Bulletin 524
March 1971

Supplementing Corn Silage For Dairy Cattle

D. L. Thacker
R. H. Ross

Idaho Agricultural Experiment Station

UNIVERSITY OF IDAHO
College of Agriculture

This Bulletin in Brief

Corn silage plus 10 pounds of urea per ton, supplemented with a 12% grain ration and properly balanced calcium and phosphorus, maintained milk production of Holstein cows at the same levels as rations that obtained additional protein from alfalfa hay or soybean oil meal.

A 3-year study, including 3 winter trials and 2 summer trials, compared performances of 82 Holstein cows on roughage rations. Rations included (1) alfalfa hay alone; (2) corn silage plus alfalfa hay; (3) corn silage plus 10 pounds of urea per ton; and (4) pasture. Soybean oil meal was added to treatment 3 in 4 of the 5 trials. All cows except those on pasture were individually fed the roughage ration in amounts sufficient to maintain about 10% weighback. All cows also were fed 1 pound of supplemental grain ration per 4 pounds of 4% FCM.

No significant differences were found in milk production from cows on any treatment. Feed costs per day and feed costs per 100 pounds of 4% FCM were significantly higher for rations in which excess protein (soybean oil meal)was supplemented.

The Authors

Both authors of this bulletin are faculty members in the College of Agriculture Department of Animal Industries. D. L. Thacker is assistant research professor of dairy science, headquartered at the Caldwell Branch Agricultural Experiment Station. R. H. Ross is professor and dairy scientist at the campus in Moscow.

AGRICULTURAL EXPERIMENT STATION

University of Idaho
Moscow, Idaho

College of Agriculture
2.5M LT 3-71

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D. L. Thacker and R. H. Ross

Corn silage has been generally accepted for dairy cows because of its unexcelled energy yield per acre, its high digestibility, and its adaptability to mechanized harvesting and handling. Corn silage can be made with relative ease and without undue nutrient loss in harvesting or storage. The greatest value of corn silage for dairy cows is in furnishing energy. It also aids in balancing the calcium and phosphorus contents of a ration so that both minerals are more available to the dairy cow.

Corn silage is low in protein and calcium, however, and when corn silage replaces more than half of the alfalfa in the ration these food nutrients must be supplemented. The feedstuffs that are readily available in Idaho for supplementing corn silage are alfalfa hay, urea, protein meals, calcium-phosphate mineral mixtures, lime, and trace mineralized salt. High-producing dairy cattle demand the efficiency of a completely balanced ration. This feeding trial was designed to test the effects on milk production of adding protein and minerals to dairy rations containing corn silage as the sole roughage.

What Others Have Done

Corn silage has often been compared with alfalfa hay and with combinations of hay and corn silage (1, 2, 3, 4, 9, 10, 11). In these studies, consumption of dry matter decreased as the amount of corn silage was increased in the ration. Milk production was not significantly affected, although actual production usually increased slightly as corn silage was increased in the ration.

Energy content of corn silage varies with the stage of maturity of the corn plant. As the plant matures, energy content of the silage increases because of the increased ratio of grain to fodder. Digestibility decreases somewhat with maturity and dairy cows tend to consume more dry matter. This results in an overall increase in the total daily amount of energy that the cows consume (5, 7, 8).

Standard procedure now is to feed corn silage with at least a 16% protein equivalent concentrate mixture. This does not take care of

the protein needs of the cow late in her gestation or dry period when grain feeding is reduced for economic reasons. Urea and other non-protein nitrogen products can also be used to meet the protein needs of the dairy cow. Most desirable rate of urea is 10 pounds per ton added at ensiling or feeding time, according to a review by Coppock and Stone (6). Urea at this rate increases the protein equivalent of corn silage about 2%, yet does not reduce palatability of the silage for dairy cows.

Hemken and Vandersall (7) found that cows on an all-corn silage roughage program produced milk at levels equal to or slightly higher than cows on half alfalfa hay and half corn silage. An 18% protein mixture was fed with the all-corn silage ration in this trial. Cows receiving the alfalfa hay-corn silage roughage were fed a 12% protein grain mixture. The cows on the all-corn silage forage did not increase milk production when fed grain at rates more than 110% of Morrison's feeding standards. In fact, production dropped slightly with each increase above the 110% level.

Thus, other research indicates that when corn silage is the sole roughage in the ration, dairy cows need supplements to meet their nutrient requirements. The kind and amount of supplement may vary with each particular area.

This study of corn silage supplementation was initiated at the Caldwell Branch Experiment Station to help develop a simpler and more economical feeding program for the dairymen of Idaho.

The Caldwell Study

First year: 18 Holstein cows 90 days or more in lactation were paired as closely as possible for level of production, size, and age, and then were assigned randomly to one of three forage treatments. The crossover design of the experiment placed each group on each treatment for 28 days and allowed one week between treatments for the cows to adjust to the new rations.

Forage treatments (Table 1) were: (1) corn silage supplemented with 10 pounds of urea at time of ensiling, 3 pounds of soybean oil meal, and 10 grams of a calcium-sulfur mixture; (2) corn silage and alfalfa hay fed at the ratio of 3 parts corn silage to 1 part hay, on an as-fed basis; (3) alfalfa hay alone. All cows were fed individually and forages were fed at rates to maintain about 10% weighback. All three groups received trace mineralized salt and monocalcium phosphate free choice and in the feed at rates of 0.01% of the corn silage and 0.02% of the alfalfa hay.

All cows were fed 1 pound of grain per 4 pounds of 4% fat-corrected milk (FMC), based upon their production during the week between treatments. The ground grain mixture contained equal parts barley, wheat, and dried molasses beet pulp. One pound of grain was fed at each milking and the rest was fed with the roughage.

The cows were fed three times a day and received approximately a third of the daily ration at each feeding. Amount of feed offered, feed consumed, and pounds of milk produced were recorded daily.

Table 1. Feeding schedule for Holstein cows on winter and summer rations during three years of tests.

Year and forage ration	Soybean oil meal	Urea	Minerals*
	(lb./cow/day)	(lb./ton)	
First year (1966-67)			
Winter			
Alfalfa hay	0	0	
Corn silage	3	10**	lime, sulfur
3:1 corn silage and alfalfa hay	0	0	
Summer			
Orchard grass-alfalfa pasture	0	0	
Corn silage	2.2	10***	lime, sulfur
Second year (1967-68)			
Winter			
3:1 corn silage and alfalfa hay	0	0	
Corn silage	1	10**	lime
Summer			
Orchard grass-alfalfa pasture	0	0	
Corn silage	2	10***	lime
Third year (1968-69)			
Winter			
3:1 corn silage and alfalfa hay	0	0	
Corn silage	0	10**	lime

* All groups were also provided trace mineral salt and monocalcium-phosphate.

** Urea added to silage at time of ensiling.

*** Urea added at time of feeding.

Milk was tested biweekly for butterfat, solids-not-fat (SNF), and mastitis. The cows were weighed at the beginning and end of each feeding period.

The corn silage used in this trial was all harvested from the same fields. The regular corn silage was stored in a pit silo and the urea-treated silage was stored in an above-ground plastic silo. Each load of green chopped corn was weighed and 10 pounds of urea per ton were scattered across the load. At the time of ensiling, the corn had 64% moisture and was in the hard dent stage of maturity.

The chemical composition of feeds used in this study is listed in Table 2 and Table 3 shows the average values for these feeds in the Caldwell area.

Second year: 18 Holstein cows were divided into two treatments: (1) corn silage plus 10 pounds of urea per ton at the time of ensiling, plus 1 pound of soybean oil meal per cow per day; (2) corn silage and alfalfa hay fed in excess at the ratio of 3 parts corn silage to 1 part hay. The trial again followed a crossover design.

Table 2. Average chemical analysis of feedstuffs (percent) fed during the trials.

	Moisture	Fat	Crude Fiber	Crude protein	N.F.E.	Ash	Ca	P
1966-67								
Corn silage	64.0	0.6	6.8	2.1	24.5	2.0	0.21	0.17
Corn silage + urea	64.0	0.7	6.2	3.4	23.6	2.1	0.20	0.18
Alfalfa	6.0	0.9	25.2	16.9	34.6	16.2	3.60	0.56
Beet pulp	5.9	0.7	25.6	11.6	49.8	6.8	0.83	0.04
Barley	6.8	1.5	13.0	10.8	62.5	5.0	0.28	1.00
Wheat	8.1	1.5	2.5	11.8	74.4	1.2	0.20	0.92
Soybean meal	8.0	1.0	3.2	50.4	31.0	6.1	0.27	0.63
1967-68								
Corn silage	71.0	0.7	8.3	3.0	14.1	2.9	0.18	0.07
Corn silage + urea	61.0	0.7	6.8	2.3	27.4	1.8	0.11	0.09
Alfalfa	9.0	1.0	26.4	15.9	37.4	10.3	1.84	0.24
Beet pulp	9.7	0.4	14.5	12.3	56.9	6.2	0.52	0.12
Barley	8.9	0.9	5.9	14.9	66.6	2.8	0.24	0.48
Corn	9.3	2.6	2.6	9.4	74.4	1.6	0.59	0.56
1968-69								
Corn silage	67.0	0.7	7.3	2.6	20.2	2.3	0.12	0.08
Corn silage + urea	67.0	0.8	6.9	4.3	18.5	2.0	0.14	0.07
Alfalfa	11.6	1.2	25.3	16.6	39.2	6.2	1.93	0.29
Beet pulp	7.7	0.2	13.8	12.2	60.4	5.8	0.38	0.09
Barley	8.5	0.6	7.3	13.8	66.1	3.6	0.08	0.41
Corn	11.8	3.1	3.0	10.0	70.3	1.8	0.03	0.40

Table 3. Average costs of feeds and value of milk produced.

Feed	As fed	As dry matter (per lb.)
Hay (per ton)	$25.00	$0.015
Corn silage (per ton)	9.00	0.015
Corn silage + urea (per ton)	9.50	0.016
Grain (per ton)	60.00	0.030
Soybean oil meal (per lb.)	0.06	
Salt and mineral (per lb.)	0.049	
Lime and sulfur (per lb.)	0.018	
Pasture (per cow-day)	0.30	
4% Fat-corrected milk (cwt.)	$ 4.60	

The cows on treatment 1 received a mineral supplement of 10 grams calcium (lime) and both rations received the monocalcium phosphate and trace mineralized salt supplement (Table 1). The grain ration was changed to equal parts barley, corn, and dried beet pulp. Method of feeding and all other procedures were the same.

Third year: 16 Holstein cows were divided into two treatments in a crossover design trial: (1) corn silage plus 10 pounds of urea per ton at time of ensiling and 10 grams of calcium (lime) per day per cow; (2) corn silage plus alfalfa fed at a 3:1 ratio.

All cows were fed 1 pound of grain per 4 pounds of 4% FCM, based upon the week's production before the experiment started. Amount of grain fed was not changed during the experiment. No additional protein was added to either treatment. The grain ration, method of feeding, and all other procedures were the same as in the second year.

Summer trials: The summer trials both years were continuous feeding trials. The cows calved in January or February and were paired by age, production, and size, and assigned to one of the treatments (Table 1). Those assigned to the corn silage ration received 10 pounds of urea per ton of silage. Monocalcium phosphate and trace mineralized salt at the rate of 20 pounds per ton were added when the silage was fed. The grain mixture of ⅓ corn, ⅓ barley, and ⅓ dried beet pulp was fed at the rate of 1 pound per 4 pounds of FCM. The amount fed was changed when both animals, as paired, had declined 4 pounds in FCM as determined with biweekly testing.

The cows on pasture received trace mineralized salt and monocalcium phosphate free choice only. The pasture was an orchard grass and alfalfa mixture and was grazed when the alfalfa was between the bud and 1/10 bloom stage of maturity. The pastures were rotated to provide new pasture twice a day.

Results of These Studies

Table 4 summarizes the average daily consumption of grain, corn silage, alfalfa hay, and dry matter in each trial, and the feed cost per day. Production averages and feed costs per 100 pounds of 4% FCM are in Table 5.

In the winter trials, the forage treatments caused no significant differences in milk production. There were also no significant differences in production from supplementing soybean oil meal. Calculated protein requirements of the cows were exceeded each year. Even in the third year, when no soybean oil meal was fed, both forage treatments and the grain ration contained more than 12% protein.

Average energy consumption during each winter trial was 45 $\pm$ 3 megacalories for all rations. This is 102 to 115% of the National Research Council (NRC) recommendations for dairy cows.

Table 4. Average daily dry matter consumption and feed costs of forage for Holstein cows* on winter and summer rations.

Ration	Dry matter consumption					Total dry matter	Feed cost per day
	Hay	Grain	Silage	Soybean meal	Minerals**		
	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	($)
1966-67							
Hay, grain	31.4	7.6	.....	.....	0.5	39.5	.71
Hay, corn silage, grain	13.6	8.6	12.0	.....	0.5	34.7	.67
Corn, silage, urea, grain	.....	8.6	22.0	3.0	0.6	32.2	.81
1967-68							
Hay, corn silage, grain	13.2	8.5	11.5	.....	0.4	33.6	.63
Corn silage, urea, grain	.....	7.6	22.4	1.0	0.5	31.5	.67
1968-69							
Hay, corn silage, grain	12.3	11.6	13.0	.....	0.4	37.3	.75
Corn silage, urea, grain	.....	11.6	22.8	.....	0.5	34.9	.75
Pasture—1967							
Corn silage, urea, grain	.....	10.0	25.0	2.2	0.6	37.8	.81
Pasture, grain — 119 days	.....	10.0	.....	.....	.....	.....	.60
Pasture—1968							
Corn silage, urea, grain	.....	11.3	28.0	2.0	0.6	33.9	.84
Pasture, grain — 126 days	.....	11.3	.....	.....	.....	.....	.64

* All cows had milked for 90 days or more and were with calf before starting the trial.
** Offered free choice in addition to amounts force fed.

Table 5. Average daily production of Holstein cows* on winter and summer rations.

Ration	Feed cost per cwt. FCM	Average production per day				
		Milk	Fat	SNF	4% milk	Total value
	($)	(lb.)	(lb.)	(lb.)	(lb.)	($)
1966-67						
Hay, grain	2.46	31	1.10	2.59	28.9	1.33
Hay, corn silage, grain	2.38	30	1.09	2.59	28.2	1.30
Corn silage, urea, grain	2.74	31	1.15	2.66	29.6	1.36
1967-68						
Hay corn silage, grain	1.91	36	1.30	3.04	33.0	1.52
Corn silage, urea, grain	2.03	36	1.30	3.07	33.0	1.52
1968-69						
Hay, corn silage, grain	2.14	37	1.37	3.21	35.0	1.61
Corn silage, urea, grain	2.21	36	1.34	3.09	34.0	1.56
Pasture—1967						
Corn silage, urea, grain	1.82	42	1.52	.....	40.0	1.84
Pasture, grain—119 days	1.65	43	1.43	.....	38.0	1.75
Pasture—1968						
Corn silage, urea, grain	2.15	43	1.45	3.62	39.0	1.79
Pasture, grain—126 days	1.56	46	1.47	3.84	41.0	1.89

*** All cows had milked for 90 days or more and were with calf before starting the trial.**

The largest differences were body weight gains obtained in the summer feeding trials. The cows on corn silage plus urea gained 120 pounds in 126 days in 1968. The pasture cows gained only 39 pounds body weight but did produce more milk per day (Table 5). The cows on corn silage, fed free choice on silage containing 40% dry matter, consumed about 122% of NRC energy recommendations. Body weight gains by cows in all other trials were within 10 pounds of each other.

Analysis of the data by years shows that only feed costs per day and feed costs per 100 pounds of 4% FCM were significantly different ($P \leq .05$). The excess protein fed in the soybean oil meal in 1966 and 1967, both winter and summer, accounted for all feed cost differences each year.

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