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DRY vs. SUCCULENT ROUGHAGE IN THE DAIRY RATION

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Dry roughage rations were compared with those containing both dry and succulent roughages during four feeding trials with dairy cows. Timothy hay replaced corn silage in two trials and dehydrated silage replaced normal silage in two. Drinking water was kept constantly before the cows.

No significant advantage pertained to either ration. The similarity of the results secured indicates that dairy cows having free access to drinking water at all times secure enough water whether fed a succulent or a non-succulent ration, making little or no more milk on one than on the other.

The cows under trial, averaging to yield 38 pounds of four percent milk equivalent, drank about 113 pounds of water daily. Adequate amounts should always be supplied, but there seem to be little gained by furnishing any in the form of a succulent roughage.

The value of a feed is measured by its digestible nutrient content and not by its water content.

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By O. M. Camburn, H. B. Ellenberger, J. A. Newlander and C. H. Jones

Introduction

Has silage been properly evaluated for the dairy cow?

The inclusion of a succulent roughage, usually corn silage, in the ration has long been held to be desirable if not, indeed, essential. Dairy farmers generally have accepted this teaching. However, in some sections and on some soils corn does poorly while hay does well. This raises the question: Can milk be produced efficiently if no succulent feed is available, provided quality hays and plenty of water are supplied?

Investigators are not agreed as to the need of including silage in the dairy ration. Bartlett (1) held in 1889 that "it is the digestible dry matter of a food that determines its value. It has been demonstrated repeatedly that carefully dried grass is as digestible after as before drying, and the same of fodder corn dried and as ensilage. Dryness is therefore no disadvantage in this respect."

Hills (2) fed in 1901 a basal ration of hay and mixed grain including or omitting silage in alternating periods and found that "almost without exception a change from silage to hay was accompanied by shrinkage and a change from hay to silage by increase in the milk flow. In a few cases no change occurred. In no case was the reverse effect obtained."

Clark (3), feeding in 1910 a basal ration of grain, clover and alfalfa, with and without corn silage, obtained as much milk and fat in one case as in the other, but slightly larger gains in live weight when silage was fed.

Foster and Meeks (4), after comparing corn silage and alfalfa hay in 1920, stated that "the results of these tests are not in accord with the common belief in regard to corn silage, since they do not show that it either lowered the cost of the ration or of the production. Neither is there any evidence that the addition of silage to a ration of alfalfa hay, on account of its succulence, increases the milk flow or keeps the cows in a more healthy condition."

Carroll (5), in trials in 1914-16, obtained "a slightly higher milk and butterfat production on the silage ration than on the ration composed only of hay and grain." He doubts the significance of the result.

Fairchild and Wilbur (6) in 1925 reported data which indicated "very decidedly the value of silage in the dairy ration. Milk production decreased markedly, when a ration without silage was fed. When silage was fed, however, milk production was practically maintained. . . . (The) cows which received silage maintained body weight much better than those which were fed no silage."

Converse (7), having fed nine cows in 1925 alternately rations of alfalfa hay and grain and of alfalfa hay, grain and corn silage, concluded that "the factor of silage succulence does not increase the value of a ration containing an ample quantity of good alfalfa hay and a satisfactory grain mixture."

White and Johnson (8) in 1934 held that "adding silage to the ration of cows receiving water once a day . . . . result(ed) in a better yield . . . . (which) did not equal that secured from a no-silage group which had free access to water." They believe that if "an abundance of leafy forage (is supplied) . . . . a farmer need not go to unusual expense or trouble to provide (cows) with a succulent feed if (they) have free access to water."

In the light of such conflicting results one may well feel that the quality of the hay fed and the freedom with which water was supplied may have affected the outcome more than did the use of a succulent roughage, especially in view of the fact that in most of these trials no attempt seems to have been made to regulate or determine the water intakes of the cows.

Four Feeding Trials

Four trials were conducted during two years, the reversal method being used twice and the continuous method twice.[1] The basic roughage ration in each trial consisted of hay and corn silage. The grain rations carried about 16 percent protein. Silage was fed at the rate of three pounds daily per 100 pounds of live weight, being replaced, for comparison, by timothy hay or artificially dried corn silage in amounts which furnished approximately the same quantity of total digestible nutrients as were contained in the silage.

Each cow had constant access to fresh water, each drinking bowl being equipped with a supply tank at a higher level into which water was weighed four times daily. Thus, the total water intake of each cow derived from both food and drink was accurately determined.

[1] The reversal method has its faults—as does, also, the continuous method. The cow is a creature of habit and does not relish frequent and radical changes in her rations, such as took place in these trials when reversals occurred. This appeared to react to the disadvantage of the dry roughage.

The cows used were "paired off" in respect to age, breed, and previous milk yield records as closely as might be, were weighed each day, milked thrice daily, each milking being weighed and sampled, weekly composites being analyzed.

The hays and silages were thoroughly mixed each day and allowances for each cow weighed out daily. Three-hundred-gram samples were taken daily and composited weekly for analysis. Concentrates were thoroughly mixed and composite samples were taken for analysis. The Henry and Morrison digestion coefficients were used, except that those determined by Newlander (10) for normal and dried silages were used for these roughages.

Comparisons were made of milk, total solids and fat yields, but the efficiency of production was measured by the amounts of total digestible nutrients eaten per 100 pounds of four percent milk equivalent.[1]

The following statement sets forth the salient features of the set-up of the four trials, I and II comparing timothy hay with silage, III and IV comparing normal with dehydrated silage.

I. Fifty-six days, two 21-day periods; reversal system; eight registered Ayrshires and Holsteins in two groups of four each; daily roughage allotments, clover hay one pound per 100 pounds live weight and either three pounds silage per 100 pounds live weight or enough timothy hay to furnish approximately the same amount of total digestible nutrients as was present in the silage.

II. Ninety-eight days continuous feeding; 10 registered Ayrshires, Guernseys and Holsteins, in two groups of five each; daily roughage allotments, one-half pound alfalfa hay and one-half pound timothy hay per 100 pounds live weight; to each of five cows three pounds of silage per 100 pounds of live weight and to each of five cows enough timothy hay to furnish approximately the same amount of total digestible nutrients as was present in the silage.

III. Fifty-six days, two 21-day periods; reversal system; seven registered Holsteins and one registered Ayrshire, in two groups of four each; daily roughage allotments, mixed hay one pound per 100 pounds live weight and either three pounds silage per 100 pounds live weight or enough artificially dried silage to furnish approximately the same amount of total digestible nutrients as was present in the silage.

IV. Two hundred and ten days' continuous feeding, two Ayrshires and two Jerseys in two groups of two each; daily roughage allotments,

[1] Overman and Gaines (9) state that "one way of expressing milk energy is in terms of four percent milk by the formula, 4 percent milk = 0.4 M + 15 F, where M is milk and F is fat, all in the same unit of weight."

one-half pound mixed hay and one-half pound alfalfa hay per 100 pounds of live weight and either three pounds of silage per 100 pounds of live weight or enough artificially dried silage to furnish approximately the same amount of total digestible nutrients as was present in the silage.

During trials I and III a commercial 16 percent protein grain ration was used; during trials II and IV a mixture consisting of corn meal six parts by weight, ground oats three, wheat bran two, gluten feed two, linseed and cottonseed meals one each, one percent salt, and carrying about 16 percent protein. Enough concentrates were fed in conjunction with roughages to supply each cow with the digestible nutrients indicated by the Haecker standard, thus insuring an ample supply of digestible protein.

The following tables show

1. Cows used.
2. Food consumption.
3. Nutrient consumption; production; weight changes; production efficiency.
4. Water intakes.

TABLE 1.—COWS

Groups					Groups			
No.	Breed	Age Yr. Mo.	Calved		No.	Breed	Age Yr. Mo.	Calved
Trial I, reversal system—42 days—silage vs. timothy hay								
112.....	H	4- 5	10/ 4/33		136.....	H	2- 9	10/28/33
102.....	A	4-11	8/ 1/33		92.....	A	4- 9	10/ 5/33
142.....	A	2- 6	12/19/33		141.....	A	2- 6	12/14/33
143.....	A	2- 6	12/28/33		146.....	A	2- 6	1/22/34
Trial III, reversal system—42 days—silage vs. dried silage								
113.....	H	3- 5	10/ 9/33		115.....	H	3- 5	11/10/33
137.....	H	2- 5	11/ 1/33		128.....	H	2- 9	9/19/33
135.....	H	2- 6	10/28/33		138.....	H	2- 7	11/ 7/33
106.....	H	4- 5	10/ 9/33		83.....	A	6	9/19/33
Trial II, continuous feeding—98 days—silage vs. timothy hay								
94.....	H	6- 1	11/16/34		112.....	H	5- 1	12/21/34
155.....	H	2- 9	9/24/34		151.....	H	2- 5	9/16/34
116.....	A	4	12/19/34		83.....	A	6- 7	11/ 4/34
141.....	A	3- 2	12/25/34		143.....	A	3- 1	12/ 8/34
139.....	G	3	11/27/34		129.....	G	3- 8	10/22/34
Trial IV, continuous feeding—210 days—silage vs. dried silage								
102.....	A	5- 5	8/22/34		92.....	A	5- 3	9/14/34
134.....	J	3	10/18/34		126.....	J	3-11	9/ 4/34

TABLE 2.—POUNDS FEED CONSUMED

	Non-succulent rations				Succulent rations			
	Clover hay	Timothy hay+*		Concentrates	Clover hay		Silage	Concentrates
Trial I: 8 cows, reversal, 21-day periods	1,584	1,583		2,299	1,716		5,201	2,415
	Mixed hay		Dried silage	Concentrates	Mixed hay		Silage	Concentrates
Trial III: 8 cows, reversal, 21-day periods	1,709		1,575	2,642	1,649		5,212	2,587
	Alfalfa hay	Timothy hay	Timothy hay+*	Concentrates	Alfalfa hay	Timothy hay	Silage	Concentrates
Trial II: 10 cows, continuous, 98 days	2,601	2,600	5,489	8,119	2,744	2,744	16,364	8,367
	Alfalfa hay	Mixed hay	Dried silage	Concentrates	Alfalfa hay	Mixed hay	Silage	Concentrates
Trial IV: 4 cows, continuous, 210 days	1,819	2,327	4,173	4,860	1,817	2,496	12,944	4,863

* Timothy + indicates weights of timothy hay fed to furnish total nutrient equivalent of the silage fed to the competing group.

TABLE 3.—NUTRIENT CONSUMPTION, PRODUCTION, WEIGHT CHANGES AND PRODUCTION EFFICIENCIES, POUNDS

	Production							
	Total digestible nutrients consumed	Milk	Total solids	Fat	Percent	4 percent milk equivalent	Weight changes	Total digestible nutrients consumed per 100 pounds of 4 percent milk equivalent
Trial I: 8 cows, reversal, 21-day periods, dry ± wet*								
Non-succulent	3,110	5,268	678	205	3.89	5,182	+4	60.02
Succulent	3,267	5,841	753	225	3.86	5,711	+17	57.21
Pounds	—157	—573	—75	—20		—529		+2.81
Percent	—4.8	—9.8	—10	— 8.9		—9.3		+4.9
Trial III: 8 cows, reversal, 21-day periods, dry ± wet*								
Non-succulent	3,361	6,480	789	220	3.39	5,892	+27	57.04
Succulent	3,329	6,713	819	229	3.41	6,120	+12	54.40
Pounds	+32	—233	—30	—9		—228		+2.64
Percent	+1	—3.5	—3.7	—3.9		—3.7		+4.9
Trial II: 10 cows, continuous, 98 days, dry ± wet*								
Non-succulent	10,961	23,276	2,969	865	3.72	22,285	+2	49.19
Succulent	11,299	24,096	3,071	882	3.66	22,868	+25	49.41
Pounds	—338	—820	—102	—17		—573		—0.22
Percent	—3	—3.4	—3.3	—1.9		—2.5		—0.4
Trial IV: 4 cows, continuous, 210 days, dry ± wet*								
Non-succulent	7,548	11,525	1,693	586	5.08	13,400	—4	56.33
Succulent	7,766	12,095	1,703	565	4.67	13,313	+45	58.33
Pounds	—218	—570	—10	+21		+87		—2.
Percent	—2.8	—4.7	—0.6	+3.7		+0.6		—3.4

* Variations of the non-succulent group from the succulent group expressed as ± (over or under).

TABLE 4.—WATER INTAKES, POUNDS

Trila	Cow No.	Water drunk	Non-succulent: Water in: Clover hay	Timothy hay	Timothy hay+*	Concentrates	Total water intake	Dry matter consumed: Total	Dry matter consumed: Digestible	Water intake per pound dry matter: Total	Water intake per pound dry matter: Digestible
I	112	2,997	27		36	43	3,113	738	472	4.22	6.60
	102	2,648	31		30	35	2,744	606	387	4.53	7.09
	142	2,415	24		23	40	2,502	556	365	4.50	6.85
	143	2,118	25		24	33	2,200	527	340	4.17	6.47
	136	2,178	20		19	31	2,248	503	328	4.47	6.85
	92	2,724	32		30	35	2,821	684	438	4.12	6.44
	141	2,832	26		25	41	2,924	660	432	4.43	6.76
	146	2,038	22		20	26	2,106	484	312	4.35	6.75
		19,950	217		207	284	20,658	4,758	3,074	4.34	6.72
			Mixed hay		Dried silage						
III	113	2,521	33		62	48	2,664	695	474	3.83	5.62
	137	2,525	30		57	38	2,650	589	399	4.50	6.64
	135	2,074	29		55	33	2,191	543	366	4.03	5.99
	106	2,766	30		57	47	2,900	662	453	4.38	6.40
	115	2,372	28		54	45	2,499	676	463	3.70	5.40
	128	2,766	29		49	37	2,881	602	408	4.79	7.06
	138	2,182	27		47	29	2,285	531	356	4.30	6.42
	83	2,724	32		59	35	2,850	639	429	4.46	6.64
		19,930	238		440	312	20,920	4,937	3,348	4.24	6.25
			Alfalfa hay	Timothy hay	Timothy hay+*						
II	94	17,338	106	100	216	240	18,000	4,080	2,736	4.41	6.58
	155	12,830	93	88	186	151	13,348	3,095	2,019	4.31	6.61
	116	13,243	82	76	159	195	13,755	3,210	2,159	4.29	6.37
	141	15,183	79	74	163	211	15,710	3,397	2,286	4.62	6.87
	139	10,286	69	66	144	139	10,704	2,528	1,678	4.23	6.38
		68,880	429	404	868	936	71,517	16,310	10,878	4.38	6.57
				Mixed hay	Dried silage						
IV	102	26,251	149	173	674	283	27,530	5,458	3,765	5.04	7.31
	134	18,771	154	144	631	296	19,996	5,245	3,645	3.81	5.49
		45,022	303	317	1,305	579	47,526	10,703	7,410	4.44	6.41

* Timothy + indicates water in timothy hay displacing silage.

TABLE 4.—WATER INTAKES, POUNDS—*concluded.*

Trial	Cow No.	Water drunk	Succulent: Water in: Clover hay	Succulent: Water in: Alfalfa hay	Succulent: Water in: Timothy hay	Succulent: Water in: Mixed hay	Succulent: Water in: Silage	Succulent: Water in: Concentrates	Total water intake	Dry matter consumed: Total	Dry matter consumed: Digestible	Water intake per pound dry matter: Total	Water intake per pound dry matter: Digestible
I	136	2,225	33				542	43	2,843	626	425	4.54	6.69
	92	2,137	34				575	41	2,787	641	433	4.35	6.44
	141	2,202	28				477	48	2,755	621	427	4.44	6.45
	146	2,011	30				493	42	2,576	598	407	4.31	6.33
	112	2,293	35				610	33	2,971	670	449	4.43	6.62
	102	2,306	30				529	29	2,894	583	391	4.96	7.40
	142	2,054	22				385	33	2,494	514	351	4.85	7.11
	143	1,812	24				417	31	2,284	522	354	4.38	6.45
		17,040	236				4,028	300	21,604	4,775	3,237	4.52	6.67
III	115	2,031	35				564	45	2,675	690	468	3.88	5.72
	128	2,175	30				493	40	2,738	611	415	4.48	6.60
	138	1,478	29				468	31	2,006	528	355	3.80	5.65
	83	2,206	30				592	40	2,868	638	433	4.50	6.62
	113	2,384	29				529	45	2,987	682	465	4.38	6.42
	137	2,168	25				464	33	2,690	555	376	4.85	7.15
	135	1,863	24				441	27	2,355	502	338	4.69	6.97
	106	2,564	28				481	45	3,118	675	463	4.62	6.73
		16,869	230				4,032	306	21,437	4,881	3,313	4.39	6.47
II	112	14,429		108	101		2,964	231	17,833	3,839	2,677	4.65	6.66
	151	13,400		95	90		2,563	143	16,291	2,916	1,999	5.59	8.15
	83	13,925		98	93		2,654	227	16,997	3,604	2,539	4.72	6.69
	143	11,484		78	73		2,136	223	13,994	3,191	2,274	4.39	6.15
	129	7,518		76	73		2,058	130	9,855	2,463	1,698	4.	5.80
		60,756		455	430		12,375	954	74,970	16,013	11,187	4.68	6.70
IV	92	19,664		156	196		5,434	323	25,773	6,107	4,236	4.22	6.08
	126	14,071		143	148		4,453	261	19,076	4,915	3,405	3.88	5.60
		33,735		299	344		9,887	584	44,849	11,022	7,641	4.07	5.87

Consumption and production data for individual cows are in hand but are not included in the tabular matter. Suffice it to say that in trial I (eight cows, reversal system, two 21-day periods), every cow produced more when fed silage than when it was omitted from the ration. Each of the four cows in group I ate about the same amount of total digestible nutrients whether fed the one or the other ration and made about three percent more milk when silage was fed; but with a fair degree of unanimity each of the four in group II ate about one-eighth more total digestible nutrients and made about one-fifth more milk when silage was fed than when it was not. The production efficiency records of the individual cows almost without exception indicate that silage outclassed timothy hay, the average difference being 4.8 percent.

In trial III (eight cows, reversal system, two 21-day periods), three of the four cows in group I made a little less milk and ate somewhat less total digestible nutrients when normal silage was fed than when dried silage was fed, and one made and ate more. All four in group II made more and ate somewhat more when fed normal instead of dried silage. Almost without exception production efficiency favored normal silage by about 5 percent.

In trial II (10 cows, continuous feeding, 98 days), comparing the cows which were "matched" one with another, three silage-fed cows made more milk than did the dry fed and two made less. In four cases out of five total digestible nutrient intakes were closely alike and in one very dissimilar. In the latter rase both food sonsumption and milk production on silage were about one-eighth greater than that on the dry ration. In three comparisons the cows fed silage produced milk more economically and in two the reverse situation obtained, averaging 1.7 percent in favor of the dry ration.

In trial IV (four cows, continuous feeding, 210 days), comparing the cows which were "matched" one with another, the normal silage-fed Ayrshire ate more and made more than did the Ayrshire fed dried silage but the normal silage-fed Jersey ate less and made less than did the Jersey fed dried silage. The production efficiencies of the two Ayrshires were closely alike, but that of the dried-silage-fed Jersey was much greater than that of the normal silage-fed Jersey, the average difference being 3.5 percent in favor of the dry-fed group.

Calculating production efficiency by groups rather than by individual cows, it took, in the two reversal trials, more total digestible nutrients (4.9 percent, 4.9 percent) to make a pound of four percent milk equivalent when the dry ration replaced the succulent ration. The reverse was

true to the extent of 0.4 and 3.4 percents in the two trials wherein continuous feeding was practiced. As previously stated, the reversal method is not well adapted to trials of this nature. The average of the four trials, giving to each equal values, slightly (1.5 percent) favors the succulent ration, a gain so small as to be without significance.

Live Weights.—The average gains per cow were infinitesimal in three instances when the non-succulent ration was fed (+4, +2, −4 pounds); in one case the average gain was 27 pounds. They were larger when the succulent ration was fed (17, 12, 25, 46 pounds).

Water Usage.—The average individual water usages per day for the 30 cows were as shown below. The average live weights per cow were 1,050 and 1,062 pounds.[1]

	Non-succulent ration	Succulent ration
	lbs.	lbs.
Milk yield (4 percent)	37.5	38.5
Water drunk	123.4	103.
Total water intake	128.9	130.7
Water drunk per pound, 4 percent milk	3.29	2.67
Water intake per pound, 4 percent milk	3.44	3.39

Total daily water intakes per cow and per pound of four percent milk equivalent were substantially the same on each ration but when on dry feed the cows drank 123 pounds of water per day as compared to 103 pounds when getting silage. This high water requirement of the milking cow should always be supplied.

A condensed summary of the four trials on a daily basis per cow is presented in the following table. The last two lines show the arithmetic average of the four trials. When fed dry roughage the cows averaged to gain 0.37 pound in live weight each day as compared to 0.46 pound when fed an allowance of succulent corn silage, but in the latter case the cows averaged to ingest daily 0.48 pound more of total digestible nutrients. The average daily production per cow from dry roughage was 35.82 pounds of four percent milk equivalent as compared to 37.20 pounds when succulent roughage made up a part of the ration. This was done respectively at a nutrient usage of 0.556 and 0.548 pound of digestible nutrients per pound of four percent milk equivalent.

These differences are well within the limits of experimental error and are without significance.

[1] Half way between initial and final weights.

Trial number		Total digestible nutrient intake	Production of four percent milk equivalent	Total digestible nutrient usage per *pound* of milk	Gain or loss in live weight
		lbs.	lbs.	lbs.	lbs.
I	Dry	18.51	30.85	0.600	+0.19
	Succulent	19.45	34.04	0.572	+0.81
II	Dry	22.37	45.49	0.492	+0.02
	Succulent	23.06	46.67	0.494	+0.26
III	Dry	20.01	35.03	0.570	+1.29
	Succulent	19.81	36.41	0.544	+0.57
IV	Dry	17.97	31.90	0.563	—0.02
	Succulent	18.49	31.70	0.583	+0.21
Average of four	Dry	19.72	35.82	0.556	+0.37
	Succulent	20.20	37.20	0.548	+0.46

CONCLUSIONS

The concordant results of four trials indicate that milking cows, having free access to water, get enough whether fed non-succulent or succulent rations and that the latter are very slightly, if at all, more efficient than the former for milk production. On farms where the corn crop does not do well but plenty of good quality hay is produced, dairy cows should yield as much milk as they do when silage is available, provided they get all the water they need. This should always be supplied. However, it need not be supplied in the form of a succulent roughage. The value of a feed is primarily determined by its digestible nutrient content. Undue expense in providing a succulent roughage seems unnecessary. However, silage provides variety, is a satisfactory, and on some farms an economical, roughage.

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