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The Need for Unfermented Grain or Forage with High Moisture Grass-Legume Silage for Dairy Cattle

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The Need for Unfermented Grain or Forage with High Moisture Grass-Legume Silage for Dairy Cattle

A. D. PRATT and H. R. CONRAD

Feed and labor costs, representing 80 percent of the cost of milk production, form the "Achilles heel" of the dairy industry.

Simplification of the ration and improvement of mechanical bunk-line feeders to eliminate labor give promise of reducing costs. However, the results of many experiments cast doubt on the advisability of using high moisture grass-legume silage and ear corn silage in mechanical feeding systems without hay or grain mixtures.

REVIEW OF LITERATURE

Conrad et al (4, 5) reported that cows which were changed abruptly from corn silage to all low dry matter legume-grass silage fell abruptly in dry matter intake and milk production for a period of 2 to 3 weeks. Apparent protein digestibility also declined after the abrupt change. It was indicated that changes in the rumen microflora were partly involved.

Salsbury et al (26) found that the ration of a fistulated animal supplying inoculum for in vitro digestibility studies should be the same as the substrate used in the in vitro test. This agrees with the original thinking of Pounden and Hibbs (22).

Langston et al (16), working with high moisture silages, found high lactic acid content when air was excluded from the silo and high acetic acid when similar silage was aerated.

Miller et al (20) found that rapid filling of the silo resulted in higher lactic acid and lower acetic acid content of grass silage. Their data indicate that liberal grain feeding masks the ill effects of slow filling and the accompanying increased oxidation. It may be inferred that increased oxidation within the silo leaves less readily fermentable carbohydrate for the use of the rumen flora.

Gordon and co-workers (12) compared wilted silage (36 percent dry matter) with half-dry silage (54 percent dry matter). They found the dry matter intake per 100 lb. of live weight to be 2.34 and 2.52 lb. respectively. The drop in milk production over a 30-day period was 11.4 percent for those fed wilted silages and 8.0 percent for those fed half-dry silage. The cows fed half-dry silage gained more body weight.

Further indication that alfalfa loses some of its feeding value and acceptability when ensiled is shown by results obtained by Sykes et al (28). They found that heifers made poorer growth up to 2 years of age from alfalfa silage of 33 percent dry matter than from alfalfa hay. Their data indicate that the less satisfactory growth was due to lowered dry matter intake. Small amounts of hay improved the dry matter intake and growth rate. The heifers fed silage only were thin at 24 months of age while those fed hay were fat. They observed that slightly less total digestible nutrients (TDN) were consumed per pound of gain by heifers fed alfalfa silage only. This difference also has been observed with respect to milk production.

In later work, Thomas et al (29) reported on the results of feeding heifers alfalfa hay, direct-cut silage, and wilted silage harvested simultaneously. For each crop year there was little difference in rates of gain or dry matter intake or in efficiency of gain for heifers fed hay or wilted silage (43-46 percent dry matter). Heifers fed direct-cut silage had lower rate of gain, dry matter intake, and efficiency. They suggested that the dry matter content of the forage when ensiled, and differences in the resulting fermentation, are major factors in determining the acceptability of silages by heifers and their resulting performance.

Dowden (8) found that dripping acetic acid in physiological saline into the jugular vein of animals reduced the dry matter intake from chopped alfalfa. Eating was resumed soon after the venous feeding ceased. In contrast, lactic acid produced no marked or definite trend.

Stoddard and co-workers (27) observed that the dry matter intake of milking cows was less from alfalfa silage than from alfalfa hay and corn silage fed on a comparable dry matter basis in the ration. They also found that milk production was not maintained as well.

Hillman et al (13) made hay and direct-cut silage of 25 percent dry matter content, preserved with sodium metabisulfite, from the same field on the same day. Silage was fed at five rates—100, 75, 50, 25, and 0 percent of the forage intake. Hay made up the balance of the forage allowance. They concluded that the milk yield was better from hay.

In a later report (3) on the same experiment, the Michigan workers recorded that dry matter intake was greater from rations containing 100, 75, or 50 percent of the ration dry matter as hay. Milk production trends were similar but not great enough to be statistically significant. The dry matter intake varied from 26.2 lb. for all silage to 41.0 lb. for all hay. Cows fed forage only (hay or silage) produced 25.8 lb.

of 4 percent fat-corrected milk (F.C.M.) daily in contrast to 33.2 lb. for those fed both forage and grain. A greater milk production response was obtained from feeding grain to cows consuming silage than to cows consuming hay.

Arnold (1) observed a close relationship between voluntary intake of herbage by sheep and the percentage of dry matter in the herbage.

Gordon et al (11) compared alfalfa hay, haylage, and direct-cut silage. A high correlation was found between the dry matter percentage of silage and dry matter intake for cattle. They found a lowered dry matter intake of high moisture silages containing high ammoniacal nitrogen. Direct-cut silages resulted in large body weight losses.

Larsen and Johannes (17) found a greater dry matter intake by cows fed haylage than by those fed silage and hay, and consequently greater milk production.

Huffman and co-workers (14) ensiled clover with molasses as a preservative and fed it in comparison with clover hay. They found the two to be equal. This suggested that the extra energy of the molasses counteracts the effect of the high organic acid content.

Brown (2), reporting at the International Dairy Congress, stated that "the limiting factor for further increase in yield from an all-silage diet appears to be the level of starch equivalent, not digestible crude protein."

Norfeldt and Hellstrom (21) compared artificially dried, barn-dried and field-dried hay with silage in feeding experiments with milking cows. The rations were equalized with respect to feed energy, digestible protein, and crude fiber. The English summary of their article does not give information on the nature of the crop used as hay or silage or on the grain. They found no significant difference in milk production.

Conrad et al (7) emphasized the importance of digestibility in regulation of feed intake. Their data indicate that, at average levels of milk production, rations with dry matter digestibility below 66 percent limit intake while those above 66 percent do not.

McCullough (19) derived a regression equation from data on cows fed largely from silages. Some cows ate less than the amount required to meet standards for maintenance and milk production when fed silages of 64 percent or less digestibility, thus confirming the work of Conrad et al (7).

The evident importance of grain in raising the digestibility of the total ration to the point where indigestibility is not a limiting factor does not seem to be generally appreciated. Some authors fail to describe the grain ration fed to supplement the forage under investigation.

Gordon et al (10) reported an experiment in which they fed hay, wilted silage of 44 percent dry matter, and direct-cut silage of 20 percent dry matter. The dry matter intake per cow daily was 24.6 lb., 22.2 lb., and 17.8 lb. respectively for the three groups ($P<0.01$). The daily production of 4 percent F.C.M. was 27.1 lb., 25.9 lb., and 24.6 lb. in the same order ($P<0.05$).

In another experiment, Gordon and co-workers (9) compared alfalfa haylage of 45 percent dry matter made in a conventional silo with hay made from the same crop at the same stage of maturity. They found no statistically significant difference in dry matter intake for heifers or milking cows and no significant difference in milk production. When the haylage was fed to milking cows with only 4 to 6 lb. of grain, no qualitative decline in feeding value was evident.

Keyes and Smith (15) fed loose hay, baled hay, chopped hay, and silage, all made from alfalfa of the same quality and stage of maturity. They reported milk yields in descending order from chopped hay, silage, loose hay, and baled hay. Dry matter intake was least from silage. The yield of milk per pound of dry matter consumed was greatest from silage.

Voelker and Bartle (31) studied the feeding values of alfalfa haylage (48-60 percent dry matter), silage (38 percent dry matter), green chop, pasture, and artificially dried hay. No significant differences in milk production were found. They found that cows fed haylage consumed the most dry matter and returned the most milk per cow.

McCullough (18) attributes the intake problem of cows fed high moisture direct-cut legume silages to compounds formed during fermentation.

Pratt et al (24) compared soilage and high moisture alfalfa-brome silage as the sole forages with three levels of grain feeding: full rate (0.4 lb. per lb. of milk above 20 for Holsteins and 0.5 lb. per lb. of milk above 12 for Jerseys), half rate, and none. The silage was made June 6 and 7 and so had not passed the stage of high digestibility. The cows fed green chop without grain produced the same daily amount of 4 percent F.C.M. as the cows fed silage and the full rate of grain. This demonstrates that fermentation reduced something, presumably carbohydrates, necessary for high production and inhibited intake.

To determine the effects of fermentation on the value of alfalfa-brome forage supplemented with corn for milk production, two experiments were conducted.

EXPERIMENT I

LEGUME-GRASS SILAGE FED WITH A GRAIN MIXTURE CONTAINING 11 PERCENT PROTEIN OR GROUND EAR CORN COMPARED WITH LEGUME-GRASS SILAGE ENSILED WITH 10 PERCENT GROUND EAR CORN

Feeding Trials

Grain and wilted alfalfa-grass silage were fed to milking cows during a 15-day preliminary period in the ratio of 25 percent grain dry matter to 75 percent silage dry matter. During a 14-day transition period, the rations were changed for two groups while that of the control group remained unchanged. The experimental treatments are shown in Table 1.

Grain mixture 79 consisted of 600 lb. of ground shelled corn, 300 lb. of coarsely ground oats, 100 lb. of soybean oilmeal, 10 lb. of iodized salt, and 10 lb. of steamed bonemeal.

The cows were allowed access to additional steamed bonemeal and salt in the exercise yard daily.

The alfalfa-grass crop was wilted and ensiled with alternate loads placed in each of two silos. The crop in one silo was not treated with a preservative or conditioner. The crop in the other was treated with 200 lb. of ground ear corn per ton of green chop to determine whether or not fermented corn could replace unfermented corn.

Six cows were selected for each treatment. These were as nearly balanced as possible with respect to breed, age, body weight, past production records, and current milk production. The cows were bedded with shavings to avoid straw consumption.

The experiment was continued for seven continuous 14-day periods. Dry matter determinations were made each week on silages and

TABLE 1.—Ratio of Grain to Forage Dry Matter in Experimental Rations.

		Planned Ratio				Actual Ratio	
Period	Group	Grain		Wilted Silage	Corn-Preserved Silage	Grain D.M.	Forage D.M.
		Kind	(%)	(%)	(%)	(%)	(%)
Preliminary	1	#79	25	75	—	25.7	74.3
	2	#79	25	75	—	25.7	74.3
	3	#79	25	75	—	25.7	74 3
Experimental	1	#79	25	75	—	25.7	74.3
	2	Corn*	20	80	—	23.2	76.8
	3	—	—	—	100	32.4	67.6

* Ground ear corn

TABLE 2.—Feeding Trial Data

Period	Group	Dry Matter				Milk/ Cow/ Day	Av. Body Weight Change*
		Silage	Grain	Ration	Per 1000 lb. Body Weight		
		(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
Preliminary	1	22.59	8.24	30.83	26.1	37.6	—
	2	20.18	7.72	27.90	28.0	34.3	—
	3	21.65	8.04	29.69	26.2	38.8	—
Experimental	1	22.38	7.72	30.10	26.0	31.8	+21
	2	19.50	5.88	25.38	26.2	27.6	+ 3
	3	25.60†	0.0	25.60	24.0	29.5	—21

*In 98 days
†Silage treated with 10% ground ear corn at ensiling

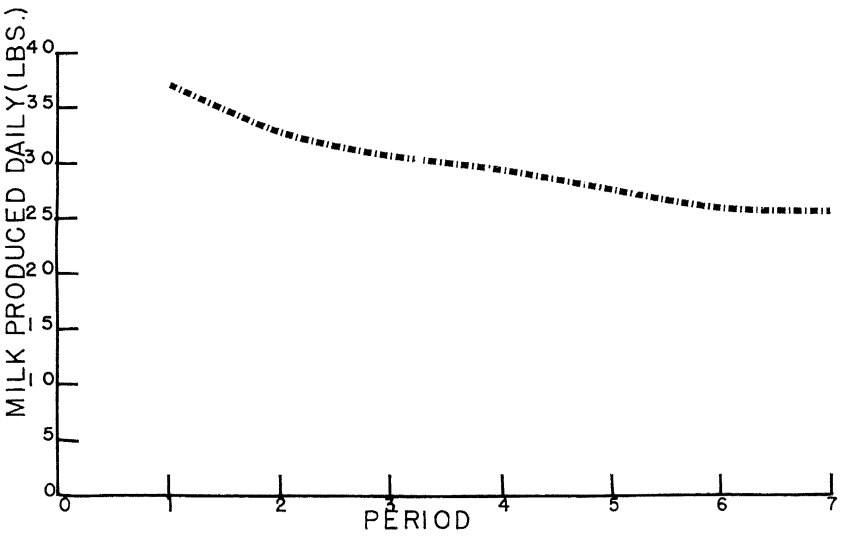

Fig. 1—Rate of decline in milk production of all cows during seven 14-day periods after adjustment by linear regression for production in preliminary period.

grains. The amounts necessary to maintain the desired ratios of grain to forage dry matter were calculated from these dry matter analyses. A small refusal was allowed daily. The feeding trial data appear in Table 2.

The adjusted 7-day production means were 234.9 lb., 203.5 lb., and 192.9 lb. for Groups 1, 2, and 3 respectively. The decline in milk production from the preliminary period to the average production of the experimental periods was 15.4 percent for Group 1, 19.5 percent for Group 2, and 24.0 percent for Group 3.

To determine the statistical significance of variations in milk production between groups, production by individual experimental periods was adjusted by linear regression on the preliminary period (Figure 1). The differences in adjusted group means were highly significant ($P < 0.01$), as were those by periods. A quadratic regression on the preliminary period did not reveal significant differences.

The dry matter intake of the experimental periods was adjusted by linear regression on the dry matter intake of the preliminary period. The pounds of dry matter eaten are plotted by periods and presented in Figure 2.

The greater dry matter intake of Group 3 at the 12th week was accompanied by higher dry matter content of the silage. During the per-

TABLE 3.—Digestibility of Rations.

Group	Ration	Crude Protein Content	Dry Matter Digested	Protein Digested
		(%)	(%)	(%)
1	Silage + grain mixture 79	13.5	67.3	67.8
2	Silage + ground ear corn	12.3	64.3	63.5
3	Corn-treated silage	10.0	64.4	55.7

iod from the 8th to 10th week, the dry matter content of corn-treated silage was 29 percent. This increased to 40 percent at the 12th week and dry matter intake increased correspondingly. The analysis of variance also showed highly significant ration differences by periods ($P < 0.01$) for all rations.

When mean body weight changes were adjusted by linear regression on the preliminary weight, group differences were not significant but period differences were highly significant. This is believed to reflect variations in silage quality and therefore in intake.

In Figure 3, the total ration dry matter intake of the three groups is shown in relationship to the dry matter content of the silages fed. The positive relationship between the dry matter intake and the dry matter content of legume-grass silage with 10 percent of corn added as

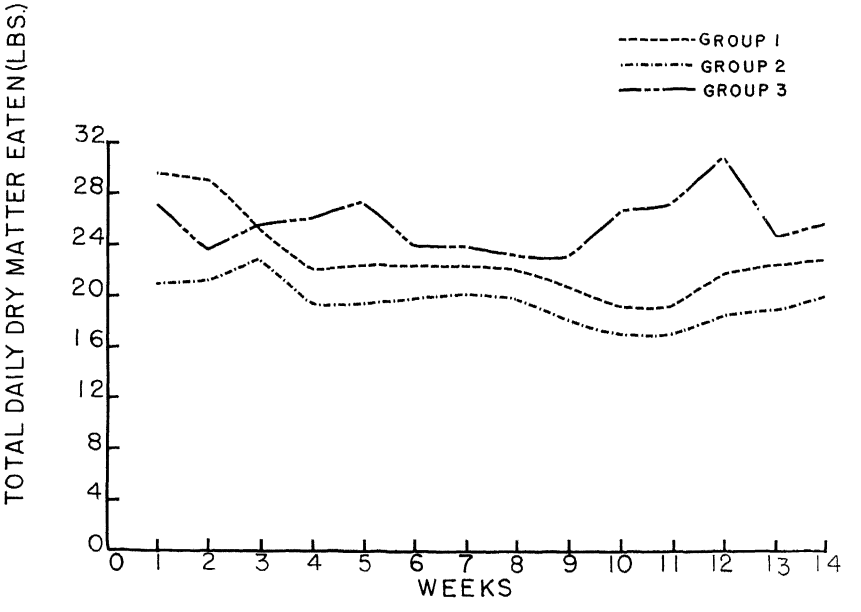

Fig. 2—Daily dry matter intake of cows in Experiment 1.

a preservative is apparent at 1 week and from the 9th week to the end of the experiment. The dry matter intake of Groups 1 and 2 is not as responsive to changes in dry matter content of the silage as Group 3, although a general relationship is apparent.

Digestion Trials

Digestion trials were conducted during the feeding trials with the cows in their own stalls (6). Analysis of the rations fed showed that the corn and cob-preserved silage ration (Group 3) contained 10.0 percent crude protein compared to 12.3 percent for the silage plus ground ear corn (Group 2) and to 13.5 percent for silage plus grain mixture 79 (13.6 percent crude protein) (Group 1). The average coefficients of digestibility for two trials are shown in Table 3.

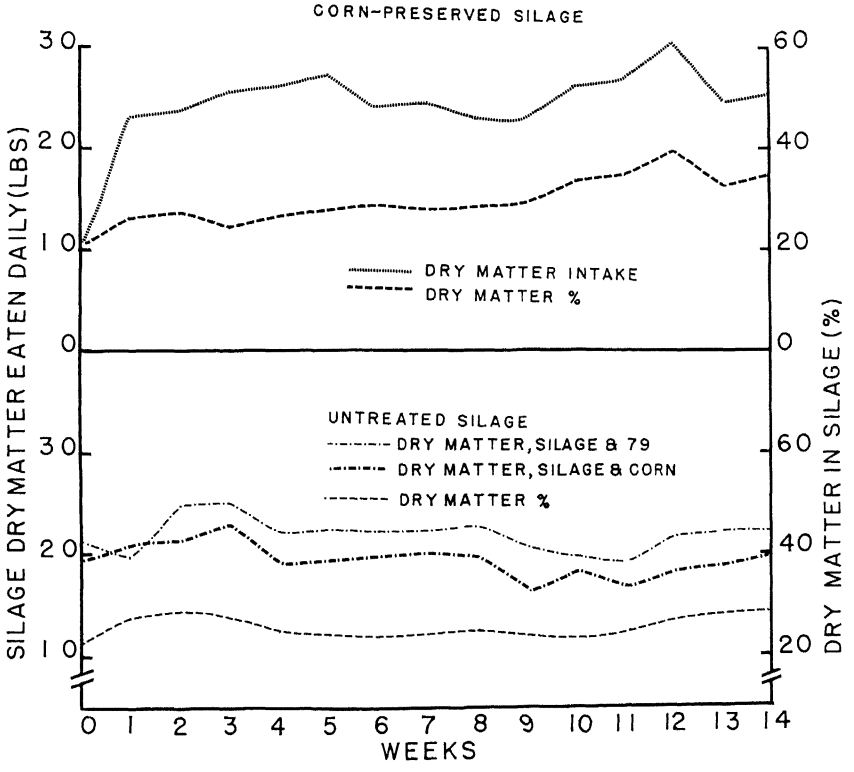

Fig. 3.—Relationship of dry matter eaten to percentage of dry matter in the silage: (a) Group 3 fed high moisture silage with 10 percent ground ear corn added at ensiling; (b) Groups 1 and 2 fed untreated high moisture silage with grain mixture 79 and ground shelled corn respectively.

The digestibility of protein was highest in the ration with the greatest protein content. The ration of Group 1 was also higher in grain than that of Group 2, which would favor the development of rumen flora and presumably improve protein utilization.

Calculation of the proportion of the total ration dry matter intake provided by grain showed 25.7 percent for Group 1, 23.2 percent for Group 2, and 32.4 percent for Group 3. So the lower digestibility of the ration fed to Group 3 is not due to less grain. The exposing of all the starch and cellulose to fermentation in the silo seems to be a more probable explanation, since it is believed that some starch will give readily available energy for multiplication of the rumen bacteria. Ten percent crude protein in the total ration is on the border line of adequacy.

The degrading of protein to non-protein nitrogen in the silo is believed responsible for poor utilization of nitrogen by rumen bacteria. Furthermore, the degrading of protein to non-protein nitrogen (16) would result in large amounts of non-protein nitrogen becoming available at one time for absorption from the rumen rather than conversion to bacterial protein. High levels of absorbed non-protein nitrogen in the blood permit elimination by the kidney before the ruminant can use the nitrogen.

The lowered digestibility of the protein by the cows of Groups 2 and 3 is reflected in lower milk production.

EXPERIMENT II

A COMPARISON OF EAR CORN SILAGE, GROUND SHELLED CORN, AND A GRAIN MIXTURE OF 11 PERCENT DIGESTIBLE PROTEIN AS SUPPLEMENTS TO ALFALFA-GRASS SILAGE

Because of the rather unsatisfactory production performance of the group fed alfalfa-grass silage with 10 percent ground ear corn added at ensiling in Experiment I, the following experiment was conducted.

Grass-legume mixtures were wilted and ensiled without preservatives. Picked ears of hybrid corn were run through an ensilage cutter and into a silo without a preservative.

Three 7-day preliminary periods were allowed for the cows to become accustomed to a common ration. Then the four groups were changed to the rations shown in Table 4. The preliminary periods were later used to establish regressions on milk production. There were eight continuous 7-day experimental periods. Groups 1, 2, and 3 had five cows each while Group 4 contained three cows.

In Experiment I, cows that had additional protein in the grain mixture maintained production a little better than those fed corn which had been fermented. This experiment (II) was designed to provide extra

TABLE 4.—Feeding Plan for Four Groups of Milking Cows

	Group			
Feed	1	2	3	4
Meadow crop silage	X	X	X	
Ear corn silage			X	X
Ground shelled corn		X		
Grain mixture 79	X			
Hay (alfalfa)				X

protein in grain mixture 79 to Group 1 in comparison with ground shelled corn (unfermented) to Group 2 and with ear corn silage (fermented) to Group 3. Group 4 was permitted hay to provide an unfermented forage with ear corn silage.

Comparison of the milk production and dry matter intake of Groups 3 and 4 and of Groups 2 and 3 was intended to show if unfermented starch of ground shelled corn or unfermented hay could or was needed to supplement meadow crop silage or ear corn silage. Grain mixture 79 is described under Experiment I (page 7).

Feeding Trials

All grains were fed to provide 0.4 lb. dry matter per lb. of Holstein milk above 20 lb. or 0.5 lb. per lb. of Jersey milk above 12 lb.

All cows were fed meadow crop silage from calving until the experiment started to avoid the effects due to disturbing rumen function by abrupt changes.

Milk production and dry matter intake are presented in Table 5 on a 1000-lb. body weight basis. The dry matter intake of all groups was adjusted by covariance for consumption during the preliminary period. The same technique was used in adjusting milk production.

A moderate but continual drop in total ration dry matter intake occurred through the first five periods for all groups fed meadow crop silage. Beginning with the sixth period, these groups had a radical drop in dry matter intake from which they did not recover. These changes parallel the changes in dry matter content of meadow crop silage. The lower dry matter content resulted in a fermentation which reduced acceptability.

The decrease in milk production was more steady (Figure 4) for Group 1 fed grain 79 containing 11 percent digestible protein than for Groups 2 and 3, which were fed ground shelled corn and ear corn silage respectively. The drop in milk production during the sixth period was greater for Group 3 fed ear corn silage superimposed on high moisture silage than for Group 2 fed ground shelled corn.

TABLE 5.—Daily Dry Matter Intake and 4 Percent F.C.M.* Production per Cow by Periods and for the Whole Experiment per 1000 lb. Body Weight, Experiment II.

Period	D.M.† in Silage	Group 1‡		Group 2		Group 3		Group 4	
		Total Ration D.M. Intake	4% F.C.M.	Total Ration D.M. Intake	4% F.C.M.	Total Ration D.M. Intake	4% F.C.M.	Total Ration D.M. Intake	4% F.C.M.
	(%)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
1	37.50	33.6	34.3	35.0	37.6	31.6	32.5	34.7	30.0
2	32.75	31.3	34.1	31.8	35.1	28.6	30.4	32.3	28.0
3	31.50	32.3	33.9	32.2	34.9	29.3	30.9	30.7	28.6
4	31.00	31.0	30.8	31.6	30.6	28.6	29.8	34.0	26.5
5	32.00	31.9	27.2	31.9	26.7	29.8	23.4	34.0	25.2
6	26.50	25.3	26.7	24.6	26.8	19.5	20.4	35.7	23.7
7	24.00	24.2	26.9	22.2	24.8	18.8	19.5	35.5	21.3
8	26.50	25.1	23.6	22.2	21.5	19.2	17.7	35.0	21.5
Daily/1000 lb. body weight		27.9	27.9	25.8	25.8	24.4	25.3	31.2	25.2

*Fat corrected milk
†Dry matter
‡Ration for Group 1, Meadow crop silage and grain mixture 79
Group 2, Meadow crop silage and ground shelled corn
Group 3, Meadow crop silage and ear corn silage
Group 4, Alfalfa hay and ear corn silage

The cows of Group 4 had a dry matter intake in period 1 similar to that of Group 2 and maintained this intake fairly well to the end of period 8. There were highly significant interactions between dry matter intake and periods.

The milk production of Group 4 (30 lb.) was lower than that of the other three groups, which varied from 32.5 to 37.6 lb. during period 1. Their production declined less than the others to period 8. Thus, although they were fed corn silage, the hay assured good dry matter intake and provided adequate protein and energy to sustain milk production at this level of production.

The cows of both Groups 1 and 2 yielded 1 lb. of 4 percent F.C.M. per lb. of dry matter eaten. Those getting both high moisture silage and ear corn silage produced more efficiently, producing 1.05 lb. of milk per lb. of dry matter eaten. Those fed alfalfa hay and ear corn silage produced only 0.81 lb. of milk per lb. of dry matter eaten. This response was similar to that reported (23) when hay was compared with low dry matter silage.

The amount of milk produced per pound of dry matter eaten was influenced by body weight changes. The cows of Group 1 lost an aver-

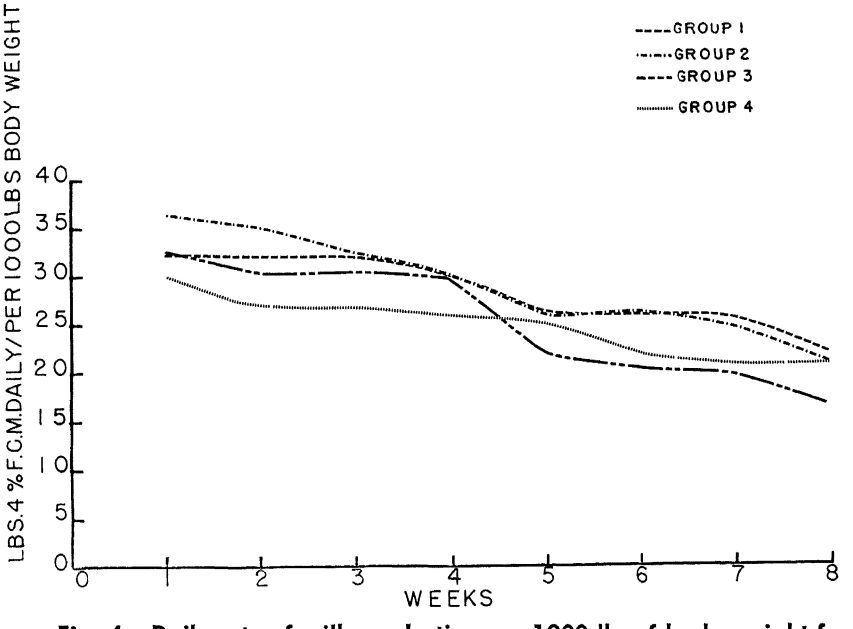

Fig. 4—Daily rate of milk production per 1000 lb. of body weight for the four groups in Experiment II. Group 1 was fed meadow crop silage and grain mixture 79; Group 2, meadow crop silage and ground shelled corn; Group 3, meadow crop silage and ear corn silage; Group 4, alfalfa hay and ear corn silage.

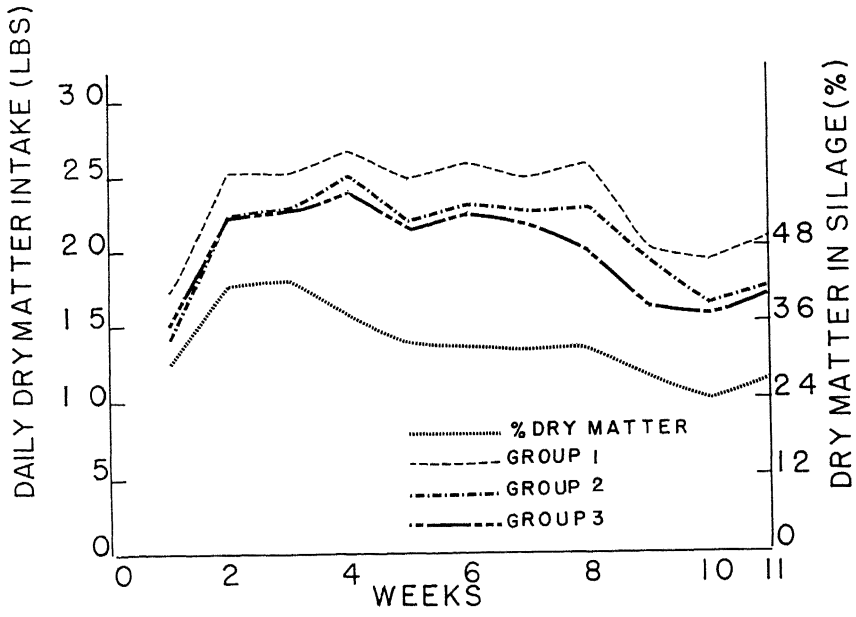

Fig. 5—Relationship between dry matter content of silage and total daily dry matter intake of the cows of three groups per 1000 lb. of body weight.

age of 56 lb. body weight in 56 days, those of Group 2 lost 93 lb., those of Group 3 lost 93 lb., and those of Group 4 gained 29 lb. Differences among the means were significant ($P<0.05$). These differences in weight changes account for the greater efficiency of the silage-fed cows compared with those fed hay. The weight losses are a result of the lowered dry matter intake.

Group 4 received 89 percent of its ration dry matter as forage while Groups 1, 2, and 3 received 82, 80, and 82 percent respectively. Thus, the ability of Group 4 to put on body weight was not due to more grain.

When the dry matter intake from the total ration is calculated per 1000 lb. of body weight and related to the dry matter percentage of the silage (Figure 5), the relationship is more marked than in Figure 3. Group 1 fed silage and grain mixture 79 maintained a higher dry matter intake than the other groups throughout the experiment. It will be noted (Figure 4) that they were not producing as much milk at the start of the experiment as Group 2 but they maintained production better than any of the other groups.

TABLE 6.—Utilization of Dry Matter (D.M.) and Protein in a Digestion Trial.

	Group			
	1	2	3	4
Ration*				
Forage	M.C.S.	M.C.S.	M.C S.	Alfalfa
Grain	#79	G.S.C.	E.C.S.	E.C.S.
Grain D.M. (lb.)	1.69	2.16	2.83	5.55
D. M. Digestibility (%)	59.4	64.3	64.1	64.8
Ration protein (%)	17.0	16.3	15.8	15.3
Nitrogen				
In feed (lb./day)	0.416	0.456	0.406	0.656
Digested (%)	63.4	65.4	67.0	68.3
Part of feed N used† (%)	16.8	20.2	24.1	30.5
Part of absorbed N used for milk (%)	30.9	25.5	30.9	30.4
Retained (g)	—6.4	5.4	4.5	29.0
4% F.C.M. (lb.)	18.9	18.4	18.9	26.0

*M.C.S.—meadow crop silage (26.5% D.M.); G.S.C.—ground shelled corn; E.C.S.—ear corn silage. Grain mixture 79 was described under Experiment 1, page 7.

†Part of feed nitrogen used for milk and that retained as a positive nitrogen balance.

Group 3, fed silage and ear corn silage, responded to changes in dry matter content of the silage by marked changes in total dry matter intake but at a lower level of intake. Group 4, fed hay and ear corn silage, began the experiment on a lower level of production of 4 percent F.C.M. than the other groups and maintained production better, although at lower efficiency.

These experiments indicate that ear corn silage or ground ear corn are not suitable as sole grains to supplement high moisture silage for milk production. Either a more acceptable grain or a minimum allowance of hay seems desirable.

Digestion Trials

Wide differences existed between the amounts of protein in the feed consumed by the cows of Groups 1, 2, and 3 fed meadow crop silage and that of the Group 4 cow fed alfalfa hay (Table 6). Even though the Group 4 cow fed alfalfa hay was producing more milk, she was able to retain much more nitrogen in her tissues than those fed meadow crop silage. The nitrogen of the feed she consumed was about one-and-a-half times that of the animals of the other three groups. This greater retention was accomplished even though the percentage of absorbed nitrogen utilized for milk production was no greater than for cows of Groups 1 and 3 fed meadow crop silage.

There appears to be a correlation between the amount of grain dry matter (energy) and the percentage of nitrogen utilized for milk and body retention.

The low percentage of digestibility of dry matter suggests that the Group 1 cow lacked adequate energy for good digestibility of fiber. Even though she had a higher percentage of protein in the ration and utilized a normal percentage of her protein for milk production, she was in negative nitrogen balance while producing milk at a low level. This also casts doubt on the quality of protein provided by the high moisture silage.

The Group 2 cow receiving more energy and more protein in her ration utilized a higher proportion of the nitrogen of the ration for milk production and for retention.

The Group 3 cow with even more energy from grain dry matter utilized more of her nitrogen intake for milk production and retention. She also utilized more of her absorbed nitrogen for milk production. The cows of both Groups 2 and 3 maintained a small positive nitrogen balance.

The Group 4 cow fed alfalfa hay only as a source of forage, while producing more milk than the other three, reached a higher degree of utilization of the total nitrogen of the ration for milk production and retention, utilized a higher percentage of absorbed nitrogen for milk production, and maintained a higher positive nitrogen balance.

The low digestibility of both dry matter and protein of Group 1 appears to be due to low energy and protein quality. Provision of more energy in the form of grain for cows of Groups 2 and 3 resulted in increased digestibility of dry matter and in better utilization of the total nitrogen of the ration.

The Group 4 cow, although she had a greater nitrogen intake, digested 68.3 percent of the nitrogen. This was a higher percentage than digested by the others. This better utilization occurred even though the source of energy of the grain was fermented ear corn silage. This suggests that the protein of alfalfa hay not degraded by fermentation is qualitatively more suitable for or more completely utilized by rumen microorganisms.

These facts appear to justify the conclusion that there is a need for unfermented grain or forage for high milk production and efficiency in the use of nitrogen.

SUMMARY

Two experiments were conducted with high moisture silages and with both fermented and unfermented sources of energy as supplements to the silage.

In Experiment I, all cows received 25 percent of their ration dry matter as grain and 75 percent as wilted silage during a preliminary period. The cows were then assigned to groups and, after a transition, began the experimental period of 14 weeks.

Following the preliminary period, the cows were assigned to three groups. Group 1 was fed wilted alfalfa-brome silage to provide 75 percent of the ration dry matter and a mixed grain ration 25 percent, Group 2 wilted silage 80 percent and ground ear corn 20 percent, and Group 3 only similar wilted silage with 10 percent ground ear corn added at ensiling. The ration fed to Group 1 proved to be more satisfactory.

The cows of Group 1 produced significantly more ($P<0.01$). However, as they ate more they produced less milk per pound of dry matter eaten.

In Experiment II, after a 21-day conditioning period, the cows were assigned to four groups. Group 1 was fed wilted alfalfa-grass silage and a mixed grain ration; Group 2, alfalfa-grass silage and ground shelled corn; Group 3, alfalfa-grass silage and ear corn silage; and Group 4, alfalfa hay and ear corn silage. The forages were fed ad lib and grain was fed in ratio to milk production.

Cows fed silage produced more 4 percent F.C.M. per lb. of dry matter eaten but lost body weight. Those fed hay gained body weight. There was a decided relationship apparent between dry matter content of the silage and total ration dry matter intake.

CONCLUSIONS

Cows fed wilted silage responded with more 4 percent F.C.M. per lb. of dry matter eaten than those fed hay. However, they ate less dry matter and lost more body weight.

As a supplement to wilted silage throughout Experiment II, mixed grain resulted in greater dry matter intake than ground ear corn. The latter, in turn, resulted in greater dry matter intake than ear corn silage.

For high dry matter intake and consequent high milk production, some unfermented grain or hay seems necessary to supplement high moisture silage.

The nitrogen of alfalfa hay was utilized more completely than that of high moisture alfalfa silage.

LITERATURE CITED

1. Arnold, G. W. 1962. Effects of Pasture Maturity on the Diet of Sheep. Australian J. Agri. Res. 13: 701.
2. Brown, S. M. 1959. Silage Feeding of the Dairy Cow and Its Effect on Milk Yield and Composition. Int. Dairy Cong. 1: 210.
3. Brown, L. D., D. Hillman, C. A. Lassiter, and C. F. Huffman. 1963. Grass Silage vs. Hay for Lactating Dairy Cows. J. Dairy Sci. 46: 407.
4. Conrad, H. R., J. W. Hibbs, A. D. Pratt, and J. H. Vandersall. 1960. Changing Dairy Rations Affects Digestibility, Rumen Function, Feed Intake and Milk Production. Ohio Agri. Exp. Sta., Res. Bull. 867.
5. Conrad, H. R., J. W. Hibbs, A. D. Pratt, and J. H. Vandersall. 1958. Milk Production, Feed Intake and Digestibility Following Initiation of Legume-Grass Silage Feeding. J. Anim. Sci. 17: 1197.
6. Conrad, H. R., J. W. Hibbs, and A. D. Pratt. 1960. Nitrogen Metabolism in Dairy Cattle. Ohio Agri. Exp. Sta., Res. Bull. 861.
7. Conrad, H. R., A. D. Pratt, and J. W. Hibbs. 1962. Some Aspects of the Regulation of Feed Intake in Dairy Cows. Abs., J. Dairy Sci. 45: 684.
8. Dowden, D. R. 1960. Inhibition of Appetite in Dairy Cattle by Certain Intermediate Metabolites. Nature, 188 (4745): 148.
9. Gordon, C. H., J. C. Derbyshire, W. C. Jacobsen, and H. G. Wiseman. 1963. Feeding Value of Low Moisture Alfalfa Silage from Conventional Silos. J. Dairy Sci. 46: 411.
10. Gordon, C. H., J. C. Derbyshire, E. A. Kane, D. T. Black, and J. R. McCalmont. 1960. Consumption and Feeding Value of Silages as Affected by Dry Matter Content. Abs., J. Dairy Sci. 43: 866.
11. Gordon, C. H., J. C. Derbyshire, H. G. Wiseman, E. A. Kane and C. G. Melin. 1961. Preservation and Feeding Value of Alfalfa Stored as Hay, Haylage and Direct-cut Silage. J. Dairy Sci. 44: 1299.
12. Gordon, C. H., J. B. Shepherd, H. G. Wiseman, and C. G. Melin. 1951. A Comparison of Wilted Silage and Half-dry Silage Stored in Gastight Silos, and Their Value as Feed for Dairy Cattle. U. S. Dept. Agr., B. D. I. Inf. 126.
13. Hillman, D., C. A. Lassiter, C. F. Huffman, and C. W. Duncan. 1959. Appetite Studies in Dairy Cattle: Grass Silage vs. Hay. J. Anim. Sci 18: 1543.
14. Huffman, C. F., C. W. Duncan, S. T. Dexter, and C. M. Chance. 1954. The Feeding Value of Red Clover Conserved as Hay and Silage in Respect to Milk Production. Mich. Agri. Exp. Sta., Quart Bull. 36: 391.
15. Keyes, E. A. and E. P. Smith. 1955. The Feeding Value of Alfalfa for Dairy Cows when Harvested and Stored by Four Different Methods. Mont. Agri. Exp. Sta., Bull. 513.

16. Langston, C. W., H. G. Wiseman, C. H. Gordon, W. C. Jacobsen, C. G. Melin, L. A. Moore, and J. R. McCalmont. 1962. Chemical and Bacterioligical Changes in Grass Silage During the Early Stages of Fermentation. J. Dairy Sci. 45: 396.

17. Larsen, H. J. and R. F. Johannes. 1961. Effect on Milk Production, Body Weight, and Dry Matter Consumption when Feeding Haylage, Hay and Silage with Simple Concentrate Supplements. J. Dairy Sci. 44: 1175.

18. McCullough, M. E. 1962. Some Factors Influencing Intake of Direct-cut Silage by Dairy Cows. J. Dairy Sci. 45: 116.

19. McCullough, M. E. 1962. Use of Digestible Dry Matter by Dairy Cows Group-fed Silage. Tech. Note, J. Dairy Sci. 45: 1107.

20. Miller, W. J., C. M. Clifton, and N. W. Cameron. 1962. Nutrient Losses and Silage Quality as Affected by Rate of Filling and Soybean Flakes. J. Dairy Sci. 45: 403.

21. Norfeldt, S. and V. Hellstrom. 1958. Artificially Dried, Barn-dried, and Field-dried Hay Compared with Silage in Feeding Experiments with Dairy Cows. Medd. St. Husdjursforsok, 69 (English Summary).

22. Pounden, W. D. and J. W. Hibbs. 1948. The Influence of the Ration and Rumen Inoculation on the Establishment of Certain Microorganisms in the Rumen of Young Calves. J. Dairy Sci. 31: 1041.

23. Pratt, A. D. and H. R. Conrad. 1963. The Effect of Ratio of Hay to Silage Dry Matter on Milk Production. Ohio Agri. Exp. Sta., Res. Bull. 948.

24. Pratt, A. D., R. R. Davis, H. R. Conrad, and J. H. Vandersall. 1961. Soilage and Silage for Milk Production. Ohio Agri. Exp. Sta., Res. Bull. 871.

25. Pratt, A. D., C. T. Settlemire, and J. W. Hibbs. 1963. High Dry Matter Zinc Bacitracin-treated Legume-grass Silage vs. Untreated High Dry Matter Silage: Each with Corn, Soybean Flakes and Dried Beef Pulp. J. Dairy Sci. 46: 1385.

26. Salsbury, R. L., J. A. Hoefer, and R. W. Luecke. 1961. Effect of Feeding Certain Defined Nutrients on Cellulose Digestion and Volatile Fatty Acid Concentration of the Rumen. J. Dairy Sci. 44: 1122.

27. Stoddard, G. E., C. H. Mickelsen, and G. I. Bateman. 1957. Comparative Value of Alfalfa Hay and Alfalfa Silage Stored as Winter Roughage for Dairy Cows. Proc., Western Div., Amer. Dairy Sci. Assoc.

28. Sykes, J. F., H. T. Converse, and L. A. Moore. 1955. Comparison of Alfalfa Hay and Alfalfa Silage as Roughage for Growing Dairy Heifers in a Limited Milk and Grain Feeding System. J. Dairy Sci. 38: 1246.

29. Thomas, J. W., L. A. Moore, and J. F. Sykes. 1961. Further Comparisons of Alfalfa Hay and Alfalfa Silage for Growing Dairy Heifers. J. Dairy Sci. 44: 862.

30. Thomas, J. W., L. A. Moore, M. Okamoto, and J. F. Sykes. 1961. A Study of the Factors Affecting Rate of Intake of Heifers Fed Silage. J. Dairy Sci. 44: 1471.

31. Voelker, H. H. and E. Bartle. 1960. Feeding Values of Alfalfa Haylage, Silage, Green-chop, Pasture and Artificially Dried Hay J Dairy Sci. 43: 869.