.52	15.55	2.00	26.03	36.38	5.55
4	85.30	6.18	15.68	1.67	27.38	34.39	5.56
Average	83.81	5.80	15.05	1.64	26.55	34.76	5.55

[a]Field-sample composed of recombined plot samples after botanical analysis, artificially dried, not included in the averages.

Blood samples were drawn from the jugular vein of all cows before the morning feeding on August 23 and at ten-day intervals thereafter. The blood was analyzed for glucose content according to the method of Somogyi (1945).

Trial II. Moisture and pH as Factors Affecting Appetite

In Trial II, 16 Holstein cows were used in a 40-day 4 x 4 latin square experiment designed to determine whether moisture or pH were factors affecting dry matter intake of silage and hay. The silage and hay fed were from the same supply as was used in Trial I. Four rations were fed, each for ten-day periods: (1) alfalfa hay, (2) alfalfa silage, (3) hay that had been soaked in water to increase the moisture content up to that of the silage, and (4) NaOH-treated silage. The NaOH-treated silage was the same as the regular silage but was treated with sodium hydroxide to increase the pH to approximately that of the hay. To determine the amount of sodium hydroxide required to adjust the pH of the silage to approximate that of the hay, the pH of representative samples of the silage was determined frequently (2 to 3 times weekly) in the laboratory by use of a Beckman pH meter. Sodium hydroxide was added to the silage in sufficient quantities to raise the pH to above that of the hay which had been determined to be 5.66 upon repeated sampling. Because of the buffering power of the silage, the samples were allowed to set for two to three hours or until the pH remained at the desired level. The amount of NaOH required for the daily feed supply was calculated and applied to thin layers of the silage spread out on the feed-room floor. After application of about one-half of the NaOH solution, the silage was mixed thoroughly and redistributed on the floor. The remainder of NaOH was applied and thoroughly mixed. A knapsack sprayer fitted with a T-jet weed spray nozzle was used for applying the NaOH. The

wet hay was prepared by weighing the dry baled hay for each cow twice daily, then submerging each portion in water contained in a series of four 55-gallon barrels. The hay was allowed to soak approximately 12 hours between feedings. The wet hay was hoisted from the barrels with the aid of a block and tackle and allowed to drain for approximately one-half hour before feeding. This method allowed accurate measurement of the dry matter supplied to each cow daily. The uneaten portion was weighed back, and dry matter determinations were made of representative samples. Dry matter consumption was determined by deducting the remaining dry matter from the total amount fed. The pH and dry matter of the treated silage is given in Table 3, and the dry matter of the wet hay is given in Table 3a.

Table 3

Dry Matter and pH of Legume-Grass Silage Treated with Sodium Hydroxide on Subsequent Sampling Dates (1957)

Date Sampled	Dry Matter	pH
10-29-57	-	6.25
11-14-57	-	5.82
11-22-57	25.17	5.66
11-28-57	26.18	5.89
Average	25.67	5.85

Table 3a

Dry Matter Content of Wetted Hay (Weigh-Back)

Sample Number	Dry Matter %
1	31.5
2	31.1
3	29.2
Average	30.6

Trial III. Effect of All-Hay, All-Silage, and Combinations of Hay and Silage on Dry Matter Intake, Milk Production, and Body Weight

Twenty-five lactating Holstein cows were used in a 90-day continuous trial to determine the effect of various combinations of alfalfa-grass silage and hay rations on dry matter intake, milk production, and body weight changes during the fall of 1958.

The hay and silage were harvested from the same field as the previous year, and the botanical composition was about the same. The silage portion was harvested with a direct cut field-chopper on June 3 and 4, 1958. Only a sprinkling of blooms appeared on the alfalfa plants. Sodium metabisulfite was applied at the rate of eight pounds per ton of green material by allowing it to flow

into the blower from a funnel attached to the back of the self-unloading wagons. Representative samples of the fresh material indicated that the moisture content was about 78 per cent when ensiled. The sodium metabisulfite was used as a preservative to insure a good quality silage. Considerable seepage drained from the two 12' x 25' silos. The alfalfa hay was cut at the same time from the same field as the silage and was baled and put in storage two days later without rain damage. It was of excellent quality. Chemical composition of the forages is given in Tables 4 and 4a.

Table 4

Chemical Analysis of Alfalfa Silage (Trial III)

Date	Dry Matter	Ash	Crude Fiber	Ether Extract	Protein	NFE	pH
				%			
7-18-58	19.19	1.85	5.00	.94	4.24	7.16	4.93
7-25-58	21.23	1.89	5.57	1.01	4.13	8.63	4.38
8- 4-58	22.58	1.91	6.99	.99	3.75	8.94	4.36
9-12-58	24.46	1.89	7.44	1.35	4.00	9.78	4.12
10-14-58	20.45	1.96	7.32	.93	3.59	6.65	5.10
11- 7-58	24.17	1.92	7.96	1.05	3.91	9.33	4.25
11-19-58	25.54	1.99	8.44	1.24	4.18	9.69	4.25
Dry Matter Basis Av.	100	8.7	31.2	4.8	17.1	38.1	4.48

Table 4a

Chemical Analysis of Alfalfa Hay (Trial III)

Sample No.	Dry Matter	Ash	Crude Fiber	Ether Extract	Protein	NFE
				%		
1	84.57	5.66	29.20	1.68	14.65	33.38
2	88.71	5.94	26.11	2.12	14.94	39.56
3	88.62	5.06	29.12	2.23	15.44	36.77
Dry Matter Basis Av.	100	6.4	32.2	2.3	17.2	41.9

When the first silo was opened there was very little top-spoilage and feeding began on July 10, 1958. All cows were fed about 20 pounds of the hay and grass silage free-choice but no grain for a preliminary adjustment period of six days after which each cow received only the experimental ration.

Five balanced groups of Holstein cows were fed one of the following rations for a period of 90 days commencing on August 16: (1) all-silage, (2) 25% hay - 75% silage dry matter, (3) 50% hay - 50% silage dry matter, (4) 75% hay - 25% silage dry matter, and (5) all-hay. Except for the all-hay ration, hay was limited to its respective part of the ration and silage was fed in excess

of daily consumption. The amounts of hay fed were approximately 10, 20, and 30 pounds daily for the three hay-silage combination rations, respectively, although this varied somewhat with individual cows. Each cow received 50 grams of a salt-mineral mixture daily. Due to insufficient numbers of cows available at the initiation of the experiment, it was necessary to start with fifteen cows and add more cows as they became available. One cow on the 75% silage ration refused to eat the silage and was switched to the all-hay ration two weeks after the experiment began. Ten more cows were added on October 16 to bring the total to five cows per group. The last group of cows lacked 13 days of finishing the 90-day period when the silage supply was depleted. The data for dry matter intake, milk production, and body weight changes were submitted to statistical analysis as described by Snedecor (1956), and the means were tested for significance by employing the studentized range tables of May (1952).

RESULTS AND DISCUSSION

Dry Matter Consumption of Hay vs. Silage

In each of the three trials conducted the cows consumed more dry matter when hay was fed as the sole roughage than when grass silage was fed. Daily feed consumption, dry matter intake, and dry matter intake per 100 pounds of body weight data are presented in Tables 5 and 5a for individual cows fed hay or silage as the sole ration during Trial I. These data indicate that every cow consumed more dry matter when fed hay than when fed alfalfa silage. The average daily dry matter intake was 34.3 pounds per cow when fed hay and 27.0 pounds per cow when fed silage (Table 6).

These differences were even more noticeable during Trial III (Table 7). Cows fed hay as the only roughage consumed 41.0 pounds of dry matter per day compared to 26.2 pounds for cows fed all silage. Dry matter intake per 100 pounds of body weight followed the same trend as for total dry matter intake. It will be noted that average dry matter intake per 100 pounds of body weight of cows fed hay was 3.14 pounds, compared to 2.46 pounds when fed silage. The corresponding values in Trial III (Table 8)

Table 5

Average Daily Dry Matter Intake and Total Roughage Consumption of Cows Fed Only Hay or Grass Silage for 21-Day Periods (Trial I)

Cow	Roughage Consumption Hay	Roughage Consumption Silage	Dry Matter Daily	Body Weight Average	D.M./100 lbs. Body Weight
	lb.				
568	-	118	27.2	1114	2.44
568	44	-	37.3	1132	3.30
K-239	-	85	19.9	1027	1.97
K-239	42	-	35.9	992	3.62
K-302	-	113	26.3	969	2.71
K-302	42	-	35.9	979	3.67
A- 76	-	129	30.0	1171	2.56
A- 76	47	-	39.8	1168	3.40
A- 77	-	127	29.6	1267	2.34
A- 77	41	-	34.8	1235	2.82
A-110	-	140	32.6	1171	2.78
A-110	46	-	39.0	1156	3.37
A-114	-	109	25.2	999	2.52
A-114	42	-	35.9	991	3.58
T- 17	-	104	24.2	1162	2.08
T- 17	41	-	35.2	1158	3.04
Hay (av.)	43	-	36.7	1101	3.35
Silage (av.)	-	116	26.9	1110	2.42

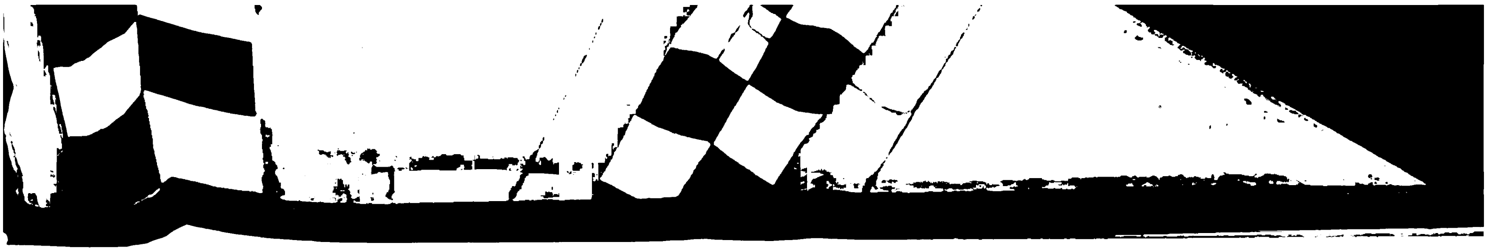

Table 5a

Average Daily Dry Matter Intake and Total Roughage Consumption of Cows Fed Only Hay or Grass Silage for 21-Day Periods (Trial I)

Cow Group II	Roughage Consumption Hay	Roughage Consumption Silage	Dry Matter Daily	Body Weight Average	D.M./100 lbs. Body Weight
	lb.				
CS-203	45	-	38.4	871	4.40
CS-203	-	95	25.4	863	2.94
K-218	37	-	31.2	1075	2.90
K-218	-	117	31.3	1050	2.98
K-303	41	-	34.9	1292	2.70
K-303	-	113	30.1	1298	2.32
A- 78	36	-	30.5	1235	2.47
A- 78	-	88	23.4	1226	1.91
A- 80	39	-	33.7	1293	2.61
A- 80	-	106	28.2	1282	2.20
A- 98	42	-	35.6	1222	2.91
A- 98	-	120	32.0	1221	2.62
A-115	29	-	24.6	957	2.57
A-115	-	90	24.1	933	2.58
A-116	31	-	26.4	1003	2.63
A-116	-	86	22.9	974	2.35
Hay (av.)	37.5	-	31.9	1118	2.92
Silage (av.)	-	102	27.2	1106	2.49

Table 6

Summary of Results of Trial I. Dry Matter Intake of Hay and Silage, Body Weight Changes, and Milk Production During a 42-Day Reversal Trial

	Group A	Group B
	lb.	
PERIOD 1. (21 days)		
Silage consumed	116.0	--
Hay consumed	--	37.3
Dry matter per day	26.9	31.9
D. M. per 100 lb. body weight[1]	2.42	2.94
Body weight change[1]	-49.6	6.4
Actual milk production	30.8	29.1
PERIOD 2. (21 days)		
Silage consumed	--	102.0
Hay consumed	42.8	--
Dry matter per day	36.7	27.2
D. M. per 100 lb. body weight[1]	3.35	2.49
Body weight change[1]	32.4	-35.3
Actual milk production	27.5	26.2
AVERAGE OF PERIODS 1 & 2	Hay	Silage
Silage consumed	--	109.0
Hay consumed	40.0	--
Dry matter per day	34.3	27.0
Dry matter per 100 lb. body weight[1]	3.14	2.46
Body weight change[1]	19.4	-42.4
Actual milk production	28.3	28.5

[1]Significantly different - 1% level.

were 3.52 and 2.44 pounds for the all-hay and all-silage groups, respectively. These differences were statistically highly significant ($P < .01$) for both trials. These results are in agreement with Graves et al. (1938), Hodgson

Table 7

Average Daily Dry Matter Intake and Feed Consumption by 30-Day Periods of Cows Fed All Hay, All Silage, and Combinations of Silage and Hay *ad. lib.* (Trial III)

Ration	First 30 Days Feed Consumption Per Day		First 30 Days Total D. M. Per Day	Second 30 Days Feed Consumption Per Day		Second 30 Days Total D. M. Per Day	Third 30 Days Feed Consumption Per Day		Third 30 Days Total D. M. Per Day	Average Dry Matter Per Day
	Silage	Hay		Silage	Hay		Silage	Hay		
	lb.									
All Silage	124	-	27.1	113	-	26.7	105	-	24.9	26.2^{e}
75% Silage 25% Hay	89	10	29.1	84	10	28.2	77	10	28.3	28.6^{d}
50% Silage 50% Hay	66	19	32.0	66	19	33.2	66	19	33.3	32.8^{c}
25% Silage 75% Hay	42	29	34.8	46	28	35.5	45	27	35.1	35.1^{b}
All Hay	-	44	38.2	-	48	41.5	-	49	43.2	41.0^{a}

a > c, d, e ($P < .01$)
b > e ($P < .01$)
c > e ($P < .05$)
b > d ($P < .05$)
a > b ($P < .05$)

Table 8

Summary of Trial III. Average Daily Dry Matter Intake, Dry Matter Intake per 100 Pounds Body Weight, Fat Corrected Milk Production, and 90-Day Body Weight Change of Cows Fed All-Hay, All-Silage, or Hay-Silage Combinations ad lib.

Ration	Dry Matter Daily	D. M. per 100 lb. Body Weight	FCM Daily	Persistency 30-Day Actual Milk	Body Weight Change
	lb.	lb.	lb.	%	lb.
All Silage	26.2	2.44	26.6	88.4	-58
75% Silage 25% Hay	28.6	2.70	26.1	90.6	-20
50% Silage 50% Hay	32.8	2.97	29.2	92.9	- 5
25% Silage 75% Hay	35.1	2.99	31.0	89.3	+51
All Hay	41.0	3.52	30.7	94.1	+23

and Knott (1940), Brundage and Sweetman (1954), and others who have observed greater dry matter intake from hay than from silage.

In Trial III when hay feeding was controlled at 0%, 25%, 50%, 75%, and 100% of the total dry matter but silage was fed ad libitum, total dry matter consumption increased as the level of hay in the ration was increased. The average daily dry matter consumption per cow fed each of the rations was as follows: all-silage, 26.2 pounds;

25% hay-75% silage, 28.6 pounds daily; 50% hay-50% silage, 32.8 pounds; 75% hay-25% silage, 35.1 pounds; and all-hay, 41.0 pounds. Statistically, daily dry matter intake was significantly greater ($P < .01$) for the cows fed all hay and 75% hay than for those fed all silage. The all hay group was significantly greater than either those fed 25% hay or 50% hay ($P < .01$), also. At the five per cent level of significance daily dry matter intake was significantly greater for cows fed 50% hay than for those fed all silage; likewise, the 75%-hay group was greater than the 25%-hay group; and the all-hay cows were significantly greater than the 75%-hay group.

The average daily dry matter intake per 100 pounds of body weight was 2.44 pounds, 2.70 pounds, 2.97 pounds, 2.99 pounds, and 3.52 pounds for cows fed all silage, 25% hay, 50% hay, 75% hay, and all hay, respectively. Statistically, dry matter intake per 100 pounds of body weight was highly significantly greater ($P < .01$) for cows fed all hay than for those fed all silage or for the 25%-hay group. Differences between other rations were not significant at the one per cent level; however, at the five per cent level of significance the all-hay, 75%-hay, and 50%-hay rations were significantly greater than the all-silage ration, and the all-hay ration was significantly

greater than the 75%-hay, 50%-hay, or 25%-hay rations. Other differences in dry matter intake per 100 pounds of body weight among rations were not significant. These results are in agreement with the report of Nicholson and Parent (1957) which indicated that dry matter consumption was increased with additional increments of hay to a grass silage ration. However, this is in contrast to frequently voiced opinion that the addition of succulent roughage to a hay ration increases dry matter intake. The apparent quality (color and odor) of the silages fed in all three experiments was very good and quite comparable. In comparing the results of Trial I (Table 6) with Trial III (Table 8), it is evident that the dry matter consumption of cows fed all-silage rations during the two trials was nearly identical. Daily dry matter intake was 27.0 pounds and 26.7 pounds; and dry matter intake per 100 pounds of body weight was 2.46 pounds and 2.44 pounds for Trials I and III, respectively. The silage fed in Trial III was treated with sodium metabisulfite but was not consumed in larger amounts than the untreated silage fed the previous year.

The silages appeared to be very palatable as evidenced by willingness of the cattle to eat, although comparative palatability trials were not conducted.

Occasionally the cows consuming larger amounts of silage were observed to go off feed. This did not occur among the cows being fed hay. During Trial I cow K-239 went off feed about one week after being placed on experiment. Since blood sugar analyses were being conducted at the same time, it was observed that the blood sugar level of this cow was 26.0 mg. per cent whereas the group average was 41.2 mg. per cent on the sampling day. The cow had been producing 60 pounds of milk per day prior to the experiment. This appeared to be ketosis but was not officially diagnosed as such.

During Trial III one cow (K-213) refused to eat the grass silage. One could not conclude that the silage was unpalatable since other cows were consuming 140 to 185 pounds of silage daily. After several days it was necessary to change this cow to the all-hay ration. Several cows during all trials consumed extremely large amounts of silage. This was particularly noticeable at the beginning of each experiment when the moisture content of the silage was rather high. During the first two weeks of Trial III, the average consumption of silage was 134 pounds per cow per day. During this period the silage was from near the top of the silo and contained approximately 80 per cent moisture. However,

the daily dry matter intake was only 28.0 pounds. It was observed that as the moisture content of the silage dropped to approximately 74 per cent, farther down in the silo, the daily silage consumption became less but the total dry matter intake remained about the same. It appeared that moisture content had very little, if any, affect on the consumption of silage dry matter. For example, cow A-110 during Trial I ate 185 pounds of silage per day for several days when the silage dry matter content was 19.25 per cent but received only 35.6 pounds of dry matter at this high level.

Since moisture content and acidity (pH) are the two most commonly noted differences between grass silage and hay, it was postulated that either of these could be factors affecting appetite for dry matter from silage.

The results of Trial II lend support to the notion that moisture content as such is not the primary factor limiting consumption of dry matter. Data in Table 9 reveal that cows consumed as much dry matter from the wet hay (approximately 30 per cent dry matter) as they did from the dry hay. These results are not conclusive, however, because the critical level where moisture content might be effective in controlling appetite could possibly be somewhat higher than was obtainable with this

Table 9

Moisture and pH as Factors Affecting Appetite

	Dry Hay	Wet Hay	Reg. Silage	NaOH Silage
		lb.		
Total consumed	41.6	121.5	92.6	100.4
Dry matter intake	35.5	35.8	23.7	24.7
D.M./100 lb. body wt.	3.23	3.28	2.17	2.21
Body weight change	+10.7	+15.0	-36.9	-22.6
Milk production (actual)	23.4	22.5	21.6	21.2

method. The exact moisture content of the wet hay as eaten may be presumed to be somewhat higher than indicated in Table 3a since these measurements represent the uneaten material weighed back. It was not possible to accurately determine the moisture content of the wet hay as fed, because a large amount of free water adhered to the stems and leaves of the hay.

Also in Trial II the effect of raising the pH of the silage to approximately that of the hay was measured. The pH of the silage ranged near 4.9 (Table 1) at the time of the trial and was raised by the addition of sodium hydroxide to between pH 5.66 and 6.25 as shown in Table 3. This approximated or exceeded the pH of the hay which

was determined to be approximately 5.66 (Table 2). Some loss of ammonia due to application of the sodium hydroxide was noted during the mixing process. All cows ate the treated silage readily. However, the results shown in Table 9 reveal that there was no significant increase in dry matter intake of the silage due to raising the pH. On the other hand the higher pH silage did not depress dry matter intake. From these data it would appear that the reduced dry matter intake of high pH silages (pH 5.88 and 5.90) reported in the data of Gordon *et al.* (1958) as compared to lower pH silages (pH 4.77 and 5.18) was due to some factor other than the pH of the silages but could have been due to different types of fermentation products as suggested by these workers.

Blood Sugar Analysis

Sugar analysis of blood samples taken from the cows at ten-day intervals during Trial I reveals that blood sugar levels were consistently higher for cows fed the all-hay ration than for those fed the all-silage ration (Table 10). Blood glucose levels averaged 2.6 mg. per cent higher for the cows fed hay as compared to those fed silage. This difference was statistically significant ($P < .05$).

Table 10

Blood Sugar Levels of Lactating Holstein Cows Fed All-Hay or All-Silage Rations

Day	Group	Ration	Sugar (mg. %)
0	I	Hay + Grain	52.4
	II	Hay + Grain	47.0
11	I	Silage	41.2
	II	Hay	42.6
21	I	Silage	42.9
	II	Hay	44.7
31	I	Hay	43.2
	II	Silage	40.4
42	I	Hay	54.9
	II	Silage	50.6
Average		Hay	46.4
		Silage	43.8

Blood sugar levels of the cows on the hay ration were significantly higher (5%).

These results are opposite to what one would expect according to the glucostatic theory of Mayer (1953, 1955) for appetite control in simple stomached animals but tends to agree with the observations of Mäkela (1955) and Gordon (1957) that there was no correlation between blood sugar levels and appetite in ruminants.

The observation that dry matter consumption was considerably reduced (17 to 45 per cent) when cows were fed grass silage as the sole roughage as compared to hay, corroborates the evidence of similarly conducted trials with milking cows as reported by Graves et al. (1938), Hodgson et al. (1940), and others and is similar to results with growing dairy heifers as reported by Converse and Wiseman (1952), Sykes et al. (1955), Keener et al. (1958), Thomas et al. (1959), and Everett et al. (1958).

The limited data presented above indicate that moisture and pH of the feed did not appear to be factors affecting appetite for dry matter in dairy cattle. However, the possibility of biochemical products of silage fermentation having a depressing affect on appetite is postulated.

Milk Production

Trials I and II were designed to measure dry matter consumption and did not cover long enough periods of time to measure the effects on milk production. As the results in Tables 6 and 9 reveal there were no significant differences in milk production during these trials.

Trial III was designed to measure the effect of all-hay, all-silage, and hay-silage combination rations on milk production and body weight changes as well as dry matter consumption .

Average daily actual milk production by ten-day periods is shown in Table 11. The pre-experimental production in this table is an average of six days during the preliminary adjustment feeding period prior to the experiment. An analysis of variance revealed the variation among rations due to treatments to be highly significant ($P < .01$). Sequential analysis of treatment means indicated that milk production of the cows fed all hay, 75% hay and 50% hay was significantly greater than that of cows fed 25% hay or all silage at the one per cent level of significance. There were no significant differences between the all-silage and 75%-silage rations, or the all-hay, 75%-hay, and 50%-hay rations at either the one per cent or five per cent levels of significance.

The pre-experimental production averages of the various groups were not as well balanced as desirable due to the addition of two cows per group after three cows per group had completed 90 days on the experiment. However, a projection of the pre-experimental production (1.1 pounds per cow) for 450 cow-days (five cows for 90

Table 11

Average Daily Milk Production by Ten-Day Periods of Groups of Cows Fed All-Hay, All-Silage, and Hay-Silage Combinations, ad lib. (Trial 3)

Period	All Silage	75% Silage 25% Hay	50% Silage 50% Hay	25% Silage 75% Hay	All Hay
	Milk Production lb.				
Pre-Exp.	36.4	34.1	37.4	39.5	37.5
1	37.3	35.8	37.2	36.9	34.8
2	33.5	31.5	35.4	35.8	33.9
3	31.6	30.0	33.2	34.6	33.1
Fat %	3.4	3.4	3.4	3.7	3.6
4	29.9	29.8	31.9	34.7	33.4
5	29.0	29.1	30.4	32.8	32.3
6	28.2	26.2	30.6	31.5	31.9
Fat %	3.5	3.5	3.4	3.8	3.6
7	25.7	25.3	30.4	28.7	30.9
8	24.6	25.8	29.6	28.4	30.2
9	24.9	25.0	29.7	27.1	30.0
Fat %	3.4	3.5	3.4	3.7	3.7
Total Milk	13080	12825	14416	14532	14521
Average 90-Days	29.1	28.5	32.0	32.3	32.3

days) accounts for only 495 pounds difference between the all-silage and all-hay group. The actual difference in total production was 1441 pounds of milk. A projection of the difference between the 75% silage-25% hay group and the all-hay group (3.4 pounds per cow) at the beginning of the experiment accounts for 1530 pounds of the difference in final production. The actual difference in final production was 1696 pounds which was significantly greater than the pre-experimental difference.

Persistency was calculated for each 10-day period as a percentage of the pre-experimental production as shown in Table 12. An analysis of variance revealed the variance due to treatments to be highly significant ($P < .01$). Sequential analysis of the differences between means revealed the persistency of cows on the all-hay ration to be significantly greater than any of the other rations ($P < .01$), and the groups fed the 25% hay and 50% hay had significantly greater persistency than those fed all silage or 75% silage ($P < .01$). In this respect it was noted that one cow in the 75%-hay group dropped in production rather abruptly during the last 30 days of the experiment due to nearing the end of her lactation which tended to distort the persistency pattern of this group. The persistency of the group fed 50% hay was significantly greater than of those fed 25% hay ($P < .01$).

Average 30-day persistency, calculated as per cent of the previous period, is given in Table 8. The same relationships appear as discussed above.

Table 12

Average Ten-Day Persistency of Milk Production from Pre-Experimental Production of Cows Fed All-Hay, All-Silage, or Hay-Silage Combinations *ad lib*.

Ten-Day Period	Rations: All Silage	75% Silage 25% Hay	50% Silage 50% Hay	25% Silage 75% Hay	All Hay
	Per Cent of Pre-Experimental Production %				
1	94	99	99	93	95
2	91	93	95	91	95
3	86	88	90	87	92
4	83	88	86	87	94
5	81	86	81	83	90
6	78	76	83	79	90
7	72	74	82	72	86
8	68	76	80	71	84
9	69	73	80	67	84

The average butterfat tests of cows fed the all-hay and 75%-hay rations were somewhat higher than for the cows fed the other three rations. As indicated in Table 11, these differences were consistent throughout the experiment and are attributed to inherent differences in the cows rather than to the rations that were fed. Average daily four per cent fat-corrected milk production was calculated and is presented in Table 8.

Since a close relationship appeared to exist between dry matter consumption and milk production, a

regression of actual average daily milk production on average daily dry matter intake for all cows on the experiment was computed and is presented graphically in Figure 1. The computed formula for the regression line was Y = 10.7 + .61X where Y is milk production and X is dry matter consumption. This strong relationship between dry matter consumption and milk production bears out the significance of the problem studied. The correlation between average daily milk production and average daily dry matter intake was computed and the correlation coefficient was found to be r = .572. Cox et al. (1956) found a correlation of .66 between intake and milk production, while McCullough (1956) found a multiple correlation of .638 between dry matter intake, level of production, and dry matter digestibility.

Changes in Body Weight

Results of Trial I show that cows fed the all-hay ration gained considerably more body weight than those fed silage (Table 6). During the first 21-day period of this trial, every cow fed the all-silage ration lost body weight. The loss ranged from 10 pounds to 99 pounds with an average of 49.6 pounds per cow. Four of the eight cows fed the all-hay ration lost weight ranging from 3 pounds to 22 pounds, whereas four cows in this group gained weight

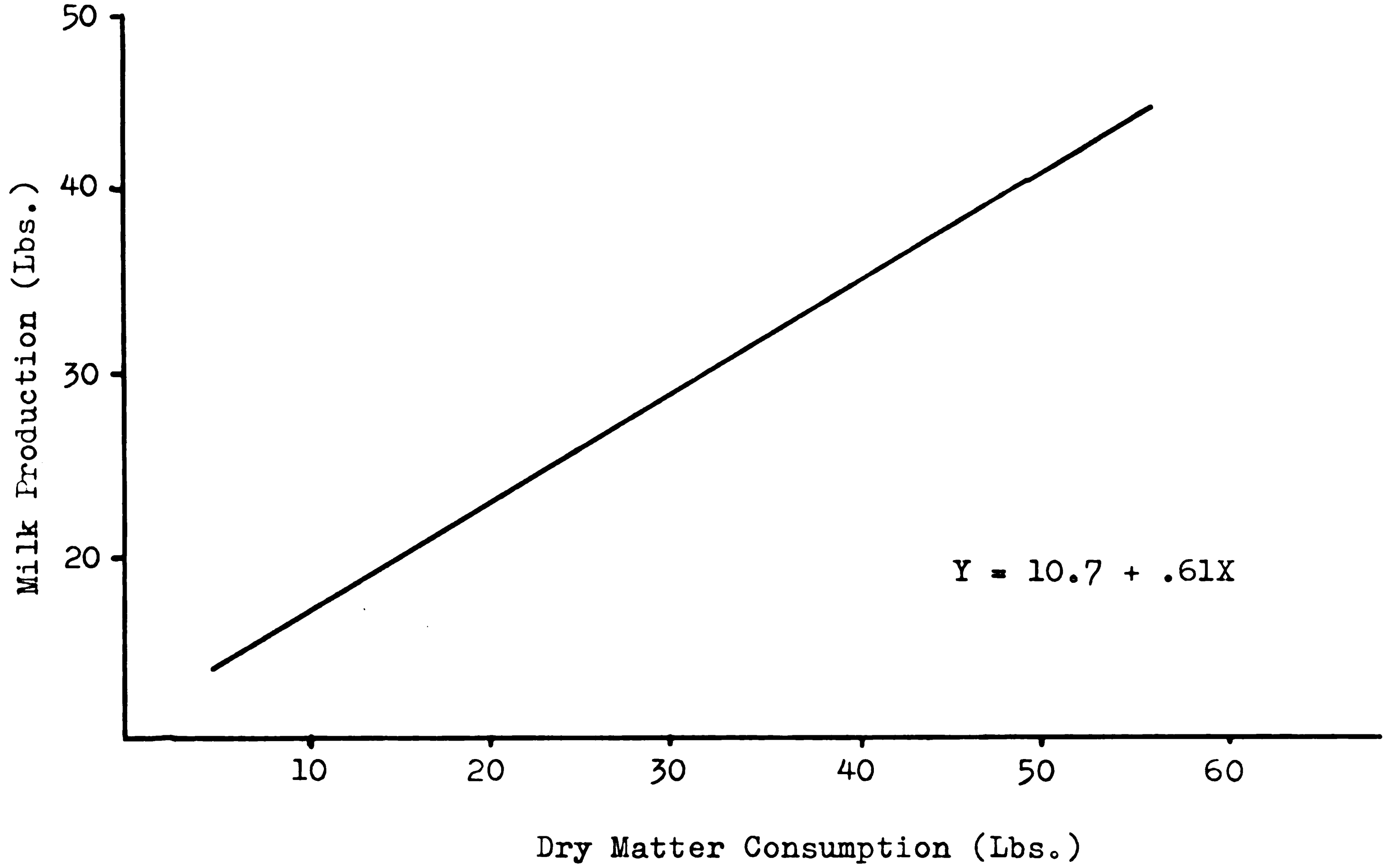

Figure 1. Regression of Average Daily Milk Production on Average Daily Dry Matter Intake of Cows Fed All Hay, All Silage, and Hay-Silage Combinations _ad. lib._

ranging from 10 pounds to 34 pounds. The net difference for the group was a gain of 6.4 pounds per cow. When this group was changed to the all-silage ration, seven of the eight cows lost weight ranging from 2 pounds to 66 pounds during the 21-day period. One cow of the group gained 2 pounds, but the average loss of weight was 35.3 pounds per cow for the period. When the first group of cows fed silage were changed to hay, every cow gained weight ranging from 4 pounds to 55 pounds. The average gain in weight per cow was 32.4 pounds for the 21-day period. These differences in body weight changes were highly significant ($P < .01$).

Data in Table 9 reveal a similar pattern of body weight changes during Trial II. Gains in body weight on either hay ration were significantly greater than on either silage ration ($P < .01$).

During Trial III (Table 8) the average body weight changes of cows fed the different rations were as follows: all silage, -58 pounds; 75% silage, -20 pounds; 50% silage, -5 pounds; 25% silage, +51 pounds; and all hay, +23 pounds. These differences among rations were statistically significant at the 10 per cent level of probability but not at the one per cent or five per cent levels.

At least part of these differences in body weight change is undoubtedly due to the amount of dry matter contained in the gastro-intestinal tract. Balch (1950) has shown that ground hay given as a small addition to unground hay was always excreted more rapidly than the unground hay; however, if all the hay were ground, the excretion pattern of stained particles was the same as for long hay. Balch (1950) has further shown that the feeding of mangolds increased the rate of excretion of stained hay in two cases and decreased it in two others. Blaxter et al. (1956) demonstrated with sheep that both increased comminution and increased feed intake accelerated passage rate. This same relationship between total intake and excretion rate was observed in goats by Castle (1956). Also, the evidence cited by Mäkela (1956) indicates that green roughages as a rule remain for a shorter time in the alimentary tract than the corresponding dry roughages. Since the grass silages used in these experiments were chopped to approximately 3/8 inch length, it seems possible that the silage ingesta passed from the digestive tract at a faster rate than the ingested hay and that this could account for some of the difference in body weight between the hay-fed and silage-fed cows.

In addition, the probability must be recognized that the cows fed silage also lost more body fat in order to maintain reasonably good milk production for a 90-day period while consuming considerably less dry matter than the cows fed hay.

SUMMARY

Three trials were conducted to determine the affects of all-hay, all-silage, and combinations of hay and silage rations fed *ad libitum* on dry matter consumption, milk production, and body weight changes of lactating dairy cows. No grain was fed during any of the trials reported. The alfalfa hay and alfalfa silage fed in each trial were harvested from the same field at the same stage of maturity. Blood sugar levels of cows fed hay and silage were studied in one trial, and the affects on appetite of moisture content and pH of the forage were studied in another trial.

In a 42-day reversal trial when hay was fed, the cows consumed from 17 per cent to 45 per cent more dry matter than when silage was fed. Average daily dry matter intake was 34.3 pounds when hay was fed and 27.0 pounds when silage was fed. These differences were highly significant ($P < .01$). Dry matter intake per 100 pounds of body weight was 3.14 and 2.46 pounds for cows fed all-hay and all-silage rations, respectively. These differences were highly significant ($P < .01$).

When wet hay (soaked in water) and silage that was treated with sodium hydroxide (NaOH) to increase the pH

to approximately that of the hay were compared with dry hay and the alfalfa silage in a 40-day latin square feeding trial, neither the wet hay nor the NaOH-treated silage had any affect on dry matter consumption of the forages.

When silage was fed ad libitum and hay feeding was controlled to 0%, 25%, 50%, 75%, and 100% of the dry matter of the ration, in each case additional increments of hay to the ration resulted in an increase in average daily dry matter consumption in a 90-day continuous trial. The average daily dry matter intake was 26.2 pounds, 28.6 pounds, 32.8 pounds, 35.1 pounds, and 41.0 pounds for the groups fed all silage, 25% hay plus silage, 50% hay plus silage, 75% hay plus silage, and all hay rations, respectively. Statistically, dry matter intake was significantly greater ($P < .01$) for the cows fed all hay and 75% hay than for those fed all silage.

Daily intake for the all-hay group was significantly greater than for either the group fed 25% hay or 50% hay ($P < .01$). At the five per cent level of significance, daily dry matter intake was significantly greater for cows fed 50% hay than for those fed all silage; likewise 75% hay was greater than 25% hay; and all hay was significantly greater than the 75%-hay ration.

The average daily dry matter intake per 100 pounds of body weight was 2.44 pounds, 2.70 pounds, 2.97 pounds, 2.99 pounds, and 3.52 pounds for cows fed all silage, 25% hay plus silage, 50% hay plus silage, 75% hay plus silage, and all hay, respectively. The all hay ration was significantly greater than the all-silage ration or the 25% hay plus silage ration ($P < .01$). Differences between other rations were not significant at the one per cent level. However, at the five per cent level, the all-hay, 75%-hay and 50%-hay rations were significantly greater than the all-silage ration; and intake per 100 pounds of body weight of the all-hay ration was significantly greater than the 75%-hay, 50%-hay, or 25%-hay rations.

Milk production of the cows fed all hay, 75% hay, and 50% hay was significantly greater ($P < .01$) than of cows fed 25%-hay or all-silage rations during a 90-day continuous trial. There were no significant differences between the all-silage and 75% silage rations or the all-hay, 75%-hay, and 50%-hay rations at either the one per cent or five per cent levels of significance. The correlation between dry matter intake and milk production for all cows was .572. There was no significant difference in milk production between the cows fed all hay and all silage during the short-term trials.

Gains in body weight were significantly greater ($P < .01$) for the cows fed all hay than for those fed all silage during the two short-term experiments. Changes in body weight were significant at the ten per cent level of probability during the 90-day continuous experiment but not at the five per cent or one per cent levels of probability.

Moisture and pH of the forages did not appear to be factors affecting appetite, but it is postulated that chemical products of silage fermentation could have a depressing affect on the appetite of dairy cattle.

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