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Optimal Replacement of Forage and Concentrate with a New Wet Corn Milling Product for Lactating Dairy Cows

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Summary

An experiment was conducted to determine the optimal amount of concentrate and forage that could be replaced with a new wet corn milling product ***(CMP)****. The CMP contained 23.1% crude protein (CP), 9.9% ruminally undegradable protein (RUP), 13.7% acid detergent fiber (ADF), 40.3% neutral detergent fiber (NDF), and 2.6% ether extract (% of dry matter; DM). Thirty Holstein cows were assigned at parturition to either a control diet (no CMP) or a diet containing 40% CMP in place of both forage and concentrate for a period of 9 weeks. This amount resulted from 50% concentrate replacement plus 30% forage replacement. The diet containing CMP resulted in 21% greater efficiency of 4% fat-corrected milk production than the control diet, with no differences in body weight change or body condition score. These results indicate that 40% of a new wet corn milling feed improves efficiency of milk production when compared with a conventional diet with no byproduct feeds.*

Introduction

Wet corn gluten feed **(WCGF)** is a readily available nonforage source of fiber that is primarily a mixture of corn bran and fermented corn extractives (steep liquor). Although WCGF contains 35 to 45% NDF, it only has 2 to 3% lignin, and consequently is a source of highly digestible fiber. A summary of beef feedlot research indicated that efficiency of gain was improved by 5.1% when diets containing 25 to 50% WCGF (corn bran:steep liquor, 1:1 DM basis) were compared with dry-rolled corn. This positive response was likely due to reduced ruminal acidosis, increased DMI, and also to a reduction in negative associative effects of ruminally fermentable starch on fiber digestion.

Ruminal acidosis is a significant concern when feeding dairy cows because of the need for optimal ruminal fiber digestion in the presence of substantial amounts of starchy concentrate feeds. Corn bran is rapidly and extensively digested in the rumen. The in situ rate of NDF digestion for WCGF has been measured as 6.8%/h, whereas rate of ruminal starch digestion ranges between 10 and 35%/h. Consequently, dilution of nonfiber carbohydrates with fiber from WCGF would result in slower rates of fermentation, reduced acid load in the rumen per unit of fermentation time, and the ability to feed a highly digestible diet with minimal risk of ruminal acidosis.

One problem with the design of some previous research that evaluated WCGF for dairy cows was that diets were formulated for CP, but not metabolizable protein. Wet corn gluten feed contains twice as much CP as corn, but less metabolizable protein. Thus, control diets containing corn grain, which use soybean meal or distillers grains to balance for CP, may contain similar CP concentrations as WCGF diets, but these control diets also contain substantially greater amounts of metabolizable protein. If metabolizable protein is not adequate for diets containing WCGF, erroneous conclusions may be made

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concerning the nutritional value of WCGF. Several studies have indicated that approximately 20% dietary WCGF (DM basis) is optimal for milk production; however, metabolizable protein may have been limiting milk production rather than energy or effective NDF.

Our goal was to evaluate the impact on early lactation DMI and milk production of feeding the optimal amount of wet corn milling product (previously determined to be 40% of DM; 50% replacement of forage and 30% replacement of concentrate). Our hypothesis was that a properly formulated WCGF product could be fed in much greater amounts than currently practiced by the dairy industry.

Procedures

The wet corn milling feed product **(CMP)** developed for this experiment was comprised of corn bran, fermented corn extractives, corn germ meal and additional sources of rumen undegradable protein **(RUP)** to increase the metabolizable protein content of the product. The CMP contained 23.1% CP, 43.0% RUP (% of CP), 13.7% ADF, 40.3% NDF, and 2.6% ether extract (DM basis). For comparison, the nutrient composition of WCGF provided by NRC (1989) is 25.6% CP, 26.0% RUP (% of CP), 12.0% ADF, 45.0% NDF, and 2.4% ether extract (DM basis); the typical nutrient profile of WCGF from the wet milling plant (Cargill Corn Milling, Blair, NE) that provided the CMP is 22.5% CP, 30.0% RUP (% of CP), 14.0% ADF, 43.0% NDF, and 2.5% ether extract (DM basis; unpublished data, Ruminant Nutrition Laboratory, Univ. of Nebraska, Lincoln). Sufficient CMP for the entire trial was stored in a plastic silage bag prior to the beginning of the experiment.

Thirty Holstein cows (10 primiparous) were assigned within parity at 1 d after parturition to one of two diets: 1) a control diet containing no CMP, or 2) a diet containing CMP in place of 50% of the concentrate and 30% of the forage (40% of total ration DM). The CMP diet was formulated to contain the optimal amount of CMP in place of forage and concentrate as determined from two previous experiments published in the 1999-2000 Nebraska Dairy Report. Diets were fed for 9 wk and were formulated to contain similar CP and RUP (Table 3).

Cows were housed in a tie-stall barn equipped with individual feed boxes. All diets were fed once daily in amounts to ensure 5% orts. Cows were removed twice daily from the barn for milking, exercise and estrus detection for a total of 4 h. Feed samples were collected daily and composited weekly for nutrient analyses. Samples of individual dietary ingredients were oven- dried (60°C), ground through a 1-mm screen (Wiley mill), and analyzed for CP, ADF, NDF and ether extract.

Daily DMI was determined by weighing the amount of the diet fed and orts daily. Net energy intake (NE_I) was derived by multiplying the weekly DMI by the calculated NE_L concentration of the diet. All ingredient NE_L values were obtained from the NRC (1989). Net energy required for body maintenance (NE_M) was calculated as NE_M (Mcal/d) = kilograms of BW $^{0.75}$ x 0.08. Net energy used for milk secretion (NE_Y) was calculated as NE_Y (Mcal/d) = milk production (kilograms) x [0.3512 + (0.0962 x % milk fat)]. Net energy balance (NEB) was calculated as NEB = NE_I - NE_M - NE_Y.

Milk samples were collected twice weekly at the a.m. and p.m. milkings and were analyzed separately for fat, protein and lactose. Body weight was measured weekly immediately after the a.m. milking and body condition score (1 = emaciated to 5 = obese) was recorded weekly by two people, and the scores were averaged.

Results

The control diet contained 50.8% forage and no CMP; the test diet contained 40% CMP in the total ration DM (50% replacement of concentrate plus 30% replacement of forage). The 40% replacement level was selected as optimal because 1) the 50% concentrate replacement level (Experiment 1, 1999-2000 Dairy Report) resulted in a significant increase in efficiency of fat-corrected milk production and higher levels of replacement did not further increase the efficiency, and 2) milk fat percentage was significantly lower for the 45% forage replacement diet versus the control diet and the 30% replacement diet was the highest level of forage replacement without reduction in milk fat relative to control

Table 1. Ingredient and chemical composition of diets.

Item	Control	CMP[1]
	--- % of DM ---	
Ingredients		
Alfalfa silage[2]	25.4	17.5
Corn silage[3]	25.4	17.5
Corn grain, ground	29.8	19.5
Soybean meal, 46.5% CP	16.2	3.1
Blood meal	0.4	—
CMP	—	40.0
Mineral and vitamin mix[4]	2.8	2.4
Composition		
DM, %	64.8	63.5
CP	18.1	18.3
RUP[5]	6.2	6.4
MP[6]	13.7	13.2
ADF	16.0	15.8
NDF	27.5	35.0
NFC[7]	43.6	35.1
Ether Extract	3.4	3.1
Particle distribution[8]		
> 19 mm	9.5	5.5
19 mm to 8 mm	47.0	28.5
< 8 mm	43.5	66.0

[1]Corn milling feed product contained 23.1% CP, 9.9% RUP, 13.7% ADF, 40.3% NDF, and 2.6% ether extract (DM basis).
[2]Alfalfa silage contained 45% DM, 20.0% CP, 31.0% ADF, and 44% NDF (DM basis).
[3]Corn silage contained 39% DM, 8.2% CP, 22.5% ADF, and 42.3% NDF (DM basis).
[4]Mineral and vitamin supplement contained (DM basis) 7.9% Ca, 2.6% P, 1.8% Mg, 2.2% Na, 1,026 mg/kg of Zn, 7.8 mg/kg of Mn, 128 mg/kg of Ca, and 15,358, 3,072, and 94,270 IU per kilogram of vitamin A, D, and E, respectively.
[5]Calculated using a value of 9.9% RUP for CMP measured in vitro and values reported by NRC (1989) for other ingredients.
[6]Metabolizable protein supplied by these diets as predicted by Cornell Net Carbohydrate and Protein Model (1994).
[7]Calculated according to Van Soest et al. (1991).
[8]Particle distribution (% of as-is TMR) determined using the Penn State Forage Particle Separator.

Table 2. Consumption of DM, protein, and NDF by cows fed experimental diets.

Item	Control	CMP[1]	SE
DMI			
lb/d	57.8[a]	54.9[b]	2.4
% of BW	4.27[a]	4.06[b]	0.10
CP intake			
lb/d	10.4	10.1	1.1
% of BW	0.77	0.75	0.08
RUP intake			
lb/d	3.5	3.5	0.2
% of BW	0.26	0.26	0.01
NDF intake			
lb/d	15.7[b]	19.1[a]	0.8
% of BW	1.16[b]	1.40[a]	0.05

[ab]Means within a row with unlike superscripts differ ($P < 0.05$).
[1]Wet corn milling feed product.

Table 3. Milk production and composition, body weight, and body condition as influenced by diet.

Item	Control	CMP[1]	SE
Milk, lb/d	85.1[b]	96.8[a]	3.5
Milk fat			
%	3.99	4.11	0.10
lb/d	3.41[b]	3.98[a]	0.17
Milk protein			
%	3.41	3.42	0.04
lb/d	2.90[b]	3.32[a]	0.11
Milk lactose			
%	4.76	4.79	0.03
lb/d	4.03[b]	4.66[a]	0.13
4% FCM, lb/d	84.9[b]	98.3[a]	2.2
FCM/DMI, lb/lb	1.47[b]	1.79[a]	0.08
Average BW, lb	1349	1346	22
BCS[2]	2.93	3.00	0.05
BCS change, wk 1 to 9	0.05	0.12	0.04
NEB[3], Mcal/d	10.8	7.9	1.5

[ab]Means within a row with unlike superscripts differ ($P < 0.05$).
[1]Wet corn milling feed product.
[2]Body condition score (1 = thin to 5 = obese).
[3]Net energy balance (NE_{intake}-$NE_{maintenance}$-NE_{milk}).

(Experiment 2, 1999-2000 Dairy Report).

Both diets supplied between 5.7% (control) and 9.5% (CMP diet) excess metabolizable protein (Table 1). The amino acid balance calculated by the Cornell Net Carbohydrate and Protein System (1994) indicated that all diets supplied at least 110% of the requirement for each amino acid. The NDF content of the diets were 27.5% for the control and 35.0% for the CMP diet. In contrast, the nonfiber carbohydrate content was 43.6% for the control and 35.1% for the CMP diet. The CMP diet contained 42% less long particles (greater than 19 mm) than the control diet.

Cows fed a diet containing 40% CMP from 1 to 63 days in milk consumed less DM and more NDF (Table 2), produced more milk, milk fat, and milk protein, and had a greater efficiency of FCM production than cows fed the control diet (Table 3). There were no differences between the two diets in body weight, body condition score, or net energy balance.

In a previous experiment, cows fed a 50% concentrate replacement diet showed a 15% improvement in efficiency of milk production. In a subsequent experiment, cows fed a 30% forage replacement diet had similar efficiency of fat-corrected milk production as a control diet, slightly depressed milk fat, but greater total tract digestibility of NDF. In combining these two treatments into one diet in this experiment, we were able to elicit a 21% improvement in efficiency of fat-corrected milk production which likely reflected the response of multi- and primiparous cows to optimal concentrate replacement plus increased NDF digestibility from replacement of forage with CMP, but still with adequate dietary effective NDF. The CMP diet resulted in better early lactation performance than a conventional diet. The CMP appears to be an excellent source of digestible NDF for high-producing cows immediately postpartum through peak milk production.

Properly formulated WCGF product can replace up to 100% of the concentrate and at least 45% of the forage in diets for lactating dairy cows containing 54% forage. These replacement levels translate into nearly 70% of the total ration DM which is substantially more than suggested by earlier research. An optimal combination for early lactation cows appears to be 50% replacement of concentrate and 30% replacement of forage. This CMP has the potential to result in rations which are economical and capitalize on an abundantly available byproduct feed in Nebraska, particularly in situations where grains or high quality forage are expensive or limited.

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Evaluation of Alternative Sources of Rumen Undegraded Protein with Wet Corn Milling Byproducts for Dairy Cattle

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Rick Stock[1]

Summary

A new wet corn milling product ***(CMP)*** *was developed with greater content of rumen undegradable protein* ***(RUP)****, metabolizable protein* ***(MP)*** *and amino acids than typical wet corn gluten feed. The product contains 23.1% CP, 9.9% RUP, 13.7% ADF, 40.3% NDF, and 2.6% ether extract. Previous research indicated that an optimal dietary amount of the CMP was 40% of DM. A major question remaining was whether or not alternative sources of RUP, when blended with the CMP, resulted in equivalent animal performance. If yes, then considerable flexibility would exist to vary the formulation of the CMP, relative to RUP sources, to capitalize on least-cost ingredients over time. We evaluated three sources of RUP that all resulted in the same RUP and MP for the wet milling product. The three diets contained 40% CMP (with three sources of RUP) and were fed to 39 cows for a period of 70 days. There were no significant differences among the diets for feed intake, milk production, efficiency of milk production, or body condition score. As long as the animal requirements for essential amino acids and MP are met, several sources of RUP may work well as part of the CMP formulation.*

Introduction

Wet corn gluten feed is an excellent source of highly digestible fiber for lactating dairy cows and can provide significant quantities of energy to the diet. However, typical wet corn gluten feed is low in MP. Wet corn gluten feed contains twice as much CP as corn grain, but MP is less. A new wet corn milling product **(CMP)** was developed based on ingredients from the wet milling industry and had improved MP content. In a series of three experiments, we demonstrated that this CMP could replace up to 45% of the forage and 100% of the concentrate for lactating cows; however,

Table 1. Ingredient and chemical composition of the experiment diets.

Item	RUP 1[1]	RUP 2[1]	RUP Blend[1]
Ingredients, % of DM			
Alfalfa silage[2]	17.5	17.5	17.5
Corn silage[3]	17.5	17.5	17.5
Corn, ground	20.0	19.5	20.0
Soybean meal, 46.5% CP	1.8	2.3	1.8
RUP source[1]	2.6	6.0	4.3
Wet corn milling feed without RUP	37.4	34.0	35.7
Mineral and vitamin mix[4]	3.2	3.2	3.2
Chemical composition, % of DM			
DM	54.9	55.2	55.1
CP	18.6	18.7	18.5
RUP	7.0	7.1	7.0
Metabolizable protein[5], g/d	2836	2850	2848
ADF	15.3	15.4	15.2
NDF	34.1	33.4	33.7
Nonfiber carbohydrates[6]	35.8	36.3	36.2
Lipid	3.1	3.0	3.0

[1]RUP 1 = vegetable source of rumen undegradable protein, RUP 2 = animal source of RUP, RUP Blend = 1:1 DM mixture of RUP 1 and 2.
[2]Alfalfa silage contained (% of DM): 40.0% DM, 20.2% CP, 31.0% ADF, and 40.5% NDF.
[3]Corn silage contained (% of DM): 35.0% DM, 8.2% CP, 26.0% ADF, and 42.5% NDF.
[4]Mix contained: 26.2% Ca, 0.01% P, 3.8% Mg, 0.09% K, 4.9% Na, 7.7% Cl, 0.22% S, 9.7 mg/kg Se, 34.1 IU/kg Vitamin A, 6.8 IU/kg Vitamin D, and 286 IU/kg Vitamin E.
[5]Calculated using Cornell Net Carbohydrate Net Protein System Model (1994). All diets supplied at least 105% of predicted LYS and MET requirement.
[6]Calculated as: OM – CP - NDF – Lipid.

Table 2. Nutrient intake as influenced by source of undegradable protein in wet corn milling feed product.

Item	RUP 1[1]	RUP 2[1]	RUP Blend[1]	SEM
DMI				
lb/d	51.5	49.1	49.1	1.5
% of BW	3.72	3.67	3.69	0.10
CP intake				
lb/d	9.5	9.2	9.0	0.4
% of BW	0.69	0.69	0.68	0.04
NDF intake				
lb/d	17.6	16.2	16.5	0.7
% of BW	1.29	1.23	1.24	0.04

[1]RUP 1 = vegetable source of rumen undegradable protein, RUP 2 = animal source of RUP, RUP Blend = 1:1 DM mixture of RUP 1 and 2.

Table 3. **Lactational performance (during 70 d) as influenced by source of undegradable protein in wet corn milling feed product.**

Item	RUP 1[1]	RUP 2[1]	RUP Blend[1]	SEM
4% FCM, lb/d	81.1	80.7	80.5	2.4
Milk fat, %	3.37	3.42	3.34	0.06
Milk true protein, %	3.03	3.05	3.09	0.02
Milk lactose, %	4.62	4.57	4.63	0.07
FCM/DMI, lb/lb	1.59	1.64	1.64	0.03
Average BW, lb	1360	1336	1330	24
Body condition score	3.11	3.14	3.09	0.04

[1]RUP 1 = vegetable source of rumen undegradable protein, RUP 2 = animal source of RUP, RUP Blend = 1:1 DM mixture of RUP 1 and 2.

40% replacement (50% of concentrate and 30% of forage) appeared to be optimal for efficiency of milk production.

The question remained whether several sources of RUP and MP could be used in the CMP. The economic benefits of being able to use multiple sources of RUP based on price/unit are obvious. The objective of this experiment was to evaluate the effect of three alternative sources of RUP and MP on lactational performance of dairy cattle.

Procedures

The three sources of RUP for the CMP formulations were: 1) a vegetable source of RUP, 2) an animal source of RUP, and 3) a 1:1 DM mixture of these two sources. The three CMP were stored in plastic silage bags prior to the start of the trial.

Thirty-nine cows were grouped by days in milk and average milk production and assigned to one of two diets for a period of 70 days to measure dry matter intake, milk production and composition, and body condition. The dietary treatments are shown in Table 1. All three diets contained 40% CMP and equal amounts of alfalfa silage and corn silage. The diets satisfied the cow's requirement for MP and essential amino acids based on the Cornell Net Carbohydrate and Protein System model (1994). Cows were housed in a tie-stall barn equipped with individual feed boxes and were removed twice daily for milking, exercise and estrus detection. Daily milk production was measured for all cows. Composite a.m. and p.m. milk samples were collected twice weekly and analyzed for fat, protein and lactose. Body weight and body condition score were measured weekly immediately after the am milking.

Results

Chemical composition of all diets is summarized in Table 1. All diets contained similar amounts of CP, RUP, MP, NDF and nonfiber carbohydrate. There were no differences among the three diets in feed intake (Table 2), milk production, or milk composition. In particular, milk true protein percentage was similar across diets (Table 3). Likewise, body condition and body weight were similar among cows fed various sources of RUP.

This study demonstrates that, as long as MP and essential amino acid requirements are met, long-term lactational performance is unaffected by source of dietary RUP in the wet corn milling feed formulation.

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Effect of Wet Corn Gluten Feed on Growth and Nutrient Digestibility of Dairy Heifers

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Summary

Wet corn gluten feed ***(WCGF)*** *replaced dietary forage in an attempt to increase total tract digestibility of a total mixed ration for replacement dairy heifers. Holstein heifers were assigned to one of four diets in a 4 x 4 Latin square, with 2-week periods, to measure total tract digestibility and performance. Diets 1 and 3 contained 40% WCGF, 21% corn silage, 21% alfalfa (**AH**; Diet 1) or brome hay (**BH**; Diet 3), and 18% concentrate (DM basis). Diets 2 and 4 contained 41% corn silage, 41% AH (Diet 2) or BH (Diet 4), and 18% concentrate. The concentrate consisted of dry-rolled corn and soybean meal. Overall animal performance was greatest with Diet 1(WCGF and AH). Addition of WCGF (Diets 1 and 3) resulted in an increase in total tract nutrient digestibility. The percentage increase in digestibility for diets containing WCGF was*

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*greater for AH than for BH. In vitro extent of neutral detergent fiber (**NDF**) digestion at 96 hours and rate of digestion were greatest for diets containing WCGF. Wet corn gluten feed may effectively replace forage in the diet for replacement heifers, but the response in digestibility and performance may differ depending on the type of forage being replaced.*

Introduction

Wet corn gluten feed has been used for several years as a feed for both feedlot and dairy cattle. According to research done at the University of Nebraska, it has been able to effectively replace corn in feedlot diets and increase growth efficiency. Wet corn gluten feed also can effectively replace both forage and concentrate in dairy rations. Wet corn gluten feed is an excellent source of highly digestible fiber, and can reduce the risk of acidosis while providing energy to the lactating cow. Because WCGF has worked so well with other animals at different stages of production, one should take advantage of the feed for the replacement animals as well.

Replacement heifers are an important part of any dairy operation. It is important that these animals grow rapidly on a low-cost ration. By replacing some of the less digestible fiber from the forage portion of a ration with WCGF, the heifer may increase its efficiency of gain while extending the forage supply of a dairy operation. Our goal was to determine how well WCGF functioned as part of a ration based on either alfalfa or bromegrass hay fed to growing dairy heifers.

Procedures

Holstein heifers were assigned one of four diets in a 4 x 4 Latin square. Diets 1 and 3 contained 40% WCGF, 21% corn silage, 21% AH (Diet 1) or BH (Diet 3), and 18% concentrate (DM basis). Diets 2 and 4 contained 41% corn silage, 41% AH (Diet 2) or BH (Diet 4), and 18% concentrate. The concentrate consisted of dry-rolled corn and soybean meal. Chemical composition of dietary ingredients and diets is shown in Tables 1 and 2. Heifers were fed once daily to allow for 10% feed refusals. The heifers were housed in a tie-stall barn, equipped with individual feed boxes to measure daily DMI.

Each period was 2 weeks in duration with the last 4 days used for sample and data collection. Composite fecal samples were collected at a.m. and p.m. time points. Ingredients, total mixed rations, and feed refusals were sampled daily. Samples from all periods were composited at the end of the trial. The heifers were weighed at the beginning of the trial and on the last day of each period. Samples were dried in a 60º C oven for two days and ground through a 1-mm screen using a Wiley mill. Total tract digestibility of dry matter (**DM**), NDF, acid detergent fiber (**ADF**), and crude protein (**CP**) were measured using two internal markers: acid insoluble ash and indigestible NDF. Performance was measure as DMI, average daily gain (**ADG**), and efficiency of weight gain (gain/feed).

Table 1. Nutrient composition of dietary ingredients.

Ingredients	DM	NDF	ADF	CP
	(%)	-------------------(% of DM)--------------------		
Corn silage	34.8	37.3	22.3	7.7
WCGF[1]	60.4	44.3	12.9	23.4
Alfalfa hay	89.7	50.8	39.2	19.7
Brome hay	89.9	76.4	51.5	10.2
Dry-rolled corn	89.3	21.6	7.5	8.1
Soybean meal	91.3	16.0	10.1	46.2

[1]Wet corn gluten feed.

Table 2. Nutrient composition of diets.

Diet[1]	DM	NDF	ADF	CP
	(%)	-------------------(% of DM)--------------------		
AH + WCGF	58.0	40.1	19.3	16.5
AH – WCGF	54.1	38.7	25.9	15.7
BH + WCGF	58.2	44.9	22.1	17.0
BH - WCGF	54.4	47.9	30.9	16.3

[1]AH = alfalfa hay; BH = brome grass hay; WCGF = wet corn gluten feed.

Table 3. Performance of growing dairy heifers.

	Alfalfa hay		Brome hay		
	+WCGF[1]	-WCGF	+WCGF	-WCGF	SE
Weight gain, lb	47.4a	22.9b	25.5b	34.0b	4.84
DMI, lb/d	25.1a	22.0b	26.2a	21.3b	0.66
Average weight, lb	1036	1038	1041	1041	24
DMI, % of BW	2.41a	2.13b	2.50a	2.06b	0.08
ADG, lb	3.39a	1.65b	1.83b	2.49ab	0.35
Gain/feed, lb gain/lb feed	0.14a	0.07b	0.07b	0.12a	0.02

[1]Wet corn gluten feed.
[ab]Means within a row with unlike superscripts differ ($P < 0.10$).

Table 4. Total tract digestibility (%).

	Alfalfa hay		Brome hay		
	+WCGF[1]	-WCGF	+WCGF	-WCGF	SE
DM					
AIA[2]	78.0a	69.2b	67.5b	58.8c	2.2
INDF[3]	60.0a	53.9b	56.5b	53.6b	1.5
NDF					
AIA	75.7a	61.9b	67.7ab	57.0b	2.4
INDF	55.9a	45.4b	58.7a	51.6ab	2.6
ADF					
AIA	69.8a	55.3b	62.1a	50.7b	2.4
INDF	45.2a	36.2b	49.8a	44.5ab	2.7
CP					
AIA	77.5a	67.7b	66.7b	53.5c	2.4
INDF	59.1a	52.7b	53.5a	47.6b	1.7

[a,b,c]Means within a row with unlike superscripts differ ($P < 0.10$)
[1]Wet corn gluten feed.
[2]Acid insoluble ash.
[3]Indigestible NDF.

Table 5.Total tract digestibility (%) following correction for sorting.

	Alfalfa hay		Brome hay		
	+WCGF[1]	-WCGF	+WCGF	-WCGF	SE
DM					
AIA[2]	78.0a	69.2b	67.5b	67.5b	1.3
INDF[3]	60.0a	53.9b	56.5b	61.6a	0.9
NDF					
AIA	75.7a	61.9b	67.7ab	65.5b	1.5
INDF	55.9a	45.4b	58.7a	59.3a	1.6
ADF					
AIA	69.8a	55.3b	62.1a	58.3ab	1.6
INDF	45.2a	36.2b	49.8a	51.1a	1.7
CP					
AIA	77.5a	67.7b	66.7b	61.5b	1.7
INDF	59.1a	52.7b	53.5a	54.7a	0.7

[a,b,c]Means within a row with unlike superscripts differ ($P < 0.10$)
[1]Wet corn gluten feed.
[2]Acid insoluble ash.
[3]Indigestible NDF.

Table 6. Digestion kinetics of NDF.

Feed	Lag	Rate	Extent	R^2
Ingredients	(h)	(h^{-1})	(%)	
WCGF[1]	8.8a	0.065	85.9a	0.95
Alfalfa hay (AH)	2.4b	0.054	46.7c	0.91
Brome hay (BH)	9.1a	0.069	53.6b	0.85
Diets				
AH+ WCGF	6.0a	0.068a	66.0a	0.98
AH – WCGF	3.9b	0.047c	56.2b	0.97
BH + WCGF	6.9a	0.054b	65.4a	0.95
BH – WCGF	7.3a	0.045c	61.0ab	0.99

[ab]Means with unlike superscripts differ ($P < 0.10$).
[1]Wet corn gluten feed.

Results

Dry matter intake was greater ($P < 0.10$) for diets containing WCGF; DMI increased 13% with AH and 22% with BH. Performance results are shown in Table 3. The ADG and gain/feed were the greatest with AH+WCGF (Diet 1; 3.39 lb/d and 0.14 lb gained/lb consumed, respectively).

Addition of WCGF (Diets 1 and 3) resulted in an increase in DM, NDF, ADF and CP digestibility, regardless of internal marker used. These results are shown in Table 4. The percentage increase in fiber and CP digestibility for diets containing WCGF was greater ($P < 0.10$) for AH than for BH. There were obvious signs of sorting in Diet 4 so performance and digestibility of the diet was greater than expected. Table 5 shows total tract digestibility after being corrected for sorting. As shown in the table, BH-WCGF had a much higher total tract digestibility when corrected for sorting and was similar to BH+WCGF. This may explain why BH-WCGF performed well while still being the least digestible and the least consumed diet.

In vitro extent of NDF digestion at 96 hours and rate of digestion were greatest for diets containing WCGF as shown in Table 6. Wet corn gluten feed had the greatest extent of in vitro fiber digestion, which may explain the overall increased digestibility of Diets 1 and 3. The results from this experiment show that wet corn gluten feed may effectively replace forage in the diet for replacement heifers, but the response in digestibility and ADG may differ depending on the type of forage that is replaced.

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Quality of Corn Silage and Wet Corn Gluten Feed Ensiled Together in Mini-Silos

Jason Mills
Rick Grant[1]

Summary

The objective of this study was to evaluate the effect of corn silage combined with graded levels of wet corn gluten feed on silage fermentation in laboratory silos (mini-silos). Treatments were corn forage with wet corn gluten feed ***(WCGF)*** *replacing 0, 20, 40, 60, 80, or 100% of the corn forage (DM basis). The treatment containing 0% WCGF was designated as the control. Samples were collected before and after ensiling to determine ensiling characteristics and forage quality. The initial pH was dramatically reduced by additions of wet corn gluten feed, which reflected the lactic acid in wet corn gluten feed (4.68% of DM). After ensiling, the pH of all treatments was below 4.20. The NDF of the silage decreased with addition of WCGF, with a slight increase in NDF after ensiling for all treatments. Ammonia-nitrogen increased with greater amounts of WCGF, with the control (0.04% of DM) having the lowest concentration, and the 100% WCGF the highest (0.10% of DM). After ensiling, the control had the greatest amount of ammonia-nitrogen production when compared with the original concentrations. The initial water-soluble carbohydrate concentrations averaged 9.4% of DM, but decreased after ensiling with the greatest amount in treatments containing higher levels of corn silage. Silages containing higher percentages of corn silage (control, 80, and 60%) had lower total organic acid prior to ensiling, but had the highest after 37 days of ensiling. Silages containing WCGF tended to have greater packing density. The dry matter recovery was variable across all treatments and did not show any obvious trends. There was an increased in vitro NDF digestion when WCGF replaced corn silage, and was highest for the silage containing 60% WCGF. Ensiling corn silage with wet corn gluten feed may be a way to extend corn forage, increase packing density and reduce storage space needed in commodity bays.*

Introduction

Whole plant corn silage is the major forage and energy source in lactating dairy cow rations in North America. The increasing costs of grain and forage have reduced the profit margin increasing the use of byproduct feeds. Byproduct feeds, such as nonforage fiber sources (NFFS), are increasingly used in lactating dairy cattle diets when forage quality and quantity is limited.

Wet corn gluten feed (**WCGF**), a byproduct of the wet milling industry, has been used extensively in the Midwest to replace both forage and concentrate in dairy cattle rations. As a replacement feed, WCGF is a source of highly digestible fiber, ranges between 18 to 24% crude protein, and has low lignin content. However, WCGF has a relatively short bunk life. Shipments may be as frequent as 1 to 2 times weekly, requiring increased time and labor for handling, therefore increasing costs.

In the past year, producers have asked about the possibility of ensiling corn silage simultaneously with wet corn gluten feed. Little to no research has looked at the effects of ensiling a combination of feeds simultaneously on silage fermentation characteristics. We know that the nutritional value of corn silage can be highly influenced by variety, growing conditions, maturity, harvesting and ensiling practices. Producing high quality corn silage requires a rapid reduction in pH, elimination of air and increased packing density to stimulate fermentation. Typically, forages are ensiled independently of other feedstuffs. However, there may be advantages to combining forages with byproduct feeds such as WCGF: 1) WCGF can be used as a silage extender, 2) the combination of corn silage (larger particles) and WCGF (smaller particles) may increase packing density, reducing dry matter and spoilage losses, and 3) high lactic acid concentrations of WCGF may cause a more rapid pH decline prior to ensiling. However, there may be some drawbacks when combining two or more feedstuffs: 1) inconsistencies in mixing may cause rations to be improperly formulated, and 2) the chemical and physical properties of WCGF may make it difficult for tractors to pack the silage. Therefore, the objective of this study was to evaluate the effects of ensiling a combination of WCGF and chopped whole-plant corn on fermentation and nutritive value of the resulting silage.

Procedures

Whole plant corn silage was harvested at 3/4 milk line stage of maturity and cut to a theoretical length of 3/8 inch with a forage harvester. Approximately 7.7 lb ($\pm$ 1.1 lb) of corn silage and WCGF mixture were immediately ensiled in triplicate (5-L) mini-silos (3.9 inches, width $\times$ 11.8 inches, height). Treatments were WCGF replacing whole plant corn at 0, 20, 40, 60, 80, and 100 %. The empty and full weights of silos were recorded,

Table 1. Chemical composition of fresh forage prior to ensiling.

	Corn to WCGF ratio						
	100:0	80:20	60:40	40:60	20:80	0:100	SEM
Dry matter, %	37.8	41.1	42.8	52.3	57.7	61.0	0.6
pH	6.02^{a}	5.06^{b}	4.83^{c}	4.15^{d}	4.14^{d}	3.91^{e}	0.03
Ammonia-N[1], % of DM	0.04^{d}	0.06^{c}	0.06^{c}	0.09^{b}	0.09^{b}	0.10^{a}	<0.01
WSC[2] , % of DM	9.2^{ab}	9.6^{ab}	9.80^{a}	9.4^{ab}	9.00^{b}	9.80^{a}	0.30
Starch, % of DM	32.3^{a}	26.4^{a}	25.8^{a}	17.1^{b}	11.5^{bc}	9.3^{c}	1.4
Crude protein, % of DM	9.1^{d}	12.6^{c}	12.8^{c}	18.8^{b}	21.0^{ab}	22.5^{a}	0.5
Total Organic Acids, % of DM	0.08	0.99	1.6	3.85	—[3]	5.04	—
Acetic, % of DM	0.04	0.07	0.07	0.22	—	0.23	—
Propionic, % of DM	0.01	0.00	0.00	0.00	—	0.00	—
Butyrate, % of DM	0.00	0.00	0.00	0.00	—	0.00	—
Isobutyrate, % of DM	0.00	0.02	0.03	0.06	—	0.13	—
Lactic Acid, % of DM	0.00	0.90	1.50	3.40	—	4.68	—

[abcd]Means in rows with unlike subscripts differ ($P< 0.05$).
[1]Ammonia nitrogen.
[2]Water soluble carbohydrates.
[3] These samples were not analyzed.

Table 2. Fiber fractions of fresh forage prior to ensiling.

	Corn to WCGF ratio						
	Control	80:20	60:40	40:60	20:80	0:100	SEM
NDF, % of DM	42.2^{a}	37.1^{ab}	36.1^{b}	34.6^{b}	33.3^{b}	33.6^{b}	1.3
ADF, % of DM	19.2^{a}	15.5^{ab}	13.1^{bc}	9.9^{c}	8.6^{c}	8.3^{c}	0.8
Hemicellulose, % of DM	23.0	21.6	22.9	24.7	24.7	25.3	0.9

[abc]Means in rows with unlike subscripts differ ($P < 0.05$).

and silos were stored in the dark at ambient temperature ranging from 18 to 25°C. Three silos were opened for each treatment at 37 days of ensiling.

Fresh forage: The DM content of fresh forage and WCGF was determined by drying (80-100 g) in a forced-air oven at 60°C for 48h. After drying, feed samples were ground, using a Wiley Mill, through a 1-mm screen and analyzed for neutral detergent fiber, acid detergent fiber, and dry matter. Crude protein was calculated by total combustion using a nitrogen analyzer.

A sample of 25 grams of each feed mixture was added to a dilution tube containing 225 ml of distilled water. Sample was homogenized in a blender for 1 min. After blending, pH was determined using an electronic pH meter. The homogenized blends were filtered through a Whatman 541 filter paper to collect a water extract sample, acidified with 50% sulfuric acid, and frozen prior to further analysis of ammonia-N and water-soluble carbohydrates **(WSC)**. Starch was determined using the Owen (1985) method. Fresh samples were sent to DairyOne DHI Lab in Ithaca, N.Y. for determination of organic acids.

Silage: After 37 days of ensiling, silage was processed as described for fresh forage with additional determination of lactic acid, DM recovery and in vitro NDF digestion. In vitro NDF digestion was determined on the ensiled silages. Samples were ground to pass through a 1-mm screen, and 0.5 g of silage was weighted into 125-ml in vitro tubes. In vitro tubes were incubated for 0 and 36 hours, samples were frozen for 24 h, and analyzed for NDF.

Results

Fresh Forage

The composition of fresh corn forage and combinations of corn and WCGF is presented in Tables 1 and 2. The DM content increased linearly when WCGF as added to corn silage, which can be attributed to the high DM content of WCGF (60% DM). The pH was markedly decreased with the addition of WCGF; this can be ascribed to the concentration of lactic acid and other organic acids in WCGF (5.04% of DM). The WSC content ranged from 9.00 to 9.80% of DM among all treatments. Ammonia-N concentrations were lowest in the corn forage control (0.04% of DM) and highest in the 100% WCGF (0.10 % of DM). The NDF percentages decreased with addition of WCGF to the mixture, ranging from 44.2 to 37.8% for corn forage to WCGF, respectively. Similar trends were observed with ADF content of the silage. The crude protein percentages increased with addition of WCGF from 9.1 % to 22.5 %. Organic acids increased with additions of WCGF, with the highest concentration of acids coming from lactic acid, at a concentration of 4.68% of DM in WCGF. Acetate was highest in treatments containing lower percentages (40, 20,and 0%) of WCGF (0.23% of DM). Propionate and butyrate were undetectable in fresh forage mixtures.

Silage Composition

The chemical composition of silages after 37 days of ensiling is presented in Tables 3 and 4. After ensiling, silage pH

(Continued on next page)

Table 3. Chemical composition of silage after 37 days of ensiling.

	Corn to WCGF ratio						
	Control	80:20	60:40	40:60	20:80	0:100	SEM
Dry matter, %	35.6^{e}	38.8^{d}	38.8^{d}	46.3^{c}	52.5^{b}	58.9^{a}	0.3
Organic matter, %	93.9	93.9	93.9	93.6	94.1	94.40.1	
pH	3.85^{d}	3.94^{cd}	3.91^{d}	4.07^{a}	4.19^{b}	4.04^{bc}	0.30
Ammonia-N, % of DM	0.085^{c}	0.093^{bc}	0.102^{b}	0.092^{bc}	0.130^{a}	0.128^{a}	0.003
Water soluble carbohydrates, % of DM	0.40^{d}	0.90^{d}	1.40^{d}	3.13^{c}	5.73^{b} 7.86^{a}	0.31	
Starch, % of DM	25.9^{a}	24.1^{a}	19.6^{a}	12.1^{b}	11.4^{b}	9.3^{b}	1.5
Crude protein, % of DM	9.4^{d}	13.0^{c}	14.1^{c}	20.8^{b}	21.9^{b}	24.0^{a}	0.3
Dry Matter Recovery, %	93.9^{b}	93.6^{b}	89.6^{c}	86.8^{d}	89.9^{c}	96.2^{a}	0.8
Total Organic Acids, % of DM	6.36^{a}	6.16^{a}	6.05^{a}	4.07^{b}	4.67^{b}	4.42^{b}	0.19
Acetic, % of DM	1.1	1.0	0.83	0.35	0.17	0.11	0.03
Propionic, % of DM	0.01	0	0	0	0	0	<0.01
Butyrate, % of DM	0	0	0	0	0	0	<0.01
Isobutyrate, % of DM	0.02	0.05	0.07	0.11	0.12	0.14	0.06
Lactic acid, % of DM	5.24^{a}	5.08^{a}	5.16^{a}	3.76^{b}	4.16^{b}	4.2^{b}	0.18
Lactic:acetic	4.73^{d}	5.03^{d}	6.23^{d}	12.3^{c}	22.3^{b}	39.3^{a}	0.87

^{abcd}Means in rows with unlike subscripts differ ($P < 0.05$).

Table 4. Fiber fractions of silage after 37 days of ensiling.

	Corn to WCGF ratio						
	Control	80:20	60:40	40:60	20:80	0:100	SEM
NDF, % of DM	46.8^{a}	45.6^{a}	43.2^{ab}	42.6^{ab}	40.2^{b}	39.5^{b}	0.9
ADF, % of DM	23.9^{a}	20.5^{b}	18.6^{b}	14.7^{c}	12.2^{c}	9.0^{d}	0.6
Hemicellulose, % of DM	22.9^{c}	25.1^{bc}	24.6^{bc}	27.9^{ab}	28.0^{ab}	30.5^{a}	0.9
In vitro digestion of NDF, %	44.9^{cd}	51.7^{bc}	50.9^{c}	60.8^{a}	58.3^{ab}	41.2^{d}	1.5
Packing Density, lb/ft^{3}	14.4^{de}	17.4^{de}	18.9^{d}	26.1^{c}	29.9^{b}	38.1^{a}	5.8

^{abcd}Means in rows with unlike subscripts differ ($P < 0.05$).

ranged from 3.87 to 4.16, and all treatments were below 4.4, which is considered a good index of silage quality. The ammonia-N concentrations were increased during ensiling, with the greatest degree of proteolysis occurring in the control treatment. There was a greater extent of starch utilization in the control and 60% corn silage, when compared with other treatments. The WSC concentration was lowest in the control (0.4% of DM) and increased with addition of WCGF (7.86% of DM, Figure 1). When comparing total organic acid concentrations of silages containing higher levels of corn silage (control, 80, and 60%), versus lower levels (40, 20, and 0%), there was an increased amount of total acids produced with higher corn silage mixtures. The increased total

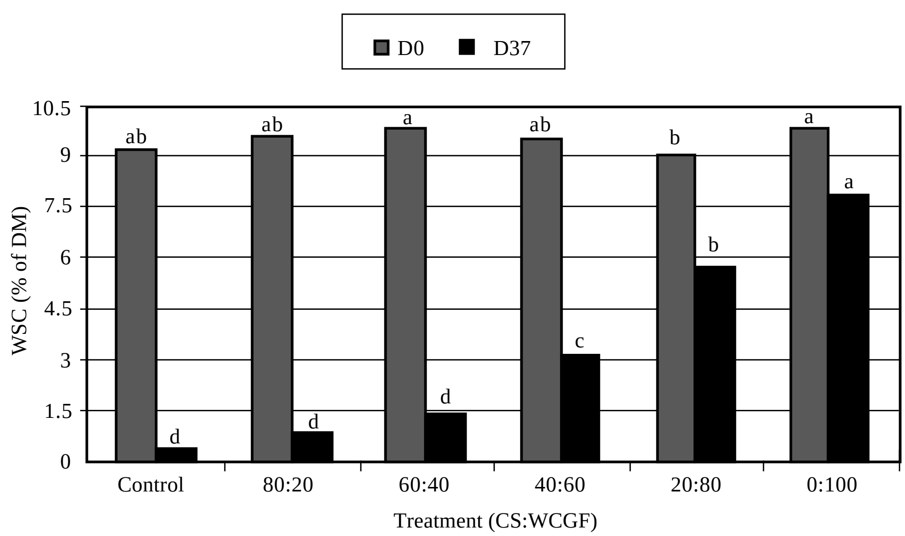

Figure 1. Water soluble carbohydrate concentrations prior to and after 37 days of ensiling.

^{abcd} Means in columns with unlike subscripts differ ($P < 0.05$).

acids can be attributed to plant bacterial activity. When small amounts or no WCGF were added to corn silage, lactic acid bacteria had to utilize WSC to produce lactic acid. The lactic acid in the higher corn silage treatments (control, 80, and 60%) were greater (average 6.19% of DM) than the concentration of WCGF prior to and after ensiling. However, the silage containing higher levels of corn silage (control, 80, and 60%) produced more acetate (average 0.98% of DM) than silages containing lower amounts of corn silage (40, 20, and 0%) at 0.22% of DM. Research conducted at the University of Delaware has documented increases in acetate concentration during ensiling of corn silage. Consequently, when WCGF was added to corn silage there was a trend toward a linear increase in lactate to acetate ratio. The packing density increased linearly from 14.4 to 38.1 lb/ft^3 (control to WCGF, respectively) with increasing percentages of WCGF in each silo.

In summary, ensiling corn silage with WCGF seemed to have no negative effects on fermentation characteristics, and may have the potential for use on-farm. The WCGF was able to cause a rapid decline in initial forage pH prior to ensiling which may have aided in silage preservation. Although not all combinations of corn silage to WCGF may be practical for on-farm use, the combinations ranging from 10 to 30% replacement of forage may be a viable way to extend corn silage reserves, and increase packing density during silage fermentation. In addition, proper mixing of feeds during ensiling is crucial for a properly blended silage mixture.

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Use of Bt Corn Silage and Grain by Lactating Dairy Cows

Jeff Folmer
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Jim Beck[1]

Summary

An experiment was conducted to evaluate the impact of the Bacillus thuringiensis (Bt)-11 transformation event in two parental corn hybrids differing in date of maturity on dairy cattle performance. Sixteen lactating Holstein dairy cows in replicated 4 x 4 Latin squares were assigned to four diets in a 2 x 2 factorial arrangement: Bt versus non-Bt trait and early versus late maturing corn hybrids. The diets contained 40% of the test corn silage plus 28% corn grain from the same corn hybrid (DM basis). There was no effect of the Bt trait on efficiency of milk production, ruminal pH, acetate to propionate ratio, or in situ digestion kinetics of NDF. The early maturing corn hybrids resulted in greater total VFA concentrations in the rumen and a 5% greater efficiency of 4% fat-corrected milk production than the later maturing hybrids. Incorporation of the Bt trait into corn had no effect on any measure of dairy cow performance.

Introduction

Bacillus thuringiensis **(Bt)** is a naturally occurring soil bacterium which produces a protein that is toxic to some caterpillar (lepidopteran) insects including European corn borer. A gene encoding this Bt protein ("Cry 1Ab" protein) has been inserted into the genome of certain corn lines, and Bt corn hybrids are commercially available. The transgenic corn plant produces the Bt protein, thus providing protection against corn borer infestation throughout the life of the plant.

The use of Bt corn hybrids for enhanced yields under conditions of borer pressure, such as commonly occurs in the Midwestern U.S., is becoming a widely adopted practice in the major corn producing states. In many cases, the corn residue is used for growing or wintering beef cows and weaned calves. Corn silage remains an important component of dairy feeding programs throughout the U.S. Additionally, many beef calves are placed on silage-based growing rations in the fall and winter prior to feeding finishing diets in late winter and early spring. However, information on the feeding value of corn silage and corn residue from Bt hybrids compared with traditional hybrids is limited.

Therefore, the objectives of this research were to evaluate the effect of corn silage from the same two Bt corn hybrids and near-isogenic non-Bt hybrids on short-term lactational performance of dairy cows and the ruminal fermentation of these corn hybrids.

Procedures

Corn Cultivation, Harvest, and Chemical Composition

Four commercial corn hybrids (N4242Bt, N4242 non-Bt, N7333Bt, and N7333 non-Bt; Syngenta Seeds Inc., Golden Valley, Minn.) were planted at the University of Nebraska Agricultural Research and Development Center

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located at Mead, Neb. in 1998. The Bt hybrids were derived from transformation event Bt11, and the non-Bt hybrids represented the corresponding near-isolines developed by conventional breeding methods. The N4242 hybrids were earlier maturing (harvested for silage at 103 days) whereas the N7333 hybrids were later maturing (harvested for silage at 112 days). All four hybrids were grown for harvest of silage in adjacent fields under comparable agronomic conditions without irrigation. At another site at the Research Center, under pivot irrigation, hybrids N7333 Bt and non-Bt were grown in adjacent fields for harvest of grain. The seed drop rate per hectare for each hybrid at planting was: N4242 Bt, 55,524; N4242 non-Bt, 56,950; N7333 Bt, 54,741; and N7333 non-Bt, 54,496.

Agronomic characteristics including plant height, number of ears, stalk and root lodging, and stalk diameter were measured for all hybrids at 112 d post-planting (3 replicates of 10 plants each per field). These results are summarized in Table 1. Agronomic data were collected for all four hybrids grown without irrigation, in addition to the later maturing Bt and non-Bt hybrids grown under irrigation for use in the stalk grazing experiment.

Table 1. Agronomic characteristics of silage fields measured 112 d after planting.

	Early maturing		Late maturing	
Item	Bt	Non-Bt	Bt	Non-Bt
Nonirrigated field				
Harvest population, plants/ha	54,363	51,892	54,363	51,892
Plant height, cm	244	236	274	277
Ears per 100 plants	92	92	96	96
Root lodged, %	0	0	0	0
Stalk lodged, %	0	3	0	0
Stalk diameter, cm	2.30	2.22	2.22	2.22
Irrigated field				
Harvest population, plants/ha			69,189	69,189
Plant height, cm			282	282
Ears per 100 plants			99	98
Root lodged, %			0	0
Stalk lodged, %			1	0
Stalk diameter, cm			2.38	2.54

Table 2. Summary of Guthrie scale ratings and other indicators of larval infestation (irrigated and nonirrigated fields).

	Early maturing		Late maturing	
Item	Bt	Non-Bt	Bt	Non-Bt
Number of observations	30	30	60	60
% infestation[a]	0	33	0	56
Larvae/plant	0	1.8	0	.6
Average tunnel lengths, cm				
Stalk	0	5.1	.025	1.5
Ear shank	0	.57	0	.12
Ear	0	.33	.025	.25
Guthrie rating	1.0	2.3	1.0	1.4

[a]Infested with live larvae (% of stalks).

Each corn field was evaluated for European corn borer infestation at d 112, 113, and 116. For each field, 30 corn stalks (3 replicates of 10 each) were evaluated for corn borer infestation. Samples were taken at least 10 rows from the field edge. The stalks were cut at the base and promptly dissected in the field. Leaf sheaths were removed and examined for feeding and for presence of larvae. The stalks were cut longitudinally to measure tunneling and to expose larvae. The ear and shank were examined also for larvae and measurement of tunnel length. Damage to individual plants also was evaluated using the Guthrie visual rating scale. The corn borer pressure data are summarized in Table 2.

The corn for silage was harvested at 3/4 milk line stage of maturity using a field chopper with knives adjusted to a 3/8 inch theoretical length of cut. The chopped corn was ensiled in separate plastic silage bags for each hybrid prior to the start of the experiments. Silage bags were opened and the feeding trials began a minimum of 100 d post-ensiling. Grain was harvested at 85.3% DM for the earlier maturing Bt and non-Bt hybrids (129 days post-planting) and at 84.9% DM for the later maturing hybrids (172 days post-planting).

Corn Silage Chemical Composition. A weekly composite sample of each of the corn silage hybrids was created during the course of the experiment and was subsequently dried (60ºC), ground (1-mm screen, Wiley mill), and analyzed for CP, ADF, NDF, acid detergent lignin, permanganate lignin, and 30-hour in vitro NDF digestibility. Starch content of the silages was determined enzymatically (SDK Laboratories, Hutchinson, KS).

Dairy Lactation Experiment

Twelve intact (4 primiparous, 8 multiparous) plus 4 ruminally fistulated, multiparous Holstein dairy cows were assigned to one of four treatments in a replicated 4 x 4 Latin square design with 3-wk periods. Cows averaged 162 ± 10 days in milk when they were assigned to treatments. Cows were not injected with bovine somatotropin during this experiment. Dietary treatments were arranged as a 2 x 2 factorial of corn hybrid (early versus later maturing) and Bt trait. The diets contained (DM basis) 10% alfalfa silage, 40% of the test corn silage, 28% rolled corn grain, and 22% of a concentrate mixture comprised of soybean meal, blood meal, tallow, min-

Table 3. **Carbohydrate and lignin composition of experimental silages and grain used in dairy experiment.**

Item	Early maturing Bt	Early maturing Non-Bt	Late maturing Bt	Late maturing Non-Bt	SEM
Corn silage					
DM, %	40.2	39.0	37.6	37.8	.6
	(% of DM)				
Ash	4.1	4.5	6.1	4.7	.1
ADF	25.0	21.9	26.9	23.9	.2
NDF	38.9	36.7	41.1	42.4	.6
ANDF[a]	38.0	36.2	38.6	41.2	.5
ADL[b]	3.25	2.69	3.62	3.36	.04
PL[c]	4.90	4.14	5.26	5.04	.15
Starch	37.6	38.6	37.3	37.1	.2
30-h NDF digestion, %[d]	32.4	30.8	34.4	31.6	1.1
IVDMD, %[e]	74.3	65.6	69.1	65.6	1.4
Corn grain					
DM, %	85.8	85.9	85.2	85.4	.2
Starch	76.7	74.5	76.5	76.6	.4

[a]NDF corrected for ash content.
[b]Acid detergent lignin.
[c]Permanganate lignin.
[d]Measured in vitro.
[e]In vitro dry matter digestibility.

erals, and vitamins. The diets were designed so that the corn grain and corn silage were from the same hybrid for each diet to maximize any possible effect of the Bt trait on animal response. The ingredient composition of the experimental diets is shown in Table 5. All diets were formulated to contain approximately 17.5% CP and to meet the metabolizable protein requirement as predicted by the Cornell Net Carbohydrate and Protein Model (1994). The four diets were fed as a total mixed rations twice daily in amounts to ensure a minimum of 10% refusals.

Experimental periods were 21 d, with the last 7 d used for sample and data collection. Cows were housed in a tie-stall barn equipped with individual feeding boxes. Daily milk yields were recorded electronically. Composite a.m. and p.m. milk samples were collected for two days at the end of each period and analyzed for fat, protein and lactose. Body weight was measured weekly immediately following the a.m. milking.

For fistulated cows only, samples of ruminal fluid were collected during the last week of each period by collecting fluid immediately beneath the ruminal mat at 0, 6, 12, 18 and 24 hours after feeding. Ruminal pH was measured using a portable pH meter, and samples were prepared to determine VFA concentration. Fractional rate of NDF digestion of each corn silage hybrid was determined using the in situ bag technique.

Performance data for cows were analyzed as a replicated 4 x 4 Latin square design with model effects for square, cow within square, period, treatment, square x treatment and residual error using the PROC GLM procedure of SAS (1996). Orthogonal comparisons were performed for early versus later maturing hybrids, Bt versus non-Bt trait, and the interaction of background genotype and Bt trait. Unless otherwise stated, significance was declared at $P < .05$.

Results

Corn Borer Pressure

The Bt11 event results in endotoxin production in all plant tissues providing 98% control of first- and second-generation corn borers. Results of the larval infestation evaluations (Table 2) indicated that the plants without Bt protection did incur some degree of corn borer infestation relative to the Bt hybrids (33 to 56% infestation). The amount of infestation was unexpectedly high given the generally low population levels for European corn borer observed throughout much of Nebraska in 1998. Results from strip trials conducted at six sites in Nebraska during 1998 indicated an infestation rate of only 11% (B. Siegfried, University of Nebraska Entomology Department, personal communication). There was no evidence of borer infestation in the Bt hybrids evaluated in these experiments.

Chemical Composition and Digestibility of Corn Hybrids

The chemical composition and digestibility of the experimental silages obtained from the weekly composite samples are detailed in Table 3. The later maturing corn hybrids contained less CP than the earlier maturing hybrids, although the protein fractions were similar among hybrids. Additionally, the earlier maturing hybrids contained less NDF and ADF than the later hybrids, which likely reflected a greater starch and CP content. Lignin, measured as either permanganate lignin or as acid detergent lignin, was slightly greater for the Bt versus non-Bt hybrids, and was substantially lower for the earlier versus later maturing hybrids. Starch content and in vitro DM digestibility were greater for the earlier versus later maturing hybrids. There was very little difference among the hybrids in 30-hour in vitro NDF digestibility, although the Bt hybrids were consistently higher than non-Bt hybrids. These observations indicate that Bt corn silage should have a feeding value similar to non-Bt corn silage.

Dairy Lactation Experiment

Feed Intake, Milk Production and Milk Composition. There was no effect of either maturation date or Bt versus

(Continued on next page)

non-Bt trait on DMI in kilograms per day or as a percentage of body weight (Table 5). As with DMI, there was no influence of corn hybrid or Bt trait on milk production. There was a range of only 1.3 lb/d in milk production per cow across all four treatments. Milk protein percentage, and most importantly, milk protein production were unaffected by treatment (Table 5). Likewise, milk lactose percentage and lactose production were similar among diets. There was no significant ($P > .05$) effect of earlier versus later maturing corn hybrid on milk fat percentage. In summary, there was no effect of Bt versus non-Bt trait on any measure of milk composition.

Efficiency of 4% fat-corrected milk production (FCM/DMI, kg/kg) was greater for the earlier versus later maturing hybrids ($P < .05$). This response likely reflected the higher digestibility and lower fiber content of the earlier maturing hybrid. There is a considerable body of literature that shows the relationship between variation in composition and digestibility of corn silage and variation in milk production and efficiency. Again, there was no effect of Bt versus non-Bt trait on production of FCM or efficiency of FCM production.

Ruminal pH, VFA, and NDF Digestion Kinetics. The effect of corn silage hybrid on ruminal pH and VFA concentrations is summarized in Table 6. Ruminal pH was unaffected by treatment and averaged 5.79. Total VFA concentration was greater for the earlier maturing Bt and non-Bt hybrids compared with the later maturing Bt and non-Bt hybrids. There was no effect of the Bt trait itself on total VFA concentration or acetate to propionate ratio.

There was no effect of the Bt trait or hybrid background genotype on in situ digestion kinetics of NDF (Table 7). The fractional rate of NDF digestion averaged .035 h^{-1} and the potential extent of NDF digestion averaged 59.2%. These data support the in vitro 30-hour NDF digestion data which indicate little difference in NDF digestion between Bt and non-Bt hybrids.

Table 4. Ingredient and chemical composition of experimental diets used in dairy experiment (% of DM).

	Early maturing		Late maturing	
Item	Bt	Non-Bt	Bt	Non-Bt
Ingredient				
Alfalfa silage[a]	10.00	10.00	10.00	10.00
Corn silage	40.00	40.00	40.00	40.00
Corn grain, rolled	28.00	28.00	28.00	28.00
Soybean meal, 46.5% CP	17.90	17.90	18.30	18.30
Blood meal	0.67	0.67	0.69	0.69
Tallow	0.57	0.57	0.57	0.57
Mineral and vitamin mix[b]	2.86	2.86	2.44	2.44
Composition				
DM, %	52.3	52.3	52.8	52.8
CP	17.5	17.5	17.3	17.3
RUP[c]	6.31	6.32	6.27	6.29
ADF	16.6	15.3	17.4	16.0
NDF	26.3	25.5	27.0	27.8
NE_L, Mcal/kg[c]	1.68	1.68	1.68	1.68

[a]Chemical composition of first-cutting alfalfa silage harvested at bud stage was (DM basis): DM, 45.1%; CP, 21.9%; ADF, 35.0%; and NDF, 44.8%.
[b]Supplement contained (DM basis) 15.2% Ca, 7.2% P, 4.1% Mg, 4% Na, 3000 mg/kg of Zn, 1750 mg/kg of Mn, 400 mg/kg of Cu, 200,000 IU/kg of vitamin A, 36,000 IU/kg of vitamin D_3, and 600 IU/kg of vitamin E.
[c]Calculated using nutrient composition and digestibility data from Tables 4 and 5 plus data in NRC (1989).

Table 5. Effect of corn silage hybrid on short-term performance of lactating dairy cows.

	Early maturing		Late maturing		
Item	Bt	Non-Bt	Bt	Non-Bt	SEM
DMI					
lb/d	50.2	49.3	51.0	49.9	.1
% of BW	3.75	3.72	3.84	3.75	.02
BW					
lb	1362	1353	1353	1366	7
change per 21-d period	47.0	49.9	46.4	39.6	4.2
Milk, lb/d	64.2	62.9	63.1	62.7	0.7
Milk fat					
%	3.80	3.82	3.70	3.73	.06
Milk protein					
%	3.54	3.55	3.51	3.52	.02
Milk lactose					
%	4.90	4.85	4.87	4.80	.40
4% Fat-corrected milk (FCM), lb/d	62.3	60.9	60.3	60.1	1.1
FCM/DMI, lb/lb[a]	1.26	1.24	1.19	1.20	.03

[a]Significant effect of early versus late maturing corn hybrid ($P < .05$).

Overall Corn Hybrid Effects

The earlier maturing hybrids resulted in greater efficiency of production than the later maturing hybrids. An explanation for this response may be found by comparing several of the compositional differences between the two hybrids. Although we could not measure a difference in NDF digestibility between the two hybrids, when comparing them, we observed that the earlier maturing hybrid had 10.6% lower NDF content, 17.5% less acid detergent lignin, 2.5% higher starch content, 9.8% higher nonfiber carbohydrates, and 4.2% higher IVDMD. Our conclusion is that the increased performance reflects the

Table 6. Effect of corn silage hybrid on ruminal pH and VFA concentrations in lactating dairy cows.

	Early maturing		Late maturing		
Item	Bt	Non-Bt	Bt	Non-Bt	
Ruminal pH[a]	5.87	5.67	5.81	5.82	.06
Total VFA, m*M*[b]	97.21	93.83	83.23	84.96	1.66
Acetate (A)	55.10	57.22	53.27	51.28	<.01
Propionate (P)	21.33	20.31	16.91	19.60	<.01
n-Butyrate	9.96	11.50	9.64	10.02	.03
Isobutyrate	1.05	1.19	.96	1.02	<.01
n-Valerate	1.33	1.61	1.06	1.35	<.01
Isovalerate	1.69	1.97	1.38	1.66	<.01
A:P	2.8	2.9	3.1	3.1	.1

[a]Mean of samples collected every 4 h for 24 h.
[b]Significant effect of early versus later maturing corn hybrid ($P < .05$).

Table 7. In situ NDF digestion kinetics of corn silage hybrids measured in lactating dairy cows.

	Early maturing		Late maturing		
Item	Bt	Non-Bt	Bt	Non-Bt	
Lag, h[a]	5.96	8.89	6.19	6.26	.74
K_d, h[a]	.034	.035	.038	.033	.005
Extent, %[c]	57.6	57.4	64.6	57.2	.44
R^2	.91	.93	.93	.95	

[a]Discrete lag time prior to NDF digestion.
[b]Fractional rate of NDF digestion.
[c]Potential extent of NDF digestion at 96 hours of fermentation.

cumulative benefits of all of these compositional changes. Data generated at Kansas State University, which summarized several years of silage comparisons, concluded that these cumulative changes in chemical composition, even though some are relatively small such as starch, can explain observed differences in animal performance.

Overall Bt Trait Effects

Incorporation of the Bt trait into two different background genotypes had no influence on performance on lactating dairy cows consuming corn silage and corn grain The Bt corn had no measurable impact on short-term lactational performance of dairy cows and did not negatively affect ruminal fiber fermentation.

[1]Jeff Folmer, Graduate Student, Rick Grant, Professor and Extension Dairy Specialist, Animal Sciences, Lincoln; Jim Beck, Syngenta Seeds, Inc., Golden Valley, MN.

Effect of Nonenzymatically Browned Sunflower Seeds on Ruminal Fermentation and Milk Composition

Rick Grant
Ki Fanning
Terry Klopfenstein
Casey Wilson[1]

Summary

*Our hypothesis was that an effective nonenzymatic browning of ground sunflower seeds would increase mono- and polyunsaturated milk fatty acids with minimal impact on ruminal fermentation. The ground, nonenzymatically browned sunflower seeds **(NEBS)** that we developed contained 59.5% ruminally undegradable lipid measured in situ. Eight lactating Holstein cows were assigned to one of four diets in a 4 x 4 Latin square with 3-wk periods. The control diet contained 50% forage with no added lipid. The remaining diets contained 50% forage and 4% added lipid from sunflower oil **(SFO)**, ground, untreated sunflower seeds **(GSF)**, or NEBS. The SFO diet resulted in the lowest intake, the GSF diet was intermediate, and the NEBS and control diets were similar. Production of 4% fat-corrected milk was greatest for the NEBS diet, intermediate for the control and GSF diets, and lowest for the SFO diet. Ruminal fiber digestion, and acetate to propionate ratio were lowest for the SFO diet. The NEBS diet resulted in the greatest C18:3, C18:2, and C18:1 cis fatty acids in milk fat. These results*

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indicate that the oil in NEBS was protected from ruminal fermentation and successfully elevated the poly- and monounsaturated fatty acid content of milk fat. These desirable changes in milk fat composition were coupled with an increase in milk fat production.

Introduction

Americans are becoming increasingly health conscious. The medical community recommends a reduction in C14:0 and C16:0 fatty acids to aid in prevention of atherosclerosis. In addition, C18:1 trans fatty acids are linked with increased cholesterol concentration and reduced high density lipoproteins in the blood. Milk fat contains 70% saturated fatty acids, with 50% of these saturated fatty acids from C14:0 and C16:0. Previous research at the University of Nebraska demonstrated that protection of protein in soybeans indirectly protected the lipid fraction also, resulting in increased transfer of C18:2 from the diet to milk. Sunflower seeds contain a more desirable fatty acid profile (increased C18:1 cis, C18:2, and C18:3) than soybeans, but they are more difficult to process and nonenzymatically brown.

The objectives of this research were to determine the optimal procedure for nonenzymatically browning sunflower seeds, and to evaluate the optimal treatment of sunflower seeds on rumen function and milk production and composition.

Procedures

Preliminary in situ trials determined the optimum combination of variables to yield the greatest ruminally undegradable lipid **(RUL)**. We evaluated combinations of 1) particle size (whole, 8.25, or 5.5 mm grind), 2) sulfite liquor (0, 2, 4, 6, 8, 12, or 16%), 3) heating time (1.5, 2.0, 2.5, or 3.0 hours), and 4) temperature which was set at 100°C. The optimum treatment for sunflower seeds was a particle size of 5.5 mm, mixed with 12% sulfite liquor, and heated for 130 minutes at 100°C. This nonenzymatic browning process resulted in a rumen undegraded protein **(RUP)** of 83.2% of CP and a RUL of 59.5% of total lipid.

Table 1. Ingredient and chemical composition of experimental diets.

Item	Control	Sunflower oil	Untreated SF[1]	Treated SF
	------------------------------(% of DM) ------------------------------			
Ingredient				
Alfalfa silage	12.3	12.3	12.3	12.3
Corn silage	37.8	37.8	37.8	37.8
Corn, ground	26.2	21.2	18.4	18.4
SoyPass[2]	15.6	16.6	17.5	15.5
Untreated SF	—	—	9.6	—
Treated SF	—	—	—	9.6
SF oil	—	4.0	—	
Urea	0.2	0.2	0.2	0.2
Sunflower meal	3.7	3.7	—	2.0
Mineral/vitamin[3]	4.2	4.2	4.2	4.2
Composition				
DM, %	55.3	55.4	55.3	55.2
CP	18.2	18.1	18.1	18.2
RUP	8.5	8.7	8.5	8.8
ADF	17.8	17.7	19.0	19.0
NDF	29.2	28.9	30.3	30.3
Ether extract	3.2	7.3	7.2	7.3

[1] Sunflower.
[2] Nonenzymatically browned soybean meal.
[3]Met or exceeded requirements of NRC (1989).

Table 2. Effect of treated and untreated sunflower seeds versus sunflower oil on milk fatty acid profiles (%).

Fatty Acid	Control	Sunflower oil	Untreated sunflower	Treated sunflower
6:0	1.96a	1.50b	1.47b	1.34b
8:0	1.12a	0.66b	0.66b	0.60b
10:0	2.72a	1.64b	1.42b	1.34b
12:0	3.53a	2.07b	1.77b	1.79b
14:0	10.90a	8.29ab	7.70b	7.11b
14:1	1.59a	1.25a	0.98b	0.63b
16:0	35.34a	23.78b	22.89b	20.98b
18:0	8.76b	13.89a	14.78a	12.27a
18:1 trans	0.55c	1.68a	1.26b	0.88c
18:1 cis	23.05c	34.39b	32.69b	37.22a
18:2	3.37c	4.18b	3.83bc	5.87a
18:3	0.52d	0.86c	1.08b	2.11a

[ab] Means within a row with unlike superscript differ ($P < 0.05$).

Eight lactating Holstein cows (150 days in milk) were fed one of four diets in a 4 x 4 Latin square with 3-wk periods (18-day adaptation and 3-day collection). The control diet contained no added lipid, the SFO diet contained 4% added lipid from sunflower oil, the GSF diet contained 4% added lipid from ground sunflower seeds, and the NEBS diet contained 4% added lipid from ground, nonenzymatically browned sunflower seeds. The cows were fed individually in tie stalls once daily in amounts to ensure 5% feed refusals. Body weight and body condition score were recorded at the beginning and end of each period. Morning and evening milk samples were collected on day 19 and 20 of each period and analyzed for fat,

Table 3. Effect of treated or untreated sunflower seeds versus sunflower oil on feed intake and milk production.

Fatty acid	Control	Sunflower oil	Treated sunflower	Untreated sunflower
DMI, lb/d	54.1a	49.1b	53.9a	51.7ab
BW, lb	1450	1478	1463	1478
DMI, % of BW	3.74a	3.32b	3.68a	3.52ab
Body condition score	3.25	3.29	3.32	3.21
Milk, lb/d	56.0ab	53.8b	61.3a	60.8a
4% FCM, lb/d	56.2b	52.3c	63.3a	58.0b
Milk fat, %	4.01a	3.60b	4.12a	3.53b
Milk protein, %	3.34	3.44	3.36	3.32
Milk lactose, %	4.56	4.58	4.52	4.46

[ab] Means within a row with unlike superscripts differ ($P < 0.05$).

Table 4. Effect of treated or untreated sunflower seeds versus sunflower oil on ruminal NDF digestion of soybean hulls and VFA concentrations.

Fatty acid	Control	Treated Sunflower oil	Untreated sunflower	sunflower
Ruminal pH	6.21	6.14	6.24	6.13
NDF digestion kinetics				
Lag, h	9.5	9.7	8.9	8.6
Rate, /h	0.069a	0.039b	0.055a	0.049ab
Extent, %	94.6	92.2	93.1	92.1
r^2	0.97	0.98	0.99	0.99
VFA, m*M*/L	89.9ab	82.8b	95.5a	92.9a
Acetate:propionate	3.84a	3.09b	3.76ab	3.69a

[ab]Means within a row with unlike superscripts differ ($P < 0.05$).

fatty acids, protein and lactose. Rumen fluid was collected for measurement of pH and frozen for subsequent analysis of volatile fatty acids at 0, 12, 18 and 24 hours on day 20. The fractional rate of NDF digestion was determined from incubating soybean hulls in the rumen starting on day 18 (0, 6, 12, 24, 48, and 72 hours).

Results

The diet composition is shown in Table 1. All diets contained 50% forage (dry basis) comprised of 25% alfalfa silage and 75% corn silage. Urea was added to all diets to ensure that there was no deficiency of rumen degradable protein. SoyPass (nonenzymatically browned soybean meal) was added to the control diet in an attempt to ensure that there would be an equal amount of nonenzymatically browned protein in all diets. Table 1 provides the nutrient composition of the diets. All diets were similar in CP and fiber; the lipid content of the test diets was 4 percentage units greater than the control diet.

Dry matter intake (Table 3) was reduced for cows fed the SFO diet, but the NEBS diet resulted in DMI similar to the control diet. Milk production was reduced for cows fed the SFO diet, as was milk fat %. The NEBS diet resulted in milk fat equal to the control diet. Ranking, from highest to lowest, for fat-corrected milk was: NEBS, control, GSF and SFO. Addition of SFO to the diet reduced ruminal NDF digestion and acetate to propionate ratio, but the NEBS did not have any negative effect compared with the control diet (Table 4).

Feeding the NEBS diet increased the percentage of C18:3, C18:2, and C18:1 cis fatty acids in milk versus the other treatments (Table 2). In addition, sunflower lipid reduced milk C16:0 content.

In conclusion, the oil in the NEBS was partially protected from ruminal fermentation. The NEBS resulted in the greatest transfer of C18:3, C18:2, and C18:1 cis fatty acids to milk fat and the largest reduction in milk fatty acids of chain length C14:0 or less without compromising rumen function. These desirable changes in milk fat composition were coupled with an increase in milk fat production.

[1]Rick Grant, Professor and Extension Dairy Specialist, Ki Fanning, Graduate Student, Terry Klopfenstein, Professor, and Casey Wilson, Graduate Student, Animal Science, Lincoln.

Carbohydrate Composition of Commonly Used Feedstuffs in the Midwestern U.S.

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Summary

Twenty-three commonly used feeds were analyzed for neutral detergent soluble and insoluble carbohydrates using the recently published techniques from the University of Florida (2000). Four different categories of feedstuffs were analyzed: wet forages, dry forages, concentrates and byproducts. The range in starch content for wet forages, dry forages, concentrates, and byproducts was, respectively: 44.9 to 0.8%, 4.8 to 0%, 66.4 to 0%, and 9.3 to 0%. For the same categories, the total 80% ethanol-soluble carbohydrate analysis for mono- and oligosaccharides was, respectively: 4.1 to 1.1%, 5.6 to 0%, 13.9 to 1.1%, and 7.0 to 0%. The organic acid content range was: 6.2 to 2.4%, 7.3 to 0%, 1.0 to 0%, and 5.2 to 0%, respectively. The neutral detergent soluble fiber content range was: 13.3 to 2.7%, 13.2 to 2.9%, 4.8 to 0%, and 26.5 to 0%, respectively. The NDF composition range was: 58.3 to 33.7%, 89.1 to 59.1%, 63.1 to 15.5%, and 69.0 to 45.5%, respectively. Using these values should allow nutritionists to formulate rations that more adequately meet the cow's requirements for the various carbohydrate fractions.

Introduction

There is a variety of feedstuffs for producers in the Midwestern U.S. to choose from when they are formulating dairy rations. Because many of these feeds differ substantially in carbohydrate composition, it is important that these carbohydrate fractions are measured to properly formulate a ration that meets the nutritional requirements of today's high producing dairy cow. Traditionally, feed carbohydrates have been divided into two fractions: non-structural **(NSC)** or non-fiber **(NFC)** carbohydrates and neutral detergent fiber **(NDF)**. When the NDF content of a feedstuff is evaluated, the filtrate is largely ignored and discarded following the assay. One should pay closer attention to this portion, which contains the neutral detergent soluble carbohydrates **(NDSC)**, when formulating a dairy ration. The NDSC fraction includes organic acids **(OA)**, sugars or mono- and oligosaccharides, starch and neutral detergent soluble fiber **(NDSF)**. Each fraction of the NDSC has its own characteristic digestion profile by the cow or ruminal microbes, its distinctive ability to support microbial growth, its potential for fermentation to lactic acid in the rumen, and whether it suffers marked depression in fermentability at low rumen pH. Knowing the values for NDSC should allow nutritionists to formulate rations that more adequately meet the dairy cow's carbohydrate requirements.

Procedures

Twenty-three commonly used feeds were collected from various sources in Nebraska and were divided into four different categories: wet forages, dry forages, concentrates and byproducts. All feeds were dried in a 60ºC oven for 48 hours and ground through a Wiley Mill with a 1-mm screen. The carbohydrate composition of the feeds was determined using procedures

Table 1. Crude protein and carbohydrate fractions of wet (ensiled) forages.

	CP	NDF	TESC[1]	Starch	OA[2]	NDSF[3]
Alfalfa silage	23.7	47.8	1.7	0.8	3.6	13.3
Corn silage	8.6	33.7	1.3	44.9	2.2	2.7
Sorghum silage	9.4	56.4	1.1	15.7	5.0	4.9
BMR[4] sorghum silage	9.5	58.3	4.1	11.2	6.2	2.8

[1]Total 80% ethanol-soluble carbohydrates for mono- and oligosaccharides.
[2]Organic acids.
[3]Neutral detergent soluble fiber.
[4]Brown midrib.

Table 2. Crude protein and carbohydrate fractions of dry forages.

	CP	NDF	TESC[1]	Starch	OA[2]	NDSF[3]
Bluestem	2.2	89.0	0.4	0.3	0	4.1
Corn stover	6.5	83.2	1.2	0.9	1.6	4.2
Switchgrass	2.4	89.1	0	0	0	6.3
Alfalfa,vegetative	30.3	36.5	3.1	4.8	5.9	13.2
Alfalfa, mature	22.3	59.1	0	1.1	2.3	11.7
Brome grass	11.4	77.8	3.3	0.9	0.5	2.9
Wheat straw	5.7	74.9	0.7	0.1	1.2	9.2
Red clover	33.0	44.1	5.6	1.6	7.3	8.0

[1]Total 80% ethanol-soluble carbohydrates for mono- and oligosaccharides.
[2]Organic acids.
[3]Neutral detergent soluble fiber.

published by the University of Florida (Hall, M. B. 2000. University of Florida Extension Bulletin 339). Wet chemistry techniques were used to determine the NDF, total 80% ethanol-soluble carbohydrates for mono- and oligosaccharides **(TESC)**, and starch. Organic acid and NDSF were determined by subtraction, which may leave these values more prone to error.

Table 3. Crude protein and carbohydrate fractions of byproduct feeds.

	CP	NDF	TESC[1]	Starch	OA[2]	NDSF[3]
Wet corn gluten feed	29.0	42.0	7.0	8.0	5.2	1.9
Dried distillers grains (corn) dry	35.5	52.7	6.0	9.3	0	0
Dried distillers grains (sorghum), dry	35.9	57.0	3.1	6.7	1.6	5.7
Soybean hulls	13.3	69.0	0	1.6	4.3	11.1
Beet pulp, dry	11.5	60.0	0.3	0.0	4.2	26.5

[1]Total 80% ethanol-soluble carbohydrates for mono- and oligosaccharides.
[2]Organic acids.
[3]Neutral detergent soluble fiber.

Table 4. Crude protein and carbohydrate fractions of concentrate feeds.

	CP	NDF	TESC[1]	Starch	OA[2]	NDSF[3]
Soybean meal	54.2	15.5	9.6	6.9	1.0	4.8
Soy Pass®[4]	55.0	47.9	13.9	2.6	0	3.8
Corn, ground	9.5	21.6	11.	66.4	0	0
Whole Sunflowers	23.1	43.6	1.6	0	11.7	0
Whole soybeans	40.2	29.8	8.2	4.1	0.1	0

[1]Total 80% ethanol-soluble carbohydrates for mono- and oligosaccharides.
[2]Organic acids.
[3]Neutral detergent soluble fiber.
[4]Nonenzymatically browned soybean meal.

Results

Carbohydrate composition of the feedstuffs is shown in Tables 1 to 4. When one examines the chemical composition for these feeds, it is obvious that reliance on "book" values for the carbohydrate fractions could lead to large errors in ration formulation. These values will allow nutritionists to more accurately formulate dairy rations since they now know the components of the NDSC content that traditionally have been discarded during feed analysis.

[1]Daryl Kleinschmit, former Undergraduate Research Assistant; Rick Grant, Professor and Extension Dairy Specialist, Animal Science, Lincoln.

Impact of the Use of Bovine Somatotropin on the Genetic Evaluation of Dairy Cows

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Summary

*Records from Dairy Records Processing Center at Raleigh, N.C., were analyzed to detect the effects of bovine somatotropin **(bST)** on genetic evaluation of cows. Data consisted of 103,965 lactation records for milk yield with 9,494 treated records. All herds and herds that were influenced by bST were compared. Different animal models were used to obtain breeding values for cows. Genetic parameters of milk yield, with and without the treatment, were obtained by a multiple repeatability animal model. Correlations between breeding values predicted from different models for all-herd and bST-herds were 0.99 and 0.98. Effects of bST treatment on genetic gain were small, but bias in the ranking of top 2% of cows was found. Adjusting genetic models to account for bST treatment within herds could reduce the effect of bST treatment on cows' evaluation programs. In general, little impact of bST on genetic programs was found in this study.*

Introduction

The ability of bovine somatotropin **(bST)** to enhance milk yield and feed efficiency in dairy cattle has been observed in numerous studies. Most of these studies have reported that treated cows tend to perform better than untreated cows and could be considered to be cows of superior genetic potential. Therefore, if response to bST treatment is ignored, bias in genetic evaluation could occur. Also, systematic use of bST within herd or on certain sire families according to phenotypic performance

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could cause substantial errors in genetic evaluations. In order to minimize the effect of bST on genetic programs, several authors have suggested random use of bST treatment within dairy herds. Others suggested a relationship between genetic merit and response to bST so they recommended bST use only for cows of low genetic merit.

In a recent study, bias in ranking of sires and cows was found with the use of bST. These authors concluded that bias in genetic evaluation programs caused by ignoring bST treatment might be significant. Another study reported a decrease in the accuracy of sire and cow evaluations when bST was administrated only for the best cows. On the other hand, different authors have reported small or non-significant effects of bST treatment on genetic evaluation programs and that bST treatment can be ignored on sire and cow genetic evaluations.

If some cows were injected with bST and no adjustment for milk production was made, bias in ranking of cows could occur. Consequently, those cows might be selected to be bull-dams to produce young bulls in next generation. However, commercial use of bST in the U.S. started in 1994 and currently more than 25% of the U.S. dairy cows are being treated with bST. Therefore, sufficient amount of DHI records of treated cows are available and can be used to study the effects of bST on selection programs. The objectives of the present study were to detect the impact of bST on genetic evaluations of cows when not all cows within herds received bST treatment. Variance components and genetic parameters for milk yield were estimated from records of cows with and without bST treatment using a multiple trait analysis method.

Procedures

Data of the present study were provided by the Dairy Records Processing Center at Raleigh, N.C., and consisted of 305-day, twice daily milking, mature equivalent yields for milk of Holstein cows calving from 1990 to 1999. Data contained 103,965 lactation records for milk yield of 43,236 cows in 705 herds. To compare treated cows and untreated cows within the same herds, a subset data from herds with at least one record of bST-treated cow also were used in this study. This dataset contained 36,645 lactation records for milk yield from 15,591 cows in 138 herds with 9,459 treated records. First lactation yield and known sire identification were required for all cows. In addition, dairy herds which did not have at least five cows were eliminated from the data set.

Three different repeatability animal models were used to predict breeding values of cows. In the first model, bST treatment was ignored. For the second model bST treatment was used to create the management group. Finally, bST treatment was included as a second fixed effect. A repeatability multiple-trait animal model was used to estimate the variance components and genetic parameters for milk yield, with and without bST effect, using Multiple Trait Derivative-Free Restricted Maximum Likelihood program. Correlations between predicted breeding values from different models were obtained and the top 2% of cows were selected to detect the effect of bST on genetic progress. Cows were evaluated by different models and were ranked to study the effect of bST on ranking of the elite cows. Difference between means of predicted breeding values were calculated to estimate the effect of bST on genetic programs.

Results

As shown in Table 1, treated cows had higher milk yield than untreated

Table 1. Milk yield means (lb) and data structure of all and bST-herds.

	All-herds	bST-herds	bST-cows
Mean±SD	24,109±4,987	23,426±4,486	24,198±4,305
Number of records	103,965	36,645	9,494
Herds	705	138	138
Sires	1,198	864	705
Cows	43,236	15,591	7,386
Management group	9,607	3,571	904

Table 2. Correlations between predicted breeding values of cows from the three different models.

	Model 1	Model 2	Model 3
Model 1		0.9954	0.9986
Model 2	0.9819		0.9968
Model 3	0.9941	0.9875	

Data for all herds are above the diagonal, and data for bST-herds are below the diagonal
Model 1: bST treatment was ignored. Model 2: bST treatment within management group. Model 3: bST treatment was considered as another fixed effect.

Table 3. Heritabilities and repeatabilities of milk yield with and without bST treatment using tow trait analysis.

	Milk yield	
	with bST	without bST
Heritability	0.25	0.20
Repeatability	0.43	0.40
Genetic correlation	0.98	
Permanent environmental correlation	0.94	

cows. The percentage increase due to bST treatment (within bST- herds) was 5%. Possible reasons for this low estimated response could be that the amount and frequency of bST treatment and date of injections were unknown. However, milk yield mean for bST-herds was smaller than the mean of all herds which indicated that the bST-herds could have low management levels. Percentage of treated records in this data were 9%. Correlation between breeding values for all cows (predicted using different models) are shown in Table 2. All correlations for predicted breeding values were high (0.99 and 0.98 for all-herds and bST-herds). Correlation between breeding values that were obtained when bST treatment was ignored and when bST used to create new management groups were slightly lower than those when bST was used as a second fixed effect. The decline in genetic gain when the top 2% cows were selected to be bull-dams and bST treatment was ignored was less than 2%. The percentage of top 2% selected cows according to predicted breeding values by all models were 89% and 67% for all-herds and bST-herds respectively. A larger proportion of treated cows were selected when bST was ignored which could be an evidence of bias in the ranking of elite cows. Estimates of genetic parameters are shown in Table 3. Heritability and repeatability estimates were slightly higher for milk yield with bST treatment. The genetic correlation between milk yield with and without bST was high (0.98). Thus, the interaction between genetic potential and response to bST were not found in this study. Generally, high correlations of breeding values and little effect of bST on genetic gain and genetic parameters estimation are evidences suggesting that the influences of bST treatment on cows genetic evaluation programs were small. However, further studies using bST records are needed to understand better the role of bST treatment on the genetic evaluation of cows.

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Divergent Selection for Predicted Transmitting Ability for Type in Holsteins

Bruce DeGroot
Jeffrey F. Keown[1]

Summary

*The objective of this study was to examine effects of divergent selection for Predicted Transmitting Ability for Type **(PTAT)** on linear type traits and production in Holsteins from 1986 to 1999. For four generations, one-half of the university research Holstein herd was bred to Holstein sires with PTAT > 1.50 and the other half to sires with PTAT < 1.25, with nearly equal PTA for yield traits for both groups. Estimates of heritabilities and genetic correlations were obtained from REML estimates of (co)variance components. Fixed effect was the date cows were classified and covariates of age in days at freshening and days in lactation at classification for model of type. Year-season when cows freshened was fixed effect in model for yield and somatic cell scores **(SCS)**. Animal genetic and residual were random effects. Final score, milk, fat, and protein yields and SCS had heritability estimates of 0.38, 0.13, 0.22, 0.09, and 0.38, respectively. Estimates of genetic correlations of final score with SCS and milk, fat, and protein yields ranged from -0.68 to -0.16. Estimates of breeding values for final score, udder traits, and SCS were significantly different between lines in the third generation. The correlations between final score and yield traits suggest that selection for increased final score would result in little change in yield traits and divergent selection on PTAT of sires had an influence on udder traits with little or no effect on body and yield traits.*

Introduction

Milk production per cow has increased in U.S. dairy herds because of genetic progress made in yield traits over many years of selection and improved management practices. In a previous study, average milk production per cow has increased by 660 lb per cow from 1960 to 1990. Top-producing U.S. Holstein herds that are eligible for genetic evaluations averaged 21,450 lb of milk, 770 lb of fat, and 682 lb of protein in 2000. Some of the highest producing cows have produced up to 67,760 lb of milk.

The heavy emphasis on selection for yield may have a negative effect on non-yield traits that could contribute to the cow's overall fitness. These traits are

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associated with body frame, feet, legs, udder and teats. Many artificial insemination **(AI)** and breed organizations maintain linear classification programs to measure these traits. The information gathered is used to select for profitable and functional cows. Recent studies have identified some linear type traits that are important for cows to produce high levels of milk over multiple lactations.

Final score is a linear type trait that represents weighted overall score for all measured conformation traits. Previous studies have found only small relationships between final score and milk yield, thus selection for final score may not have much effect on milk yield. However, selection on final score may result in changes in individual linear type traits and somatic cell scores **(SCS).**

The objectives of this study were to estimate genetic parameters and measure response of yield and linear type traits and SCS.

Procedures

A selection experiment was designed in 1986 at the Nebraska dairy research herd to study the effects of selection for or against final score. For four generations, the herd was split into two divergent lines, designated as plus and minus type. Holstein cows were randomly assigned to the lines. Selection was on predicted transmitting ability of type **(PTAT)** of AI sires. In the plus line, sires had to report a PTAT greater than +1.50. Sires selected for the minus line had to have a PTAT less than +1.25. Selected sires for a particular line were randomly mated to the cows. An attempt was made to keep the selection on yield traits the same across lines. This was done to study the response to selection for selecting solely on PTAT. Sires selected in both lines had to have a PTA for milk yield greater than +1892 to 1991 lb, fat yield greater than +44 to 66 lb, and protein yield greater than +66 lb. Over the course of the study, there were a total of 107 different sires used in the plus line and 94 different sires used in the minus line.

Table 1. Definition of linear type traits.

Trait	Scores: 50	Scores: 1
Stature	Tall	Short
Strength	Strong	Frail
Body Depth	Deep	Shallow
Dairy Form	Open	Tight
Rump Angle	Sloped	High pins
Thrul Width	Wide	Narrow
Rear Legs-Side Views	Straight	Sickle
Rear Legs-Rear View	No toe out	Severe toe out
Foot Angle	Steep	Low
Fore Udder Attachment	Strong	Loose
Rear Udder Height	High	Low
Rear Udder Width	Wide	Narrow
Udder Cleft	Strong	Flat
Udder Depth	Shallow	Deep
Front Teat Placement	Close	Wide
Teat Length	Long	Short

Table 2. Estimates of heritability for linear type traits, final score, yield traits, and SCS.

Trait	h^2
Stature	0.47±.091
Strength	0.41±.087
Body Depth	0.36±.089
Dairy Form	0.36±.091
Rump Angle	0.36±.087
Thrul Width	0.30±.088
Rear Legs-Side View	0.12±.081
Rear Legs-Rear View	0.11±.082
Foot Angle	0.04±.073
Fore Udder Attachment	0.37±.085
Rear Udder Attachment	0.32±.085
Rear Udder Width	0.30±.084
Udder Cleft	0.29±.088
Udder Depth	0.23±.080
Front Teat Placement	0.52±.088
Teat Length	0.29±.097
Final Score	0.38±.087
Milk Yield	0.13±.075
Fat Yield	0.22±.079
Protein Yield	0.09±.087
SCS	0.38±.119

Lactation records were obtained from the Dairy Herd Improvement Association for 1987 to 1999. Yields were 305-day, twice milking, mature equivalent milk, fat and protein. Protein data were not available for some cows at the beginning of the study. Only first lactation records were used for this study because of different culling criteria between the lines. After the edits, there were 711 records for milk and fat yield and 561 records for protein yield. Data on SCS were obtained from the Animal Improvement Programs Laboratory at ARS-USDA from 1992 to 1999. The scores were pre-adjusted for age, season of calving and length of lactation. As with lactation records, only first lactation SCS were used in the study. There were 368 SCS records available for analysis. Data for the linear type traits came from the official evaluation program of the Holstein Association. All cows were scored each year from 1989 to 1999 for final score and 16 type traits (scored on a 50-point scale) in Table 1. Evaluators were not aware of which cows were in a particular line. There were 541 records for the analysis.

The analysis was done using MTDF-REML program to estimate (co)variance components for the animal model. Fixed effect was year-season that the cow freshened in the model for yield and SCS. Fixed effect in the model for linear type traits was date of classification. There were also two covariates in the model to adjust scores for effects of age at freshening and stage of lactation at classification. Random effects included animal genetic and residual. At convergence for estimates of (co)variance components, estimates of breeding values (EBV) were obtained for each individual cow. The EBV were averaged and plotted by generation. This

Table 3. Estimates of genetic correlations among final score, yield traits, and SCS.

	FS	MY	FY	PY	SCS
FS[1]		0.01	-0.18	0.06	-0.64
MY			0.36	0.34	-0.21
FY				0.56	0.43
PY					0.11
SCS					

[1]FS = final score, MY = milk yield, FY = fat yield, PY = protein yield, and SCS = somatic cell score.

Table 4. Estimates of genetic correlations among udder traits, milk yield, and SCS.

	FU	UH	UW	UC	UD	MY	SCS
FU[1]		0.58	0.74	0.39	0.89	-0.45	-0.24
UH			0.86	0.60	0.37	0.16	-0.16
UW				0.62	0.48	0.12	-0.32
UC					0.22	-0.10	-0.35
UD						-0.65	-0.20
MY							-0.21
SCS							

[1]FU = fore udder attachment, UH = rear udder height, UW = rear udder width, UC = udder cleft, UD = udder depth, MY = milk yield, and SCS = somatic cell score.

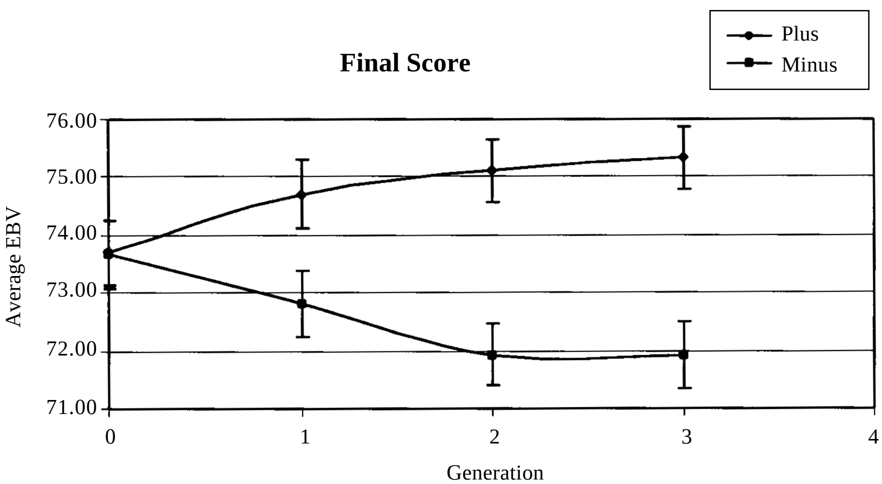

Figure 1. Average EBV for final score for cows in the plus and minus lines by generation.

was done to identify trends for each trait. The mean differences for EBV between lines were tested at generation three by using a Student's *t* test of significance. This was done only at generation three because of the small number of cows in the fourth generation entering the first lactation.

Results

Estimates of heritability for yield traits, SCS, final score and linear type traits are in Table 2. The estimates for milk, fat and protein yield were low compared to estimates found in previous studies. The Holstein Association reports heritability estimates of 0.25 for each of the yield traits. The lower estimates found in this study could be due to the small number of animals with records or to selecting for sires with high PTA for yield traits. SCS had a higher estimate of heritability compared with 0.10 reported by the Holstein Association. Final score and the linear type traits had heritability estimates generally larger than estimates from previous studies.

Estimates of genetic correlations between yield traits, SCS and final score are in Table 3. Final score had low estimates of 0.01, -0.18 and 0.06 with milk, fat and protein yields respectively. These estimates were comparable with estimates found in previous studies. Final score had a large negative genetic correlation with SCS. Final score had genetic correlation estimates with the udder traits that ranged from 0.66 to 0.88. Table 4 contains estimates of genetic correlations between udder traits, milk yield and SCS. The estimates among the udder traits were similar to those reported by previous studies. Fore udder attachment, udder cleft and udder depth had negative estimates of genetic correlation with milk yield, whereas rear udder height and rear udder width had small positive estimates with milk yield. SCS had negative estimates of genetic correlation between the udder traits. The estimates of genetic correlation between the udder traits, milk yield and SCS were similar to those reported in earlier studies.

The averaged estimated breeding values **(EBV)** by generations for final score of the plus and minus lines are plotted in Figure 1. This graph shows a divergent of the mean EBV between the lines. The plus line had an upward (increased score) genetic trend and the minus line had a downward (decreased score) genetic trend. The response to selection was large in the lines from the base to the second generation, and then the response seemed to decrease after the second generation.

Table 5 contains the mean scores and EBV for the lines and difference between lines for final score, linear type traits, yield traits and SCS at generation three. Stature, strength and body depth were significantly different ($P<.05$) between the lines in the third generation. The udder traits and front teat placement were also significantly different ($P<.01$) between the lines. The mean difference of 3.42 for final score was

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Table 5. **Mean scores and estimated breeding values (EBV) for linear type traits, final score, yield traits, and SCS at generation 3.**

	Plus line		Minus line		Difference	
Trait	Mean score	Mean EBV	Mean score	Mean EBV	Mean score	Mean EBV
Stature	25.11	0.17	20.95	-1.31	3.16	1.48[a]
Strength	19.32	0.55	17.10	-0.97	2.22	1.52[a]
Body Depth	20.18	0.39	17.22	-0.93	2.96	1.32[a]
Dairy Form	24.43	0.36	22.43	0.30	1.00	0.06
Rump Angle	25.57	-1.01	24.84	0.14	0.73	-1.15
Thurl Width	20.14	0.47	18.97	-0.52	1.17	0.99
Rear Legs-Side View	24.80	-0.19	27.60	0.14	-2.80	-0.33
Rear Legs-Rear View	22.96	0.54	20.71	-0.19	2.25	0.73
Foot Angle	23.52	0.15	21.34	-0.10	2.18	0.25
Fore Udder Attachment	20.13	1.57	16.86	-1.55	3.27	3.12[b]
Rear Udder Height	25.63	1.37	22.09	-0.42	3.54	1.79[b]
Rear Udder Width	25.02	1.39	20.57	-0.71	4.45	2.10[b]
Udder Cleft	29.84	1.39	25.24	-0.66	4.60	2.05[b]
Udder Depth	31.79	1.09	24.93	-1.47	6.86	2.56[b]
Front Teat Placement	25.04	2.14	19.02	-1.69	6.02	3.38[b]
Teat Length	20.63	-0.01	21.62	-0.23	-1.00	0.22
Final Score	75.71	1.84	70.05	-1.58	5.66	3.42[b]
Milk Yield (kg)	10308.04	15.80	10660.36	93.48	-352.32	-77.68
Fat Yield (kg)	377.49	-1.14	400.19	6.38	-22.70	-7.52
Protein Yield (kg)	323.02	0.62	327.71	1.68	-4.69	-1.05
SCS	3.30	-0.22	3.84	0.21	-0.53	-0.43[a]

[a]*P* < .05
[b]*P* < .01

significant (*P*<.01) between lines in the third generation. Milk, fat and protein yields were not significantly different between lines in third generation. SCS were significantly difference between (*P*<.05) between the lines.

Selection for final score would have a positive effect on udder traits as indicated by estimates of genetic correlations and correlated responses. The yield traits would have little effect in response to selection for final score. The genetic correlations between final score would suggest that selection for increased final score could decrease SCS. Divergent selection on PTAT of sires did have an influence on udder traits and SCS with little or no effect on body and yield traits.

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Effect of Time of Initiation of the Breeding Program and Bovine Somatotropin Supplementation on Reproduction

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Summary

One hundred sixty Holstein cows were assigned to a 2 x 2 factorial arrangement of treatments to study the effect of length of voluntary waiting period and time of initiation of bovine somatotropin (bST) supplementation on reproductive performance. The breeding program was initiated after a voluntary waiting period of either 56 days in milk (DIM) or 112 DIM. The bST supplementation was initiated after the voluntary waiting periods, either before the start of the breeding program (before first AI) or 4 weeks after the first AI. Extending the voluntary waiting period to 112 DIM increased the interval postpartum to conception. However, the 56-day delay in starting the breeding program only increased the interval to conception by 30 days and fewer cows left the herd for failing to breed back. Initiating bST supplementation before the start of the breeding program inhibited reproductive performance, particularly with the shorter voluntary waiting period of 56 DIM. These results suggest that reproductive performance might be enhanced if bST supplementation is not initiated until 4 weeks after AI, particularly with a shorter voluntary waiting period.

Introduction

Milk yield and reproductive performance play major roles in determining the profitability of a dairy herd. Unfortunately, there is an inverse relationship between milk yield and fertility, which is particularly manifested in primiparous cows. Conception rates have declined, whereas annual milk yield per cow has increased over the years. Thus, changes in management procedures to increase milk yield in the modern dairy cow can be detrimental to reproduction, but factors other than milk yield, per se, may be more important. These factors include energy balance, incidence of postpartum disease, season of calving, increasing herd size, type of housing, use of

Table 1. Effect of length of voluntary waiting period on reproductive performance.

Item	VWP (56 days)[1]	VWP (112 days)
Number of cows	90	74
bST started, DIM[2]	77.6[a]	129.6[b]
First AI		
DIM	73.6[a]	123.4[b]
% conception	31.1[c]	45.9[d]
Second AI		
DIM	107.9[a]	156.7[b]
% conception	26.7	33.3
Days Open	128.4[a]	157.6[b]
Services per conception	2.6	2.1
Pregnancy rate at 180 DIM, %	58.9	66.2
VWP to pregnancy, days	75.3[c]	49.9[d]
Cows culled not pregnant, number	20	6

[a,b]Means within a row with unlike superscripts differ ($P < 0.05$).
[c,d]Means within a row with unlike superscripts differ ($P < 0.10$).
[1]VWP = voluntary waiting period.
[2]DIM = days in milk.

Table 2. Effect of time of initiation of bST supplementation on reproductive performance.

Item	bST before AI	bST after AI
Number of cows	80	84
bST started, DIM[1]	82.4[a]	124.8[b]
First AI		
DIM	102.7[a]	94.4[b]
% conception	33.8	41.7
Second AI		
DIM	143.2[a]	121.4[b]
% conception	34.0	23.9
Days Open	154.7[a]	131.4[b]
Services per conception	2.4	2.2
Pregnancy rate at 180 DIM, %	56.3	67.9
VWP[2] to pregnancy, days	74.2	51.0
Cows culled not pregnant, no.	13	13

[a,b]Means within a row with unlike superscripts differ ($P < 0.05$).
[1]DIM = days in milk.
[2]VWP = voluntary waiting period.

bovine somatotropin (bST), genetic selection, and changes in metabolism rates and endocrine patterns.

In most modern dairies, the general practice is to initiate the breeding program early in the postpartum period, after a 60-day voluntary waiting period (VWP), with the goal of obtaining the accepted optimal herd average calving interval of 12 to 13 months. However, the incidence of death, disease, and other factors that could result in the involuntary removal of the cow from the herd is highest around parturition. Also, many cows may not have reestablished their reproductive cycles at the start of the rebreeding period after a VWP of 60 days. Milk production level and persistency of lactation are crucial factors in determining the appropriate calving interval. Milk yield and persistency are increased in cows supplemented with bST and extending the VWP before starting the breeding program in cows receiving bST has been suggested.

The effect of bST on reproductive performance in dairy cattle may depend on the timing at which bST administration is initiated. Previous reports on the effect of bST on reproduction are not consistent. Supplementation of bST has been reported to have no effect on reproduction, to decrease pregnancy rates, or to increase pregnancy rate when given at a specific time. Administration of bST beginning about 63 days postpartum decreased pregnancy rates, delayed conception and increased incidence of abortion and increased behavioral anestrus. However, when bST was initiated on the day of first GnRH administration of the Ovsynch-timed AI breeding protocol at 63 DIM, pregnancy rate was increased compared with the cows not started on bST until 105 DIM.

Thus, the effect of length of the voluntary waiting period and the time of initiation of bST supplementation relative to the time of the start of the breeding program in lactating cows needs to be studied.

Procedures

One hundred sixty four Holstein cows were grouped by parity and assigned randomly by calving date to a 2 x 2 factorial arrangement of treatments. The factors were: length of voluntary waiting period (VWP: 56 DIM or 112 DIM); or, time of first bST administration (3 d before the start of the breeding program or 4 wk after first AI).

The breeding program was initiated after a VWP of either 56 or 112 days. All cows received a single prostaglandin $F_{2\alpha}$ (PGF, Lutalyse®, Pharmacia-UpJohn Co., Kalamazoo, MI; 25 mg, im) treatment on the first Monday after their assigned VWP and inseminated at detected estrus following standard AI procedures. Cows not detected in estrus received additional PGF treatments on subsequent Mondays until estrus was detected. Repeat services also were based on time of detected estrus.

Supplementation of bST (Posilac®, Monsanto Co., MO; 500 mg, sc) was also initiated after the VWP of either 56 or 112 days. Cows received their first bST treatment beginning on either the Friday before the start of the breeding program (3 d before first $PGF_{2\alpha}$ and therefore, before the first AI) or 4 wk after their first AI. Supplementation of bST continued biweekly thereafter.

Conception rate was the percentage of inseminated cows diagnosed pregnant. Pregnancy rate was the percentage of all cows in the treatment group diagnosed pregnant. Data were analyzed as completely randomized design

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in a factorial arrangement of treatments using the mixed procedure with repeated measures option of SAS. Chi-square values were used to test for significance. Non-normally distributed variables (i.e., pregnancy and conception rates), were analyzed using GENMOD procedure of SAS for binomial data.

Results

Extending the VWP by 56 days, from 56 DIM to 112 DIM, increased the interval from parturition to first and second AI and to conception as expected (Table 1). However, the 56-day delay in initiating the breeding program only increased the interval to conception by 30 days. This difference appears to be primarily the result of the improved conception rates obtained by extending the VWP to 112 days.

Initiating the supplementation of bST at the start of the breeding program (after the assigned VWP and before the first AI) compared to starting 4 weeks after the first AI was generally detrimental to several measures of reproduction (Table 2). The detrimental effects were greatest in the cows assigned to the 56 day VWP compared to the VWP of 112 days. Supplementation of bST before the start of the breeding period tended to produce longer intervals from the end of the VWP to first and second AI and to conception. Cows were inseminated based on the time of detected estrus. Therefore, the intervals to AI and conception were prolonged because estrus was not detected as efficiently in the cows started on bST before the start of the breeding program. Data were not available to determine if the longer intervals between detected estrus in cows receiving bST before the first AI were a result of the cows failing to have normal reproductive cycles or because they failed to express the symptoms of estrus strongly enough to be detected. The percentage of cows pregnant by 180 DIM was the poorest in cows assigned to the 56 day VWP and started on bST supplementation before the start of the breeding program. Numerically, the fewest days postpartum to conception was observed in cows assigned to the 56 day VWP and bST supplementation was not started until 4 weeks after their first AI.

Reproductive performance appeared to be enhanced by the extended VWP and by waiting to initiate bST supplementation until 4 weeks after the first AI in this study. Milk yield is being evaluated to determine if this would be an economical practice.

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Tunnel Ventilation for Freestall Dairy Facilities versus Natural Ventilation with Supplemental Cooling Fans

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Curt Gooch
Scott Inglis[1]

Summary

The exceptionally hot summers of 1998 and 1999 made many Midwest dairy producers consider alternatives to naturally ventilated facilities for enabling cows to be cool and comfortable. Of these alternatives, tunnel ventilation — a mechanical ventilation system designed to provide both adequate air exchange and good interior air velocity — probably gained the most attention.

Results of a study conducted by The Ohio State University[2] in collaboration with Cornell University during the summer of 2000 showed that both ventilation systems perform well during temperate summer conditions with indoor thermal conditions closely tracking those outdoors.

Comparisons in two states...

Three pairs of naturally ventilated and tunnel-ventilated dairy barns were monitored during the summer of 2000 to compare the thermal environments developed by the two warm-season ventilation systems, as well as cow activity and response of the herds. Supplemental cooling fans were used within each of the naturally ventilated barns to direct airflow onto the cows.

Each barn was equipped with four temperature & humidity dataloggers and two black globes. A university technician visited both barns within a region roughly one day every other week, in the morning and again that afternoon, to take measurements and collect data.

Cows had it made in the shade...

Ambient air temperatures during midsummer were cooler than normal in both New York and Ohio, but all study regions had near-normal cooling seasons overall (based on the load placed on air conditioners). Tunnel ventilation provided only a slight advantage during the heat of the day in terms of moderating air

Table 1. Barn environments for conditions when ambient THI ≥ 70 during summer 2000.

	Applicable # of hours	Temperature differential, $T_i - T_o$, (F)		THI differential, $THI_i - THI_o$	
Farm ID	n	Mean[a]	Std. Dev.	Mean[a]	Std. Dev.
NV-NY	265	1.60	1.04	0.98	0.67
TV-NY	247	0.72	1.66	0.75	0.99
NV-OHC	478	1.04	1.17	0.73	0.69
TV-OHC	555	0.29	1.17	0.07	0.70
NV-OHW	642	1.37	1.08	0.82	0.70
TV-OHW	692	0.72	1.35	0.51	0.88

[a]The means for each barn pair differ at P < 0.01.

Table 2. Average respiration rates and interior environmental parameters (measured during visits to the study barns).

	Respiration rate (bpm)		THI		Airspeed (m/s)	
Location	Natural	Tunnel	Natural	Tunnel	Natural	Tunnel
Central New York	56.7	55.1	71.5	71.6	—	—
Central Ohio	51.7	55.7	66.3	69.6	0.80	0.94
Western Ohio	58.5	66.3	74.4	73.1	1.02	0.98

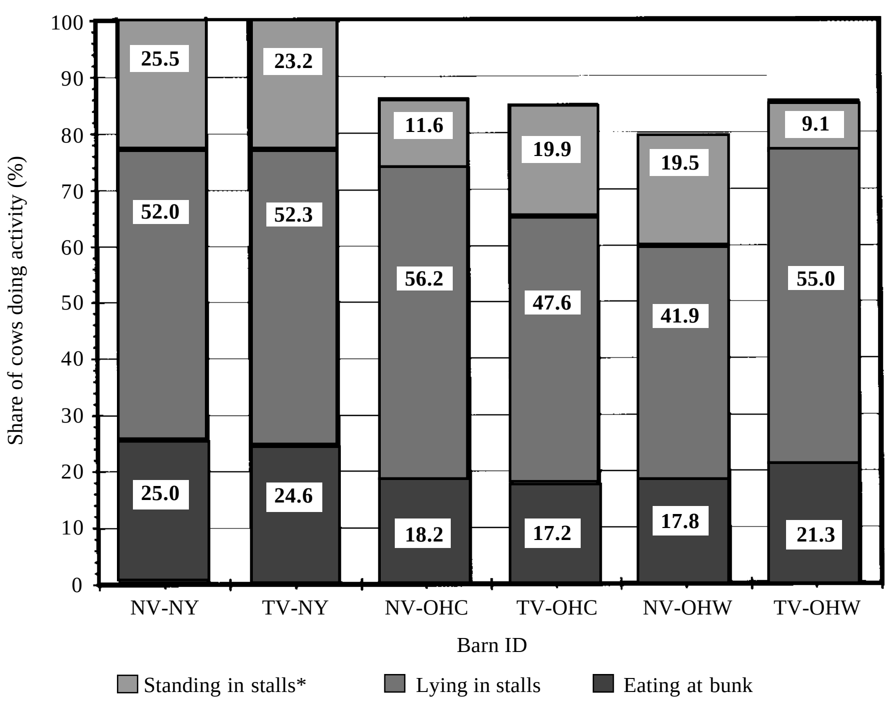

Figure 1. Overall levels of cow activity observed during multiple visits to the comparison barns.

temperature and THI (temperature-humidity index is an indicator for heat stress). Each of the tunnel-ventilated barns provided a slightly cooler interior environment than its naturally ventilated counterpart when outdoor conditions were potentially stressful (THI greater than 70) as shown in Table 1. In both types of facilities, cows were exposed to air temperatures similar to those found outdoors in the shade.

During hot, humid weather, air velocities at cow level must be sufficient to enable a cow to dissipate heat fast enough to offset her rate of metabolic heat production, regardless of the overall air exchange rate for the building. Average air speeds within the cow spaces of the barn pairs were similar — no difference existed for the two summertime ventilation systems. Considerable spatial variation in airspeed existed with both systems — at least a spread of 2 mph in all barns. There was no difference in temporal variation of airspeed in the cow spaces of the barns; neither ventilation system produced a consistent airspeed at cow level throughout the barn. Therefore, microclimate control should be an area of emphasis for improving both ventilation systems.

Contented cows...

The activity levels of cows — the extent to which cows were at the feed bunk, lying in stalls, standing in stalls, etc. — could not be said to be different within the tunnel-ventilated barns than within the naturally ventilated barns. Activity comparisons were made on a barn-wide basis using the total number of cows in each barn at the times in which observations were made. The average share of cows performing productive activities (eating at the bunk or lying in stalls), ranged from 60 to 78% (Figure 1). Differences in productive/nonproductive activities could not be attributed to the ventilation system employed. As an aside, the share of cows standing in stalls was lower in barns with sand-bedded stalls (Barns NV-OHC and TV-OHW) than in the comparison barns with mattresses.

A summary of data for the study period (Table 2) shows that average respiration rates were near expected levels for moderate summer environmental conditions and that no consistent advantage could be attributed to using either ventilation system. Average respiration rates of monitored cows during individual visits ranged from 40 to 81 breaths per minute over the course of the study period. The normal-to-moderately-elevated respiration rates confirmed observations that the cows seldom experienced significant levels of heat stress.

(Continued on next page)

The cumulative result was that there was little or no negative effect of barn environment on milk yield in any of the herds/barns. Both ventilation systems performed well, in general, and neither had an advantage in terms of reducing declines in the volume of milk sold during the summer.

Looking ahead...

Based on the data collected in this study, the researchers concluded that, for summer weather conditions that are typical for the Great Lakes area (i.e. there are few, if any, extended periods of hot, muggy weather), naturally ventilated barns with supplemental cooling fans and tunnel-ventilated barns produce similar overall thermal environments and similarly effective convective conditions within barns.

The results of this study indicated that tunnel-ventilation likely would provide more consequential benefits during more extreme summer conditions, especially extended periods with little wind, as often occurs during hot, muggy weather. It is during these periods that tunnel ventilation can maintain high levels of air exchange through a barn, while naturally ventilated systems cannot. Risk management approaches should be used to evaluate these systems on a regional basis using historical weather data and cost-benefit analyses.

This study also revealed several areas for improvement in the design of tunnel-ventilated dairy barns. The buildup of heat and moisture needs to be countered in long barns. In Barn TV-NY, which was over 800 feet long, temperatures in the downstream quadrants consistently were 3-5ºF warmer than those upstream. Also, improved means of maintaining a uniform air velocity within the barn, especially in the cow space, need to be developed. Airflow was channeled toward the areas providing the least resistance and away from areas offering more resistance due to blockage (cows and freestalls) or confinement (shorter heights). Installation of a horizontal ceiling at eave height proved fairly effective in this regard in one barn, although it presented complications for year-round ventilation. Providing proper cold-weather ventilation is a separate, but important challenge for tunnel ventilation systems that requires attention.

[1]Rick Stowell, Assistant Professor, Biological Systems Engineering, Lincoln; Curt Gooch and Scott Inglis, Senior Extension Associate, and Research Associate, Pro-Dairy Program / Agricultural & Biological Engineering, Cornell University, Ithaca, NY.

[2]Financial support for this project was provided by the Ohio Dairy Farmers Federation and Aerotech, Inc., Mason, MI.

Financial Performance of Dairy Herds in Nebraska

Krishna Boddugari
Doug Jose
Rick Grant[1]

Introduction

The dairy industry is undergoing rapid changes; the changing market structure, decreasing price supports, in addition to the relatively stable milk prices and increasing input costs have narrowed the profit margins. In the face of such a situation, financial management and decision making continue to be critical to the success of dairy producers. Many nutritional and management practices have been adopted to improve the financial performance of dairy farms. Accurate data regarding the income and expenses incurred on farms would help farmers assess the financial situation of their operations. This data also will help farmers compare their performance to better performing dairies in the region and help them get a clear picture of their performance relative to the other dairies. A number of surveys have been conducted to assess the income and expenses from dairy herds in Nebraska. However, the use of different income and expense parameters and different accounting procedures on each farm skewed the outcome of such surveys. Also, since most of the farms are multi-enterprise farms, it is difficult to analyze each enterprise separately.

The specific objectives of the study were to:1) provide benchmark financial data for dairy producers in Nebraska to compare with their own financial performance, 2) develop a tool to help the farmers analyze the income and expenses from the dairy enterprise, and 3) establish some important income and expense parameters to analyze financial performance.

Procedures

Data Collection

Twelve herds were selected based on their production performance from DHIA records. The herds selected were some of the best performing dairies in the state of Nebraska and most also were in the process of expansion. Most of the data requested was from financial and DHI records. The input form was from a spreadsheet program designed at the University of Missouri (K. Bailey and A. Kleibeoker, 1997), which later was modified to meet the specific needs of the Nebraska dairy producers. The questions on the survey ranged from the beginning and ending herd sizes to the expenses incurred on the various inputs. Since most of the dairies also have some other subsidiary operations apart from dairy, the form was designed to separate the expenses and income from the dairy from those of the other operations. Most of the inputs were provided by the farmers. Based on some of these inputs other calculations like the herd replacement costs and depreciation on livestock were calculated using the standard industry accounting procedures. The inputs sent by the farmers were analyzed using the spreadsheet program and were averaged across all the farms.

The annual publication of the Nebraska Farm Business Association report and the annual reports of Genske, Mulder and Company (Chino, Calif.) were the two major sources of data used for comparison purposes. Even though the detailed data were collected from the 12 herds for the 1998 accounting year it still provides a useful comparison. This is validated by a comparison with Genske, Mulder and Company data for 1999 to 2001.

Calculation Procedures

The procedures minimized farm-to-farm variation in the calculation of income and expenses. For example, milk production was measured by the amount of milk shipped rather than total milk production, bulk tank measurements, or DHIA records. Other concepts such as the depreciation on dairy cattle, herd replacement cost, and the method used to separate the expenses on dairy from those of the other enterprises are also discussed. The procedures follow the methods used by the accounting profession to calculate true production costs.

Depreciation on Livestock

Livestock depreciation is an important expense item that is overlooked most often while calculating the expenses on the farm. The various inputs provided by the farmer such as the average herd size, replacement cost and average salvage value of the replacements were used in calculating the depreciation expense on the livestock.

Table 1. Gross Income for Nebraska Monitor Herds, 1998.

Item	Per Head	Per Cwt	Percent*
Milk	$2,968	$15.14	97.7
Calves	$24	$0.12	0.8
Patronage	$13	$0.07	0.4
Other	$33	$0.17	1.1
Total	$3,038	$15.50	100.0

*Percent of total gross income.

The herd turnover rate is the percentage of the herd that has left the herd due to death or disease (culled). This number then is used to calculate the life expectancy of the herd. Depreciation expense per cow then can be calculated using the average cost of replacement and the average salvage value.

The cost incurred on feeding and raising replacements is deducted from expenses to arrive at the cost of production. A total cost of $1.25 is deducted per heifer per day. This includes a cost of feeding a heifer per day of $1; the remaining $0.25 is the other cost incurred on raising the heifer per day. This is based on previous observations that the total costs incurred on raising a heifer per day would be $1.25. The spread sheet program allows the user to change these values to reflect the costs of raising the heifers on any farm.

Feed Expenses

Feed expenses were separated into home-grown and purchased feed costs. The cost of home-grown feeds was assessed at the market value. Other inputs used in the dairy and crop enterprise were separated based on the percentage use in the respective enterprises, so there is no double accounting for the home-grown feed costs. The feed expenses incurred in feeding the replacements is not considered. The procedure discussed above is used to calculate the feed expenses of the replacement herd and is deducted from the total herd feeding costs.

Income Calculation Based on Cwt Shipped

Income calculations are done based on the number of cwt of milk shipped and not according to the amount of milk produced. All the milk produced may not be shipped for various reasons and calculating the income based on this would inflate the income and give a distorted picture of farm performance. Table 6 shows the income and expenses comparisons from three different surveys. The monitor herds and Genske, Mulder and Company surveys use the same procedures, but the NFBA calculates income based on the total production which might have resulted in the higher gross income than that of the monitor herds.

Results

The output from the spreadsheet program shows the income and expenses on a per head, per cwt milk sold, and percent of gross income basis. The average number of cows in the herd for the 12 dairies surveyed was 276 with a range of 154 to 625 cows. The average pounds of milk shipped per cow was 19,610 lbs. Table 1 shows the average gross income from the 12 farms. Income from milk accounted for 97.7 percent of the total gross income with the rest coming from the sale of calves, patronage dividends, and sale of other items. The gross income per head was $3,038 and gross income per Cwt milk shipped was $15.50.

Tables 2 and 3 show the major expense items. Some of the minor expense items are not shown. Feed costs were a major expense and accounted for 29.5 percent. This cost is the cost of

(Continued on next page)

Table 2. Milk Production Expenses for Nebraska Monitor Herds, 1998.

Expense Item	Per Head	Per Cwt	Percent
Feed	$895	$4.56	29.5
Herd Replacement	$294	$1.50	9.7
Marketing	$141	$0.72	4.6
Vet, Med & AI	$170	$0.86	5.6

Table 3. Other Operating Expenses for Nebraska Monitor Herds, 1998.

Expense Item	Per Head	Per Cwt	Percent
Vet, Med, and AI	$170	$0.86	5.6
Labor	$285	$1.45	9.4
Supplies	$56	$0.28	1.8
Utilities	$ 40	$0.21	1.6
Interest	$111	$0.57	3.6
Depreciation	$347	$1.77	11.4

Table 4. Net Income for Nebraska Monitor Herds, 1998.

Item	Per Head	Per Cwt	Percent
Gross Income	$3,038	$15.50	100
Total Expenses	$2,817	$14.36	92.7
Net Income	$221	$1.14	7.3

Table 5. Production and Herd Turnover Comparisons, 1998.

Item	Monitor herds	NFBA[1]	Genske, Mulder & Co.
Avg Herd size	276	92	1,185
Avg Production/cow	19,610	20,117	22,265
Herd turnover rate	40%	43.9%	27.3%

[1]Nebraska Farm Business Association

Table 6. Expense Comparisons on a Cwt Basis, 1998.

Item	Monitor Herd	NFBA[1]	Genske, Mulder & Co.
Feed	$4.56	$7.08	$5.38
Herd replacement	$1.50	——	$1.69
Vet, med & AI	$0.86	$1.07	$0.32

[1]Nebraska Farm Business Association

feeding the dairy herd and does not include the cost of feeding the replacements. The feeding cost of the replacements is calculated separately and are included in the herd replacement costs. Feed costs include the cost of both purchased and home grown feeds, being assessed at their market value. Some of the other important expense items were herd replacement cost, accounting for 11.4 percent. The depreciation expense includes depreciation on equipment, machinery, buildings and livestock.

Table 4 shows the average net income from the 12 operations. Total expenses were 92.7 percent of the gross farm income, leaving a net income of 7.3 percent or $1.14 per cwt of milk shipped. The operating expense ratio, which is the percentage of gross income that has gone into paying for all the expenses except for the depreciation and interest expense, is 77.7 percent — higher than the benchmark number of 70 percent provided by the Ohio State University Extension Service (1997). One of the reasons for high expenses on these farms could be that all these farms were in various stages of expansion and so the expenses on some of the items needed for the expanded herds would result in higher operating expense ratios.

The results obtained from the 12 monitor herds have been compared to those of the Nebraska Farm Business Association (NFBA, 1998) and Genske, Mulder and Company (1998). Results of the NFBA are from the averages of herds from Nebraska, and the results from the Genske, Mulder and Co. are the averages from the high plains dairies, which include some of the largest dairies from the states of Nebraska, Kansas and Colorado. The average milk production per cow for the monitor herds was 19,610 lbs, lower than the NFBA and Genske, Mulder and Co. averages. Monitor herds being some of the best performing herds, the milk production would be expected to be much higher than that of the NFBA herds, but the lower milk production reported for the NFBA herds stems from differences in the methods of calculation. NFBA takes into account the total pounds of milk produced whether all of that milk is shipped or not. This approach would inflate the gross income value because some of the milk produced may not be eligible for shipping. A different approach was used to calculate the total income from milk in case of the monitor herds. The total pounds of milk shipped was used for calculating the income from milk sales. The herd turnover rate, which is the average percentage of the herd leaving the herd every year, was very high for the Nebraska herds (40 and 43.9 percent for monitor and NFBA herds respectively versus 27.3 percent for the high plains herds). This high herd turnover rate could be due to the higher veterinary and medical costs for the Nebraska herds ($0.86 and $1.07 per cwt, for monitor and NFBA herds respectively versus $0.32 for high plains dairies) endorses this reason.

The gross and net income comparisons are shown in Table 6. The income for the NFBA herds was higher than that of the other two. This could be because of the different methods used in the calculation of income and expenses. The total expenses for the Nebraska herds were higher than those of the high plains dairies. This could be because of the higher veterinary and medicine cost on the Nebraska dairies and the higher herd turnover rates.

Conclusions

The dairy herds in Nebraska are doing as well as the other dairies, but the higher veterinary and medical costs and the higher herd turnover rates are narrowing the profit margins. The data set can be used by the dairy producers to compare their financial performance with other herds in the state. The expense parameters and the methods discussed for calculating the income and expenses would enable the farmers to arrive at an accurate data set.

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[1]Krishna Boddugari, former graduate student; Doug Jose, Professor and Farm Management Specialist, Agricultural Economics; and Rick Grant, Professor and Extension Dairy Specialist, Animal Science.

Nebraska Dairy Web Site

Rick Grant
Jeff Keown[1]

A comprehensive web site for the Nebraska dairy industry was developed in 2000. The web address is:

http://nebraskadairy.unl.edu

The major functions of this web site are:

1) Submission of questions to extension specialists. If you type in a question, and then select the topic area (such as nutrition, facilities, etc.), the message will go to an appropriate specialist who will then e-mail back an answer.
2) Provide links to Nebraska dairy information. You can easily access NebGuides and other extension bulletins that provide useful dairy management information.
3) Provide links to state and national resources. We have quick links to all state agencies and their publications as well as links to major sources of dairy information from major land grant universities and USDA.
4) World wide dairy links. You can link to the National Dairy Data Base, Dairy-L, Graze-L, and several world-wide agricultural data bases.
5) Updates on hot topics. Currently, there is information on Johne's disease, for example.

In the past year, the site has averaged 2,783 hits per month. In a typical month, there are 109 hits per day with the following distribution: 33% from US educational institutions, 22% from UNL, 18% from U.S. commercial users, 10% international (30 countries), and 17% of unknown origin.

Although we cannot determine specifically how the information gained from the web site has influenced the user, it is clear that the Internet is an effective and well-used method of disseminating information and allowing communication with the dairy industry. We encourage you to check out the web site and provide us with feedback and questions!

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[1]Rick Grant and Jeff Keown, Extension Dairy Specialists, Animal Science, Lincoln.

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NEBRASKA DAIRY

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Dairy NebGuides & UNL Extension Publications

Manure Management

University of Nebraska Links

Dairy Grazing Resources

State of Nebraska Websites

World Wide Dairy Links

Dairy Expansion in Nebraska

Nebraska Dairy Organization Links

Department of Dairy and Foods Requirements

Dairy Technician Certification Program

Welcome to Nebraska's dairy resource homepage!

This site provides you with links to **vital dairy information** from Nebraska and across the country.

Our goal is to provide you with rapid access to the most cutting-edge information and technology in dairy production.

Whats New

UPCOMING EVENTS

2000-07-15 - For more information on the Nebraska program —click on "QUESTIONS" and send a message to " DAIRY HEALTH and DISEASE ".

This web site from the University of Wisconsin will upodate a dairy producer on Johnes Disease.

2000-08-10 - NEW PUBLICATION AVAILABLE!!! Hiring Dairy Personnel: Making the Process Easier Check out this new Nebraska Dairy Publication.

2000-08-10 - NEW PUBLICATION!!! Nebraska Milk and Cheese Opportunity Study. This publication covers the facts relating to the capacity of Nebraska to produce and

NEW DAIRY INFO

- Nebraska Dairy Largest dairy web site for Nebraska

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Dairy Technician Certification Program

Bill Matzke
Jeff Keown
Rick Grant[1]

Over the past few years, there has been a significant increase in the number of dairy producers in Nebraska asking, "Do you know of anyone interested in working on a dairy operation?" Unfortunately, there are very few individuals with the proper training to immediately start working on a modern dairy operation. Since we knew there was a shortage of trained workers, we decided to network with Northeast Community College (NECC) to begin to train individuals to work on dairies.

We soon realized that NECC did not offer any courses in dairy and therefore if we were going to train individuals, we would need to offer at least an Applied Dairy Production Management Course in Norfolk. Last spring, we offered the class for the first time with 11 students enrolled. This course also gives us another opportunity to train graduate students that may eventually want to teach. Bill Matzke, a M.S. student studying with Rick Grant, taught the class. Since this is a production-oriented class, we needed a few hours in one time segment to teach. The class was offered on Thursday afternoon. This also reduced our costs and travel time to teach in Norfolk. A few of the classes were held on farms and we would like to take this opportunity to thank Mike Henn and Matt Winkelbauer for allowing the class to meet several days at their farms located near Norfolk. We also asked leading industry professionals to assist in the more hands-on classes.

The entire Certification Program takes 1 1/2 years. The student takes the regular production agricultural curriculum as well as the Applied Dairy Production Management Course. After completing this year-long study, we will work with the student in obtaining a paid summer internship. This will be a supervised internship. We want to be certain that the student is actually working on all areas of the dairy operation and is gaining valuable experience to start a career. Once the student has completed all of the requirements for the certificate, he/she will be issued a Certificate of Completion from NECC and NU Cooperative Extension.

Some of the topics covered in the course are:

1. Dairy Systems Overview
   - Job descriptions
   - Expectations of the employee and employer
   - The Basics of Dairying
2. Basic Dairy Nutrition
   - Determining dry matter percent
   - Dry matter intake
   - Particle size, measurement and application
   - Basics of ration balancing
3. Forage Quality/Bunker Management
   - Forage quality measurement
   - Interpreting forage analyses
   - Bunker silo management
4. Total Mixed Rations (TMR)
   - TMR mixing routines
   - TMR wagon maintenance and safety
   - Feed bunk management
5. Hoof Health
   - Laminitis
   - Hairy heel warts
   - Footbath management
6. Mastitis
   - Causes
   - Prevention
   - Treatment
   - Proper milk sampling
   - Bedding
7. Fresh Cow Protocols
   - Postpartum metabolic diseases
   - Monitoring systems
   - Footbath management
8. Baby Calf Management
   - Colostrum management
   - Dehorning
   - Diseases
9. Vet Tech/Bio Security
   - Proper IV techniques
   - DA diagnosis
   - Johnes, Leukosis, BVC
   - HAACP (Hazard Analysis Critical Control Points)
10. Reproduction
    - Heat Detection
    - Ovsynch®, Modified Target Breeding
    - Pedometers
11. Cow Comfort
    - Bedding
    - Curtains
    - Heat stress
    - Stall design

When the course is offered again, it will be open to producers and dairy workers in northeast Nebraska. The participants can attend any of the sessions for a nominal fee paid to NECC. We plan to notify the producers in the area the next time the course is offered with instructions for enrolling in the various sections. We are pleased that Dr. Chuck Pohlman, Dean of the Agricultural Programs at NECC, has let us make this option available.

For more information on this program, please contact Jeff Keown or Rick Grant, University of Nebraska, A218g Animal Science, P.O. Box 830908, Lincoln, NE 68583-0908, phone (402) 472-6453, jkeown1@unl.edu or rgrant1@unl.edu.

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[1]Bill Matzke, Graduate Student, Jeff Keown and Rick Grant, Extension Dairy Specialists, Animal Science, Lincoln.

Mid American International Agricultural Consortium (MIAC)

Jeffrey F. Keown[1]

What is the Mid American International Agricultural Consortium and how does it benefit the Institute of Agriculture and Natural Resources? MIAC is a consortium of five Midwest universities (University of Nebraska, Iowa State University, University of Missouri, Oklahoma State University and Kansas State University) with agricultural programs that are forming new linkages in the education and extension efforts with Mexico. This group meets regularly with representatives of Mexican universities, governmental agencies and producer groups to find areas for research, extension and education that are of mutual benefit and interest to both countries.

The major focus areas are:

- Livestock and Meats
- Biotechnology
- Women's Issues
- Maize
- Wheat
- Natural Resources

The lead for each program is based at an individual campus. IANR is the leader of the Livestock and Meats Program. As the head of this program, we have sponsored a Co-product Symposium in Queretaro, Mexico in 1997 and are in the final planning stages for a Dairy Symposium to be held in Queretaro and Aquacalentes later this year. MIAC has also sponsored a Conservation Tillage, Biotechnology and a Women's Forum in Mexico.

When meeting with our Mexican counterparts, we work on areas of research and education that are of interest to both countries. Currently, foot-and-mouth disease is of primary concern. Natural resource issues along both sides of the border and water conservation are assuming major importance as time progresses.

What do we get from these exchanges? We get good input into our program emphasis as to research that can be conducted here in the Midwest that can be of benefit to each country. We get graduate students and post-doctorates to work at our universities, thereby increasing the scientific exchanges between the two countries. This exchange also gives us the opportunity to travel to Mexico to learn more about the Mexican culture and customs.

We plan to emphasize distance education, offering some classes via satellite to various Mexican universities. We will be able to offer programs or modules to Mexico that Mexican universities may not be able to offer.

With the ever-increasing trade between our two countries, it is important for us to open communications with various Mexican institutions. MIAC has given us the opportunity to offer more programs to Mexico that we could not have done individually.

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[1]Jeffrey Keown, Professor and Extension Dairy Specialist, Animal Science, Lincoln.

Dairy Research Herd Report

Erin Marotz[1]

This report recaps the last two years at the Dairy Research Unit and provides a preview of plans that will improve service to the entire dairy industry.

In July 1999 the 140 ft x 60 ft hay and commodity shed was destroyed by fire. The contents and the structure were a total loss. This was a severe loss to the Dairy Unit, but it provided a unique opportunity to improve the design and create a building that better suited the unit's needs. The new 140 ft x 60 ft hay and commodity building was completed in May of 2000. This shed is a monoslope roof design with three 16 ft concrete bays for bulk feed storage. These bays are open to the south and allow for semi-truck deliveries of cottonseed, wet corn gluten feed, sawdust for bedding, or any other commodities. There are four bays on the east end that measure 9 ft x 16 ft. These are used for bulk grain storage. The remaining 96 ft is used for hay storage. These additions and changes to the previous shed have provided better bulk storage which in turn enables the unit to track inventories better and feed cows faster and more efficiently.

In August of 1999 the unit updated its parlor equipment as the old milking equipment was outdated and unreliable. New Boumatic® meters and detachers were installed in the double-five parlor. These units have provided accurate milk production data and more reliable service. Plans are to add automatic identification to these units in the future.

In November of 1999 a temporary hay storage building was added to provide storage of commodities and hay through the winter and until the new hay shed could be built. This building is a 30 ft x 72 ft hoop structure. When the hay shed was completed, this barn was renovated into a new facility for weaned replacement heifers. The south wall, which was four feet high, was removed, and the covering pulled to the north side. This resulted in a five foot high opening to the south. A rain gutter was added to the south side and the interior of the barn was divided into four pens. Three of the pens are 16 ft x 16 ft and one is 16 ft x 24 ft. A fence-line feed bunk was built and the new calf barn was nearly complete. Outside runs were added to each pen; they are 40 ft long. A working alley and head gate is provided for all routine work and treatments. Inside the barn a concrete surface gives the calves space to stand on while they eat, and the remainder is straw pack. This barn is one of the nicest additions made to the dairy in many years. It combines great calf comfort with optimum worker efficiency and it has improved the aesthetics of the Dairy Unit a great deal.

In November of 1999 construction began on a new free stall barn to house some of the lactating cows. The barn is a 60 ft x 130 ft hoop style structure. The barn has 60 stalls that are head-to-head design and also is equipped with 63 locking stanchions. The barn was built with 10 ft roll-up curtains and a ridge vent to allow for maximum ventilation. Fans over the free stalls and misters over the feed bunk alleviate as much heat stress as possible. Metal halide lights on timers take advantage of the long-day lighting benefits. The free stall beds have sand traps installed in them to help keep a level base to the stalls and to help conserve sand. These have worked very well and have added to cow comfort in the barn. Construction ended and cows were moved into the barn in May of 2000.

In 2000 the hospital barn alley was redesigned to increase both worker safety and cow flow and comfort. Improvements continued in the appearance of the Dairy Unit because it is visited by many people each year to learn about the dairy industry or to find answers to the problems that face them in their dairy operations. In October of 2000 the feed mixer was upgraded to a hay processing mixer box. This has allowed incorporation of long-stemmed alfalfa into the ration without having to grind it first. The unit can be more selective of hay quality because it is able to buy alfalfa that better suits its needs, instead of relying solely on alfalfa silage as a forage source.

The year 2001 has seen the addition of new perimeter fencing around the unit that will form the external boundaries of the grazing pastures. A new tractor is used on the manure spreader. In March the unit hosted the Nebraska State Dairymen's Association meeting and provided tours to those in attendance.

The Dairy Unit is always focused on improving the conditions of animals' housing and care. Goals are to build a new breeding heifer free-stall barn and upgrade the special needs area to improve cow comfort. A redesign of the grazing scheme is under way to allow some rotational grazing research on replacement heifers and/or dry cows. There is limited research done in this area and this may enhance the productivity of the heifers.

The Dairy Research Unit milks about 110 to 125 cows twice daily. It raises all of its replacements and sells the bull calves shortly after birth. The current RHA is 24,141 lb of milk, 983 lb fat and 759 lb protein. Current calving interval is 14.0 months and services per conception is 2.3. Annual cull rate is approximately 35%. The dairy employs seven people including the manager and performs enough research trials to keep several graduate students busy essentially all year. The Dairy Research Area is on about 180 acres at the Agricultural Research and Development Center (ARDC) near Mead.

For more information, call (402) 624-8068 or email emarotz@unlserve.unl.edu. Due to biosecurity concerns, please contact the unit ahead of time for a tour.

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[1]Erin Marotz, Manager, Dairy Research Herd, Mead, NE.