BULLETIN 443
MARCH 1973

Supplementing Coastal Bermudagrass Hay for Lactating Dairy Cows

AGRICULTURAL EXPERIMENT STATION/AUBURN UNIVERSITY
R. Dennis Rouse, Director/Auburn, Alabama

CONTENTS

FIRST PRINTING 3½M, MARCH 1973

Supplementing Coastal Bermudagrass Hay for Lactating Dairy Cows

G. H. ROLLINS, E. L. MAYTON, J. A. LITTLE, and G. E. HAWKINS*

NORMAL MILK PRODUCTION persistency was not maintained by dairy cows fed Coastal bermudagrass (*Cynodon dactylon*) hay ad libitum as their only source of forage in research by several investigators *(3,4,6,7,10)*. In those trials, concentrate mixtures were fed at rates ranging from 1 pound per 5 pounds of 4 per cent fat-corrected milk (FCM) to 1 pound per 2 pounds FCM. Low intake and low nutritive value of the hays were factors reported to depress lactation persistency. Lactation persistency of cows fed higher levels of concentrate *(4,6)* was improved somewhat over that of cows fed low concentrate levels.

Providing high quality harvested forages for dairy cows is difficult in the Southeastern United States, particularly in Alabama. Much of the State's land is not suited for row cropping and silage harvest. In many areas corn silage yields are comparatively low and drought often further reduces yield. Coastal bermudagrass has become the major hay crop, with its production increasing at the same time that legumes and other quality hay crops have been grown on fewer and fewer acres. The result is that, during confined feeding periods when corn silage and legume hay are scarce or unavailable, dairymen rely on Coastal hay partially or wholly as the harvested forage for their cows. Therefore, it is important to find practical ways to supplement Coastal hay and maintain milk production persistency of cows.

A series of four feeding trials was conducted by Auburn University Agricultural Experiment Station, with these objectives:

* Associate Professor, Department of Animal and Dairy Sciences; Superintendent, Piedmont Substation; Instructor, Department of Animal and Dairy Sciences; and Professor, Department of Animal and Dairy Sciences, respectively.

(1) to determine lactation performance of cows fed long Coastal bermudagrass hay supplemented with high, intermediate, and low concentrate levels, corn silage, or pelleted alfalfa; (2) to determine the relationships between concentrate intake and animal performance; and (3) to compare the experimental rations with regard to feed cost per hundredweight of FCM and return over feed cost. The trials were conducted at the Piedmont Substation, Camp Hill, Alabama.

EXPERIMENTAL PROCEDURE

Forages

The Coastal bermudagrass hay fed in Trial 1 was purchased. Hays fed in trials 2, 3, and 4 were harvested at the Substation. All were sun-cured, and some lots were exposed to rain during the curing process. Pelleted alfalfa was purchased. Corn forage for each trial was ensiled in upright silos when the grain was in the dent stage of maturity.

Feeding Trials

Grade Holstein cows producing 11,000-13,000 pounds of milk per cow annually were used as test animals. All were between 40 and 135 days post-partum at the beginning of each trial; none was beyond 5 months in gestation by the end of the trials. During a 14-day standardization period preceding each trial, cows were group-fed corn silage (silage) and Coastal hay (Coastal) ad libitum. Cows assigned to Trial 1 had continuous access to both forages, whereas those assigned to trials 2, 3, and 4 were restricted to silage during the day and Coastal at night. Concentrate was fed to each cow at 1 pound per 3 pounds of milk preceding trials 1 and 2 and at 1 pound per 2.4 pounds of milk preceding trials 3 and 4.

Concentrate mixtures consisted of shelled corn, oats, cottonseed meal (41 per cent crude protein), and minerals. Each was formulated, using Morrison's *(11)* crude protein values for corn and oats, to contain 20 per cent crude protein. All concentrates were custom mixed.

All test rations were identified with respect to the forage(s) and the initial rate of concentrate feeding, which was expressed

as concentrate-to-FCM ratio. (For example, Coastal 1:1.8 = Coastal hay ad libitum plus 1 pound concentrate per 1.8 pounds of FCM.) Initial daily concentrate allowance for each cow during the first 28 days of each trial was based on her FCM production during the standardization period. Thereafter, concentrate was reduced 5 per cent at the end of each 28-day period. The silage 1:3.0 ration served as a control ration in all trials.

Rations compared in trials 1 through 4 are given in tables 1 through 4, respectively. Each trial is described below.

TRIAL 1. Four rations were compared using a 4 x 4 Latin square-design feeding trial with 4 cows per ration. Each period lasted 28 days, the first 7 days being a preliminary or change-over period and the last 21 days the comparison period. Following the initial random assignment of cows to rations, reassignment to another ration at the end of each 28-day period was according to a pre-established sequence.

TRIAL 2. Six rations were compared in a continuous, 112-day, 3 x 2 factorial-design feeding trial with 4 cows per ration.

TRIAL 3. Three rations were compared in a continuous, 140-day feeding trial with 8 cows per ration.

TRIAL 4. Three rations were compared in a continuous, 120-day feeding trial with 7 cows per ration. Cows fed the Coastal hay-pelleted alfalfa ration received 4 pounds of pelleted alfalfa once daily.

During each trial, cows were group-fed Coastal or silage ad libitum in drylot. Treatment groups receiving both forages were penned at night with cows confined to Coastal and during the day with cows confined to silage. Concentrate was fed twice daily prior to milking.

Milk weights and concentrate consumption were recorded twice daily, and 48-hour composite milk samples taken for analyses. These composite samples were obtained during the second week of the standardization period preceding trials 1 and 2 and at 28-day intervals during these trials, and weekly during the standardization period preceding trials 3 and 4 and at 14-day intervals during these trials. Milk fat was determined by the Babcock procedure, protein by the Kjeldahl method, total solids by the Mojonnier method, and solids-not-fat by difference. Milk was converted to 4 per cent fat-corrected milk by the Gaines formula *(5)*.

Persistency of milk production was calculated by expressing the daily average production per cow during a given interval as the percentage of that for a preceding interval. A persistency of 94 per cent per 28-day interval was considered normal *(12)*.

Body weight changes for each cow were determined from individual weights obtained immediately following the morning milking at the end of the standardization period and at 28-day intervals throughout each trial. Feed and water were withheld for a 14-hour period prior to weighing.

Forage Intake and Economic Evaluations

Forage intake per cow was estimated using the formula given in the Appendix. Feed cost per hundredweight of FCM and return over feed cost were calculated for each ration and trial using the values given in the Appendix.

Digestion Trials

Digestion coefficients for the corn silages and Coastal hays fed in each trial were determined by feeding each forage without concentrate to 400- to 600-pound dairy steers in conventional digestion trials.

Chemical Analyses

Representative samples of the hays, silages, pelleted alfalfa, and concentrate mixtures were collected during each 28-day period of each feeding trial. Proximal chemical composition of forages, concentrates, and fecal samples was determined by official methods *(1)*.

Statistical Analyses

Performance data were treated statistically. Statements of differences are based on odds of at least 19 to 1 that the differences are the result of the rations fed.

RESULTS AND DISCUSSION

Feeding Trials

Milk production persistency in Trial 1 averaged near 100 per cent when the cows were fed the Coastal 1:1.8 or the silage 1:3.0

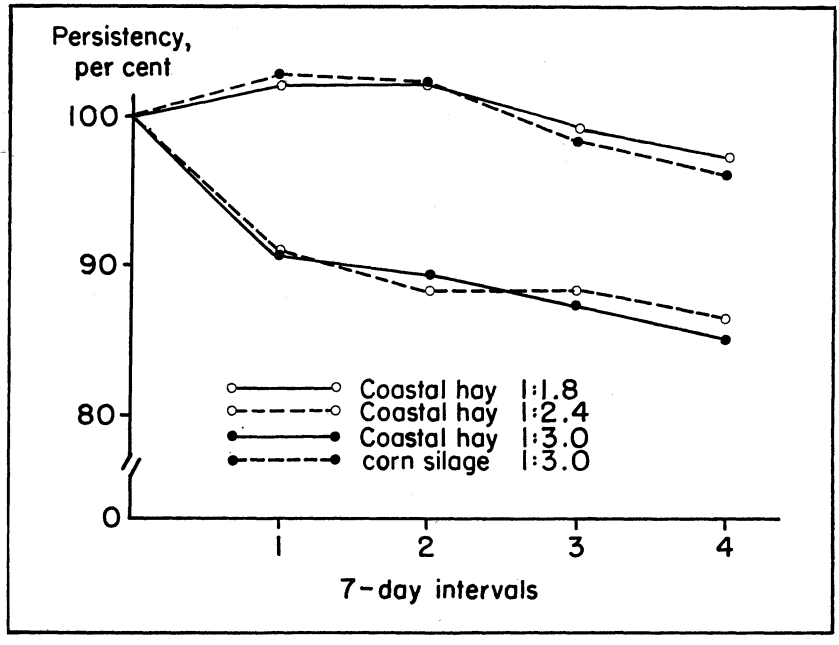


FIG. 1. Milk production persistency of cows during Trial 1, expressed as per cent of mean daily FCM production during 14-day standardization period.

rations but only about 88 per cent when fed the Coastal 1:2.4 or the Coastal 1:3.0 rations, Table 1. The relationships of weekly persistency to ration, illustrated in Figure 1, show that milk production increased during the first week when cows were fed the Coastal 1:1.8 or the silage 1:3.0 rations. In contrast, when the cows were switched to either the Coastal 1:2.4 or Coastal 1:3.0 rations milk production declined sharply during the first week. However, during the 21-day comparison period the decline in persistency for all treatments was at a similar rate. Mean daily FCM production on the Coastal 1:1.8 ration was higher ($P < .05$) than that on the Coastal 1:3.0 ration, Table 1. Among all other rations, daily FCM was not significantly different.

Milk composition was not greatly influenced by ration. There was no effect on fat per cent. Solids-not-fat and total solids of milk from cows fed the Coastal 1:2.4 and Coastal 1:3.0 rations were lower ($P < .05$) than that of milk from cows fed the other rations, Table 1.

Cows fed the Coastal hay with high, intermediate, and low

TABLE 1. MEAN RESPONSES OF COWS DURING 21-DAY PERIODS, TRIAL 1

Responses	Rations[1]			
	Coastal hay 1:1.8	Coastal hay 1:2.4	Coastal hay 1:3.0	Corn silage 1:3.0
Milk production				
Persistency[2], pct.	100.2	88.6	88.2	99.8
FCM, mean/cow/day, lb.	42.2[a]	40.6[ab]	39.0[b]	41.5[ab]
Milk composition				
Fat, pct.	4.08[a]	3.99[a]	4.04[a]	4.14[a]
Solids-not-fat, pct.	8.92[a]	8.79[b]	8.68[b]	8.90[a]
Total solids, pct.	13.00[a]	12.78[b]	12.72[b]	13.04[a]
Feed intake/cow/day				
Concentrate, air dry, lb.	25.6	19.5	15.6	15.3
Coastal hay, air dry[3], lb.	15.0	24.2	29.6	----
Corn silage, wet[3], lb.	----	----	----	76.5
Total dry matter[4], lb.	36.5	39.7	41.2	35.7
ENE from concentrate[5], pct.	75.0	59.0	48.0	45.0
ENE intake/cow/day, Mcal	22.6	22.0	21.4	22.4
Body weight, mean/cow				
Experimental period, lb.	1,220	1,220	1,222	1,214
Gain/day, lb.	1.06[a]	0.97[a]	0.92[a]	1.12[a]

[1] Means having unlike superscripts differ significantly ($P < .05$).
[2] Represents average of persistency calculated for each of four weekly intervals.
[3] Values calculated as described in procedure.
[4] Represents measured intake from concentrate plus calculated forage dry matter intake.
[5] Expressed as per cent of net energy required for performance (maintenance, milk production, weight gain).

concentrate levels and those fed the silage ration consumed 75, 59, 48, and 45 per cent, respectively, of their total energy requirement from concentrate. Gain in weight was similar on all rations, approximately 1 pound per day. The below-normal lactation persistency of the cows when fed the Coastal 1:2.4 and Coastal 1:3.0 indicated that these rations were inferior to the other rations.

In Trial 2, average milk production persistency among rations ranged from 89 to 95 per cent, Table 2. Only that on the silage 1:3.0 ration (95 per cent) exceeded normal. Within the Coastal and the Coastal-silage treatments, cows fed the high concentrate level (1:1.8) maintained a higher average persistency than those fed the low concentrate level (1:3.0). In contrast, with silage as the only roughage, cows fed the low concentrate level (1:3.0) maintained a higher average milk production persistency than those fed the high concentrate level (1:1.8). Persistency of cows fed the Coastal 1:3.0 and the Coastal-silage 1:3.0 rations was

TABLE 2. MEAN RESPONSES OF COWS DURING 112-DAY EXPERIMENT, TRIAL 2

Response	Rations[1]					
	Coastal hay		Coastal hay-corn silage		Corn silage	
	1:1.8	1:3.0	1:1.8	1:3.0	1:1.8	1:3.0
Milk production						
Persistency[2], pct.	92.0	89.0	93.0	91.0	93.0	95.0
FCM, mean/cow/day, lb.	44.5[a]	38.7[a]	43.3[a]	41.3[a]	44.0[a]	45.1[a]
Milk composition						
Fat, pct.	3.77[a]	3.73[a]	3.93[a]	3.86[a]	3.91[a]	3.97[a]
Solids-not-fat, pct.	9.18[ab]	9.01[ab]	8.97[a]	9.15[ab]	9.26[ab]	9.39[b]
Total solids, pct.	12.97[ab]	12.71[a]	12.92[ab]	12.97[ab]	13.12[ab]	13.37[b]
Protein, pct.	3.44[a]	3.45[a]	3.39[a]	3.42[a]	3.45[a]	3.39[a]
Feed intake/cow/day						
Concentrate, air dry, lb.	27.9	15.5	26.0	14.7	24.1	15.3
Coastal hay, air dry[3], lb.	13.8	24.5	5.7	10.7	----	----
Corn silage, wet[3], lb.	----	----	16.9	31.4	44.0	62.0
Total dry matter[4], lb.	38.1	37.0	34.2	32.9	32.6	33.6
ENE from concentrate[5], pct.	76.0	50.0	75.0	47.0	71.0	46.0
Concentrate refusal/cow/day, air dry, lb.	1.37	0.00	0.49	0.03	1.96	0.11
Body weight, mean/cow						
Experimental period, lb.	1,220	1,185	1,245	1,122	1,239	1,126
Gain/day, lb.	1.06[a]	0.98[a]	1.22[a]	0.71[a]	0.91[a]	0.86[a]

[1] Means having unlike superscripts differ significantly ($P < .05$).
[2] Represents average of persistency calculated for each of four 28-day intervals.
[3] Values calculated as described in procedure.
[4] Represents measured intake from concentrate plus calculated forage dry matter intake.
[5] Expressed as per cent of net energy required for performance (maintenance, milk production, weight gain).

noticeably below that of those fed the other rations for all 28-day intervals, as illustrated in Figure 2.

There were no significant differences among rations in mean daily FCM production, Table 2. The variability in milk production response among animals within treatment was somewhat high (CV = 12.4%).

Ration had no pronounced effect on milk composition. Milk fat and milk protein were not affected. Differences ($P < .05$) in solids-not-fat and total solids were observed between certain rations, Table 2. Body weight gain was similar on all rations.

Daily concentrate intake by cows fed at the high (1:1.8) and low (1:3.0) levels averaged approximately 26 and 15 pounds per cow, respectively. On all forage treatments, cows fed the

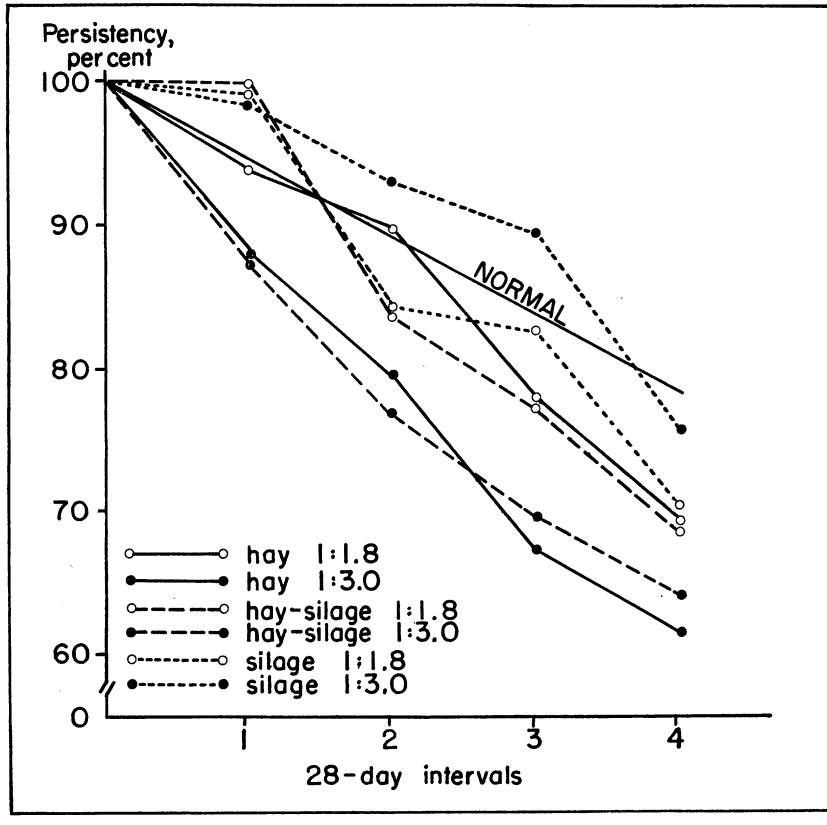


FIG. 2. Milk production persistency of cows during Trial 2, expressed as per cent of mean daily FCM production during 14-day standardization period.

high and low levels of concentrate consumed 71 to 76 and 46 to 50 per cent, respectively, of their required energy from concentrate. Considerable amounts of concentrate were refused by cows fed at the high level, mostly by cows producing 50 to 70 pounds of FCM at the start of the experiment. Initial daily concentrate allowances for these cows ranged from 28 to 39 pounds, and refusals averaged 2 to 5 pounds per cow daily.

Cows fed the Coastal 1:1.8 ration in Trial 3 had average milk production persistency of only 91 per cent, which was below normal. However, this was nearly equal to persistency for the similar ration fed in Trial 2 (92 per cent). In comparison, the average persistencies by cows fed the Coastal-silage 1:2.4 and the silage 1:3.0 rations were slightly above normal (95 and 96 per cent, respectively), Table 3. Differences among the 28-day persistency values for the respective rations are illustrated in Figure 3.

TABLE 3. MEAN RESPONSES OF COWS DURING THE 140-DAY EXPERIMENT, TRIAL 3

Responses	Rations[1]		
	Coastal hay 1:1.8	Coastal hay-corn silage 1:2.4	Corn silage 1:3.0
Milk production			
Persistency[2], pct.	91.0	95.0	96.0
FCM, mean/cow/day, lb.	36.4[a]	41.4[ab]	42.0[b]
Milk composition			
Fat, pct.	4.13[a]	4.32[a]	4.12[a]
Solids-not-fat, pct.	9.00[a]	9.18[a]	9.12[a]
Total solids, pct.	12.98[a]	13.58[a]	13.40[a]
Protein, pct.	3.40[a]	3.44[a]	3.38[a]
Feed intake/cow/day			
Concentrate, air dry, lb.	22.4	17.8	14.0
Coastal hay, air dry[3], lb.	12.2	9.51	---
Corn silage, wet[3], lb.	---	30.9	74.0
Total dry matter[4], lb.	31.3	36.5	33.4
ENE from concentrate[5], pct.	72.0	55.0	42.0
Concentrate refused/cow/day, air dry, lb.	1.17	0.05	0.10
Body weight, mean/cow			
Experimental period, lb.	1,172	1,102	1,196
Gain/day, lb.	1.63[a]	1.46[a]	1.32[a]

[1] Means having unlike superscripts differ significantly ($P < .05$).
[2] Represents average of persistency calculated for each of five 28-day intervals.
[3] Values calculated as described in procedure.
[4] Represents measured intake from concentrate plus calculated forage dry matter intake.
[5] Expressed as per cent of net energy required for performance (maintenance, milk production, weight gain).

Mean daily FCM production of cows fed the Coastal 1:1.8 ration was lower ($P < .05$) than that of cows fed the silage 1:3.0 ration. Milk composition was not affected by ration. Weight gains did not differ among rations.

Energy intake from concentrate accounted for 72, 55, and 42 per cent of the net energy requirements of cows fed the high, medium, and low concentrate levels, respectively. However, considerable concentrate was refused by high-producing cows fed the Coastal 1:1.8 ration. For example, two cows which averaged 67 and 56 pounds of FCM daily during the standardization period were initially fed 37 and 31 pounds daily of concentrate, respectively, and their refusals accounted for approximately 88 per cent of the concentrate refused by their group. Refusals by cows fed the medium and low levels of concentrate were small.

Mean milk production persistency on all rations was below

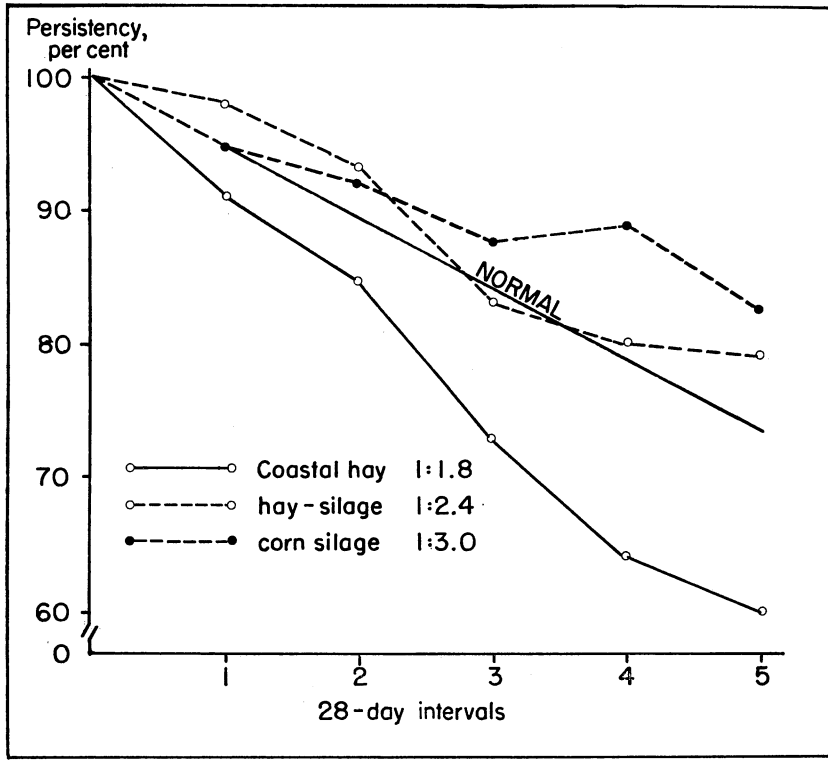


FIG. 3. Milk production persistency of cows during Trial 3, expressed as per cent of mean daily FCM production during 14-day standardization period.

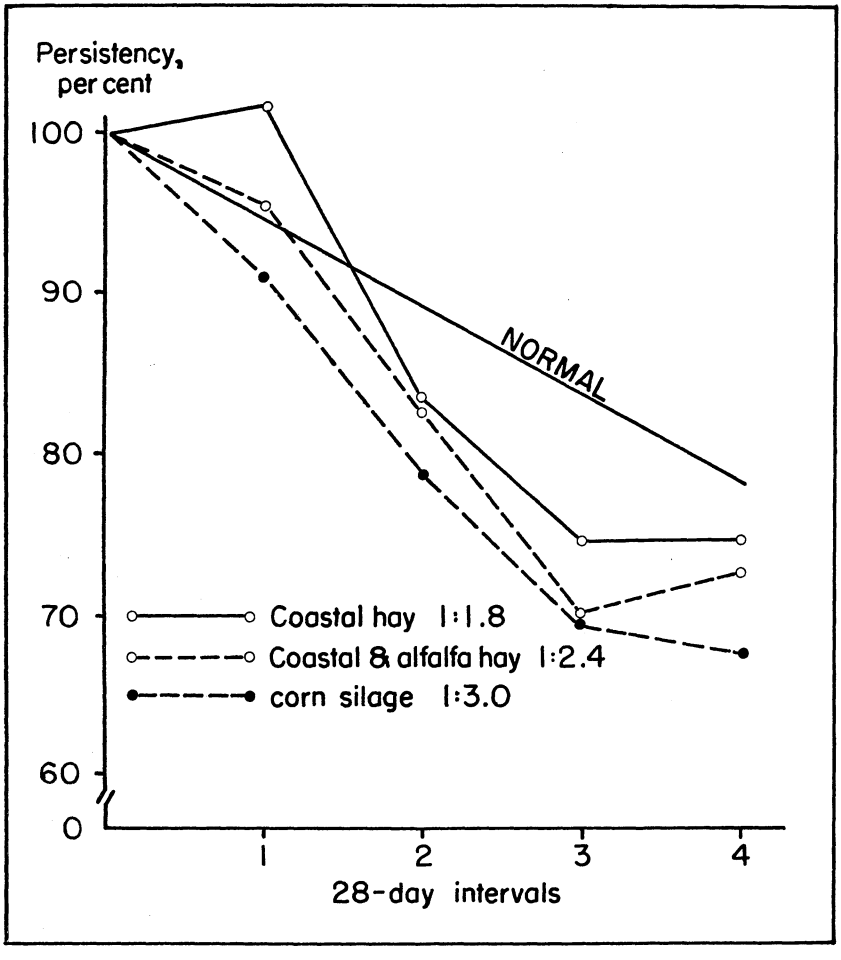


FIG. 4. Milk production persistency of cows during Trial 4, expressed as per cent of mean daily FCM production during 14-day standardization period.

normal in Trial 4. Persistency on all rations dropped sharply during the second and third 28-day intervals but showed some recovery during the fourth 28-day interval, Figure 4. Among these rations there were no significant differences in mean daily FCM production, milk composition, or body weight gain, Table 4.

Energy intake from concentrate accounted for 73, 55, and 45 per cent of net energy requirements of cows fed the high, medium, and low concentrate levels, respectively. In this trial, however, noticeable amounts of concentrate were refused by two

TABLE 4. MEAN RESPONSES OF COWS DURING 112-DAY EXPERIMENT, TRIAL 4

Responses	Rations[1]		
	Coastal hay 1:1.8	Coastal hay-pelleted alfalfa 1:2.4	Corn silage 1:3.0
Milk production			
Persistency[2], pct.	93.0	93.0	92.0
FCM, mean/cow/day, lb.	42.1[a]	40.4[a]	39.7[a]
Milk composition			
Fat, pct.	4.25[a]	4.23[a]	4.32[a]
Solids-not-fat, pct.	8.83[a]	8.75[a]	8.93[a]
Total solids, pct.	13.12[a]	13.05[a]	13.27[a]
Protein, pct.	3.43[a]	3.33[a]	3.41[a]
Feed intake/cow/day			
Concentrate, air dry, lb.	24.3	17.9	15.2
Coastal hay, air dry[3], lb.	14.0	18.8	----
Pelleted alfalfa hay, air dry, lb.	----	4.0	----
Corn silage, wet[3], lb.	----	----	66.6
Total dry matter[4], lb.	34.4	36.7	34.1
ENE from concentrate[5], pct.	73.0	55.0	45.0
Concentrate refused/cow/day, air dry, lb.	0.55	0.66	0.32
Body weight, mean/cow			
Experimental period, lb.	1,205	1,246	1,220
Gain/day, lb.	1.27[a]	1.15[a]	1.66[a]

[1] Means having like superscripts are not significantly different ($P > .05$).
[2] Represents average of persistency calculated for each of four 28-day intervals.
[3] Values calculated as described in procedure.
[4] Represents measured intake from concentrate plus calculated forage dry matter intake.
[5] Expressed as per cent of net energy required for performance (maintenance, milk production, weight gain).

cows assigned to each ration. These cows averaged 50 to 66 pounds FCM daily at the start of the trial. Their refusals occurred periodically on successive days and ranged up to 4 pounds daily. Except for one cow that was "off feed" for a short time, no reason for concentrate refusals was apparent.

Chemical Composition and Digestibility

Chemical composition of the experimental forages and concentrate mixtures are given in Table 5. Coefficients of digestibility and the total digestible nutrient (TDN) content of the Coastal hays and corn silages are in Table 6.

The purchased Coastal hay fed in Trial 1 was noticeably lower in crude protein and TDN and higher in crude fiber than the other Coastal hays. The silages varied in composition and TDN

TABLE 5. CHEMICAL COMPOSITION OF FORAGES AND CONCENTRATE MIXTURES FED DURING EACH TRIAL

Forage	Trial	Dry matter as fed	Proximate composition (dry basis)				
			Crude protein	Ether extract	Crude fiber	N-free extract	Ash
		Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Coastal hay	1	93	6.2	2.0	32.7	54.9	4.2
	2	94	9.2	2.1	30.4	52.9	5.4
	3	91	10.3	2.4	26.3	56.2	4.8
	4	91	10.2	1.7	29.3	54.4	4.4
Corn silage	1	29	8.4	3.5	25.6	57.9	4.6
	2	32	9.2	2.9	21.3	62.7	3.9
	3	28	10.9	3.4	21.4	59.7	4.6
	4	31	7.8	3.0	22.4	63.6	3.2
Pelleted alfalfa	4	91	14.9	1.6	29.3	44.8	9.4
Concentrate mixtures	1	88	25.1	4.8	5.8	57.3	7.0
	2	90	22.7	5.2	6.4	59.3	6.4
	3	90	27.3	4.9	4.0	57.7	6.1
	4	89	20.1	3.2	6.7	66.0	4.0

content. However, chemical compositions (wet basis), TDN contents (wet basis), and digestion coefficients of all Coastal hays and silages were near the means or within the ranges reported by Morrison *(11)* for similar forages. Also, the Coastal hay fell within the range in chemical compositions reported by others *(4,7,8,10)*. Composition of the pelleted alfalfa was about equal to that for fair to good alfalfa hay reported by Morrison *(11)*. In general, the forages fed in these trials were representative of those available to dairymen.

TABLE 6. COEFFICIENTS OF DIGESTIBILITY AND TOTAL DIGESTIBLE NUTRIENT CONTENT OF THE FORAGES FED DURING EACH TRIAL, DRY BASIS

Forage	Trial	Digestion coefficients[1]					
		Dry matter	Crude protein	Ether extract	Crude fiber	N-free extract	TDN
		Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Coastal hay	1	55.3	45.8	69.8	56.7	56.0	55.3
	2	58.2	55.8	67.3	63.9	58.0	58.4
	3	56.7	47.1	67.7	55.0	64.7	59.3
	4	57.2	55.0	60.2	63.0	56.4	57.1
Corn silage	1	70.7	58.9	85.4	64.4	75.7	72.0
	2	65.9	53.5	72.0	64.4	71.3	68.0
	3	63.6	59.0	72.6	46.9	72.0	65.0
	4	66.8	42.4	59.8	62.6	74.0	68.4

[1] Determined by total fecal collection method using three steers per forage in Trial 1 and four steers per forage in trials 2, 3, and 4.

Crude protein content of some of the concentrate mixtures was higher than the 20 per cent intended. The cause is unknown; however, it is not likely that the protein content of the mixtures caused any problem with intake.

Feed Cost and Return

Feed cost per cow per day, feed cost per hundred pounds of FCM, and return per cow per day above feed cost for the respective rations in each experiment are summarized in Table 7. These data show that the higher levels of concentrate intake resulted in a higher daily feed cost per cow. However, data in tables 1 and 2 show that each increase in concentrate level resulted in increased milk production by cows on the Coastal hay-concentrate rations in Trial 1 and the Coastal hay and Coastal

TABLE 7. FEED COST PER COW PER DAY, FEED COST PER HUNDRED POUNDS OF FCM, AND RETURN PER COW PER DAY ABOVE FEED COST FOR THE RATIONS FED IN EACH TRIAL[1]

Rations		Feed cost per cow per day	Feed cost per hundred pounds FCM	Return/cow/day above feed cost
		Dollars	*Dollars*	*Dollars*
Trial 1				
Coastal hay	1:1.8	1.24	2.94	1.71
Coastal hay	1:2.4	1.18	2.92	1.66
Coastal hay	1:3.0	1.14	2.92	1.59
Corn silage	1:3.0	0.98	2.35	1.93
Trial 2				
Coastal hay	1:1.8	1.31	2.67	2.10
Coastal hay	1:3.0	1.04	2.73	1.62
Coastal hay—corn silage	1:1.8	1.18	2.70	1.89
Coastal hay—corn silage	1:3.0	0.90	2.37	1.76
Corn silage	1:1.8	1.08	2.46	1.99
Corn silage	1:3.0	0.90	2.03	2.21
Trial 3				
Coastal hay	1:1.8	1.07	2.93	1.49
Coastal hay—corn silage	1:2.4	1.01	2.44	1.89
Corn silage	1:3.0	0.92	2.19	2.00
Trial 4				
Coastal hay	1:1.8	1.17	2.82	1.75
Coastal hay—pelleted alfalfa	1:2.4	1.13	2.84	1.65
Corn silage	1:3.0	0.92	2.26	1.93

[1] Calculations were based on mean daily FCM produced per cow, concentrate consumption, forage fed, and prices given in the Appendix.

hay-corn silage rations in Trial 2. Furthermore, each increase in concentrate level was accompanied by a higher daily return above feed cost. In contrast, the higher concentrate level gave no economic advantage with the corn silage-concentrate ration, Trial 2. There was little difference in feed cost per hundred pounds of FCM among the Coastal hay-concentrate rations fed in trials 1 and 2; the lower daily feed cost was offset by the lower milk production.

Among the rations compared in trials 3 and 4, feed cost per hundred pounds of FCM decreased as the level of concentrate fed decreased, while return above feed cost increased except for the Coastal-pelleted alfalfa ration, Trial 4. In all experiments, daily return per cow above feed cost was highest for the corn silage 1:3.0 rations.

GENERAL DISCUSSION

Both persistency of milk production and return over feed cost, figures 1 and 2 and Table 7, were greater when high levels of concentrate were fed with Coastal hay in trials 1 and 2 and with Coastal hay plus corn silage in Trial 2. These results suggest an economic advantage for the higher levels of concentrate with Coastal hay during both short and long term feeding periods. In contrast, there was no economic advantage in feeding the high rate of concentrate with good quality corn silage.

Persistency of milk production in Trial 3, Figure 3, and return over feed cost, Table 7, reacted in reverse order to the level of concentrate fed. These data show that supplementing Coastal hay with corn silage and the intermediate concentrate level is more desirable than supplementing with the high concentrate level.

In Trial 4 persistency of cows fed Coastal hay supplemented with pelleted alfalfa and the intermediate concentrate level was nearly equal to that of cows which consumed the same Coastal hay and 6.4 pounds more concentrate (high level) per cow daily, Figure 4. However, return over feed cost for the Coastal-high concentrate ration was superior to that for the Coastal-alfalfa ration.

Among the Coastal hay-concentrate rations fed in Trial 1, levels of milk production ($r = .992$), body weight changes ($r = .993$), and solids-not-fat contents of milk ($r = .998$) were cor-

related significantly with levels of concentrate consumed. Within trials 2, 3, and 4 the relationships were evaluated across forage treatments. Although certain of the correlation coefficients obtained for performance criteria were significant, relationships among the same criteria in the different experiments were inconsistent. These results indicate that, among these rations, differences in level of concentrate consumed had no consistent effect on performance and suggest that differences in nutrient intake from concentrate were offset by consumption of forage, forage quality, or by variation in cow response.

The large quantity of concentrate refused by a few cows without apparent reason suggests that the daily amounts fed exceeded their appetites for concentrate when Coastal hay was fed ad libitum.

Based on actual intake of concentrate and on estimated hay intake, Appendix Table 1, the calculated protein intake from all Coastal hay rations was adequate to support the initial levels of milk production. Insufficient energy intake may have been a factor limiting milk production of high producing cows, especially those fed the Coastal 1:3.0 rations (trials 1 and 2). However, since cows on all rations in all trials gained in body weight, energy intake appeared to exceed that utilized for maintenance and milk production.

Although favorable results were obtained for the feeding of high compared to low levels of concentrate with Coastal hay, it is important to observe results during the extended feeding trials. In these extended periods, normal milk production persistency was attained only by cows fed the silage-low concentrate ration during trials 2 and 3 and by cows fed the Coastal-silage-intermediate concentrate ration during Trial 3, figures 2, 3, and 4. While persistency on the Coastal-high concentrate and on the corn silage-low concentrate rations fed during Trial 1 appear to exceed normal, the persistency curves shown in Figure 1 more accurately compare performance among rations. Because the experimental design followed in Trial 1 was distinctly different from the others, a direct comparison is not valid.

The low persistency of cows fed the silage ration in Trial 4, Figure 4, may be accounted for in part by the fact that the corn was infested with dwarf mozaic virus. Crude protein and digestible protein of this silage were low, tables 5 and 6. In addition, the silage was coarsely chopped and the cows were observed to

be more selective when eating this than the other silages. However, in all trials return over feed cost was highest for the corn silage-low concentrate rations.

Differences in return per cow per day over feed cost among the rations fed may seem small, Table 7. Nevertheless, any economic advantage is accumulative with days and with cow numbers. It is important to note that feeding periods of this kind usually occur during the milk base-building period. Therefore, cow performance has considerable economic impact not only during such feeding periods but throughout the ensuing year. Also, because feed cost, milk prices, and cow responses are variable, economic appraisal requires the use of current values.

SUMMARY

A series of feeding trials was carried out to evaluate extra concentrates, corn silage, and pelleted alfalfa hay as supplements to Coastal bermudagrass hay using lactating grade Holstein cows as test animals.

In these trials, persistency of milk production and return over feed cost by cows fed Coastal hay supplemented with the highest level of concentrates always were greater than by cows fed Coastal and lower levels of concentrates. Also, in two of four trials the persistency of production on the Coastal hay-high concentrate rations was equal to that of cows fed corn silage and the lower level of concentrates. The combination of either Coastal hay and corn silage or Coastal hay and pelleted alfalfa supplemented with the intermediate level of concentrates gave good cow performance. These combinations resulted in milk production persistencies similar to that obtained with the corn silage-low concentrate rations and superior or equal to that of the Coastal hay-high concentrate rations. Return over feed cost was highest for the corn silage-low concentrate control ration in all trials. Supplementing Coastal hay with corn silage and feeding with an intermediate level of concentrates gave a higher return over feed costs than the Coastal hay-high concentrate rations. Supplementing Coastal hay with pelleted alfalfa did not increase returns above feed costs.

Milk fat per cent and weight gains were similar among rations within trials.

Concentrate refusals by higher-producing cows fed the high rate of concentrates suggested that the amounts fed exceeded the cows' appetites for concentrate.

These trials indicate that some Coastal bermudagrass may be used successfully in rations of lactating dairy cows provided energy and other nutrient intakes are maintained at a high level through supplementation with extra concentrates and other high quality feeds.

ACKNOWLEDGMENT

Hoyt E. Burgess, former Assistant Superintendent of the Piedmont Substation, assisted with these studies. J. H. Blackstone, Department of Agricultural Economics and Rural Sociology, provided the hay and silage cost data used. His counsel concerning cost and return values was most helpful.

LITERATURE CITED

(1) Association of Official Agricultural Chemists. 1965. Official Methods of Analysis. 10th ed. AOAC. Washington, D.C.

(2) Brody, S. Bioenergetics and Growth. 1945. Reinhold Pub. Co. New York, N.Y.

(3) Brooks, O. L., W. J. Miller, R. E. Beaty, and C. M. Clifton. 1962. Performance of Dairy Cows Fed Pelleted and Baled Coastal Bermudagrass and Alfalfa Hay. J. Dairy Sci. 45:1188.

(4) Clifton, C. M., W. J. Miller, and N. Cameron. 1963. Coastal Bermudagrass Hay and Silage at Two Stages of Maturity, Fed with Two Concentrate Levels to Lactating Cows. J. Dairy Sci. 46:959.

(5) Gaines, W. L. 1928. The Energy Basis of Measuring Milk Yield in Dairy Cows. Ill. Agr. Exp. Sta. Bull. 308.

(6) Hawkins, G. E. 1958. Coastal Bermudagrass vs. Alfalfa Hay as a Dairy Feed. Highlights of Agr. Res. Vol. 4, No. 4. Auburn Univ. (Ala.) Agr. Exp. Sta.

(7) ———, Gary E. Parr, and Joe A. Little. 1964. Composition, Intake, Digestibility, and Prediction of Digestibility of Coastal Bermudagrass Hays. J. Dairy Sci. 47:865.

(8) ——— and J. A. Little. 1970. Some Relationships between Chemical Composition and Nutritive Value of Coastal Bermudagrass Hays for Dairy Cows. Auburn Univ. (Ala.) Agr. Exp. Sta. Bull. 405.

(9) Huffman, C. F. 1961. High-Level Grain Feeding for Dairy Cows. J. Dairy Sci. 44:2113.

(10) King, W. A., C. C. Brannon, and H. J. Webb. 1961. Comparison of Coastal Bermuda, Common Bermuda, and Oat Hays with Alfalfa Hays for Milking Cows. S.C. Agr. Exp. Sta. Bull. 490.

(11) Morrison, F. B. 1956. Feeds and Feeding. 22nd ed. Morrison Pub. Co. Ithaca, N.Y.

(12) Smith, Verle R. 1959. Physiology of Lactation. 5th ed. The Iowa State College Press. Ames, Iowa.

APPENDIX

Formula and Assumptions Used for Estimating Mean Forage Intake Per Cow

$$\text{Forage intake (lb.)} = \frac{\text{total ENE required daily} - \text{ENE consumed from concentrate}}{\text{ENE content of forage}}$$

where: ENE = estimated net energy; total ENE required daily = sum of ENE required for maintenance (using upper limit of Morrison's *(11)* standard for mean body weight), mean daily FCM (lb.) x .333 therms per pound, and weight gain (lb.) x .909 therms per pound *(2)*; ENE consumed from concentrate = concentrate consumed daily (lb.) x .75 therms per pound of dry matter; and ENE content of the respective forages was computed from chemical composition data by the formula used in the Alabama forage testing program *(7)*. It was assumed that cows having access to both silage and hay consumed equal amounts of dry matter from each.

Prices Used to Calculate Relative Feed Cost Per Hundredweight of FCM and Return Per Cow Per Day Over Feed Cost by Ration

Coastal hay	$30 per ton[1]
Corn silage	$10 per ton[1]
Pelleted alfalfa	$55 per ton[2]
Concentrate mixture	$75 per ton[3]
FCM	$ 7 per hundredweight

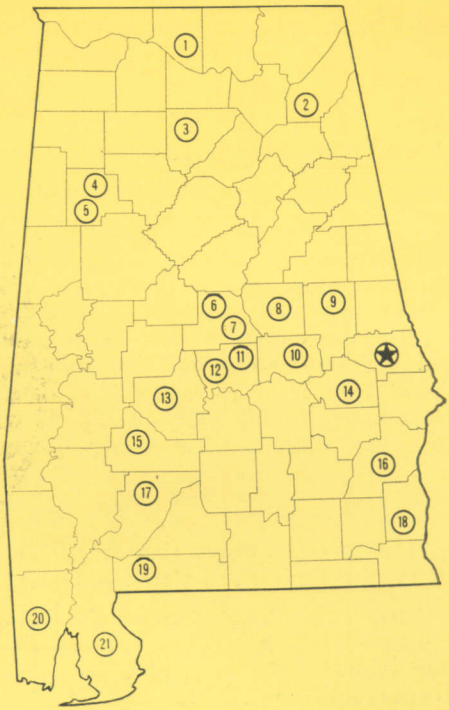
[1] Values arrived at in cost studies over several years by Department of Agricultural Economics and Rural Sociology.

[2] Purchase price.

[3] Ingredient cost plus charges for grinding and mixing.

AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.