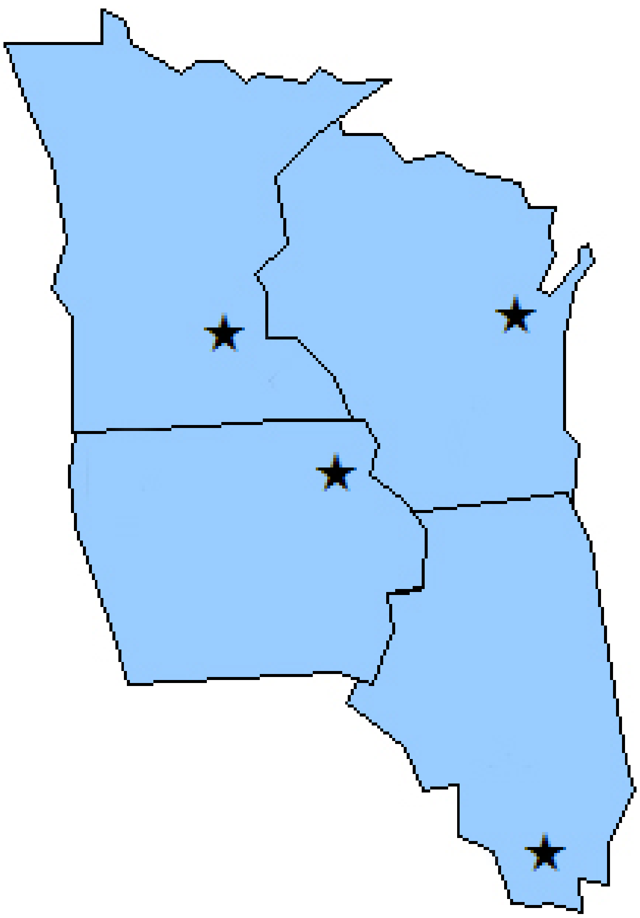
4-State Dairy Management Seminar



February 21, 2005
Carver County Dairy Expo
Norwood Young America, Minnesota

February 22, 2005
NE Iowa Dairy Foundation Center
Calmar, Iowa

February 23, 2005
Starlite Club
Kaukauna, Wisconsin

February 24, 2005
American Legion Hall
Breese, Illinois

Presented by the Extension Services of Illinois, Iowa, Minnesota, and Wisconsin.

Table of Contents

What Milking Frequency is Right for My Farm?

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Take Home Message

- Labor availability and parlor capacity are key factors when considering a change in milking frequency.
- Increases in early lactation milking frequency may provide a better return when labor supply is limited than 3X milking.
- Cow movement and time budgets must be optimized for any increase in milking frequency to succeed.

A number of management factors need to be evaluated when a shift in milking frequency is under consideration. Besides the obvious labor supply and schedule questions, these include nutritional factors such as feed availability and time at the bunk, cow movement and distance to the parlor, and throughput of the milking system. In addition, when to implement the higher frequency of milking, throughout lactation or only in the early weeks, is also a factor that must be considered. While not an exhaustive list, the objective of this paper is to highlight major decision points that require investigation before movement from the typical twice daily (2X) schedule is implemented.

As with other mammals, when cows are milked more frequently they produce more milk. Because milk yield is ultimately a function of the number of mammary epithelial cells that are active and the relative metabolic activity of those cells, it is reasonable to expect that more frequent milk removal influence both of those endpoints. However, <u>when</u> in the lactation cycle mammary cell number versus metabolic activity is affected may differ. More complete knowledge regarding when and how frequency responses change during lactation will allow for more appropriate management decisions to optimize production and profitability.

The most common milking frequency of 2X removal likely evolved as the trade-off between labor efficiency and milk output. Twice daily milking provides significant yield advantage over milking once a day, and that advantage is magnified as the absolute level of production increases. For example, the depression of yield that occurs with a decline to once daily milk removal has been estimated to be as little as 20%, yet most of the studies examining that effect were completed in late lactation cows, at relatively low production levels, and under challenging nutritional conditions of late season pasture. Though direct comparison of 1X versus 2X milking under conditions more typical of North American management is not available, it is likely that yield depression on 1X would far exceed the 20% reported.

In contrast to the 1X vs. 2X comparison, a number of studies have compared 2X to 3X and greater frequency under intensive management conditions. Summaries of those experiments suggest that an average increment of 8 lb/d of milk can be expected throughout lactation with 3X compared to 2X. Because the increment is fixed over a range of production levels rather than increasing as production rises, the 8 lb/d value (or less) should be used in economic decisions rather than a herd specific value based on an expected percentage increase. Using percentage increases, particularly in higher production herds, can result in overestimation of the expected increase in production as well as inaccurate estimations of feed resources required to support that production response. The same consideration should be applied to continually milking 4, 5 or 6X.

Rather than milking cows at a higher frequency than 2X over the entire lactation, recent studies suggest that cows milked at a frequency of 4 to 6X in early lactation, and then returned to 2X or 3X, continue to produce more milk throughout the remainder of that lactation. For example, one study compared a 6X frequency to 3X frequency for the first 21 days of lactation, from which time all animals were milked 3X until they went dry. Cows in the 6X group produced over 2000 lbs. more milk than the 3X cows, and the higher yield persisted long after they were returned to the 3X frequency. Similar effects on persistency have been noted when cows were milked 4X for the initial 21 d in milk and then milked 2X. That is, the 4X cows produced more milk when milked at the higher frequency, and continued to yield more milk than 2X cows through 40 weeks of lactation.

Potential Collateral Benefits

In addition to the positive milk yield responses, there are some other potential benefits that may accrue from increasing milking frequency, especially in the early lactation phase. Some studies indicate that higher milking frequencies are associated with improved udder health. The most common endpoint for udder health is somatic cell count (SCC) or score. Relative to 2X, cows milked 3X over the entire lactation have lower SCC. There is some evidence that even the transient high frequency milking in early lactation, i.e. 4-6X for the first 21 d in milk, can produce persistent reduction in SCC well into lactation. In situations where premiums are offered based on milk quality, lower SCC must be considered as another potential revenue benefit to offset additional costs of implementation.

Although less tangible, behavioral benefits of higher milking frequency have also been noted. Increasing the number of visits to the parlor may accelerate training of first lactation animals to the parlor and milking procedures. Because transition cows tend to be immuno-suppressed relative to later lactation animals, they are prone to a variety of diseases, both primary and secondary to an infection. Surveillance of cows during this critical period, including temperature monitoring, is useful to detect and treat disease events early and limit the overall effect on the cow. Thus the increased number of observations on a cow that is milked at a higher frequency should provide for earlier detection of problems and limit progression of those incidents.

Cost Considerations

The major cost factors associated with higher frequency milk removal are feed, labor, and supplies and utilities associated with each milking. With regard to diet, it appears that increasing milking frequency does not require a change from normal feeding practices. That is, cows fed ad libitum will increase intake to meet the greater caloric demand of higher milk production. In fact higher intakes in early lactation have been observed with higher frequency milking in early lactation. Interestingly enough, there is little indication that 3X milked cows consume more feed than cows milked 2X in the same study. However, the duration of those studies that directly compare 2X to 3X feed consumption may not have been extended into lactation long enough for significant divergence in intakes to appear. It is likely that 3X cows will have to replace body condition in later lactation and so increased intake should be assumed and budgeted for. Further, any factors that limit feed consumption, either physical (e.g. bunk space limitations) or environmental (e.g. heat stress), are likely to have a negative influence on the ability of cows to respond to higher frequency milking no matter what stage of lactation that it is imposed on.

Labor cost and capacity must both be considered before shifting to a higher frequency scheme. Moving from 2X to 3X is often viewed as a low input approach to improve production efficiency. Certainly it is expected that returns from 3X milking will cover variable input costs (Table 1 and 2), but capacity of the labor supply to sustain a 3X schedule may vary by farm and cow number in particular. In the case of a single owner-operator milking 100 cows, implementation of 3X is likely to be impossible to sustain, yet a 2X/4X system may be easily integrated into the schedule, and ultimately produce 60 to 70% of the revenue of 3X (Table 1). Conversely, a dairy milking 1200 cows 2X may be able to add a shift of milkers to increase to 3X, if there is a reliable supply of labor available.

Management Factors

An area of concern with greater milking frequency is that of time budgeting for other activities to support optimal lactation. Research suggests that cows spend approximately 21 hrs/d resting, ruminating, and feeding, so it is easy to envision a situation where doubling the frequency of milking could negatively impact a cow's ability to meet baseline needs for performance. It is critical that factors such as distance traveled to the parlor, relative mobility (i.e. lameness), and standing time on concrete in the holding pen be managed appropriately so that a response is not negated by other limitations. Particularly in the case of fresh cows milked at high frequency (i.e. 4X to 6X), time away from stalls, feed and water should be minimized. Fresh cows should be housed in a pen close to the parlor, grouped so that extra time in the holding pen is minimized, and lame cows may not be candidates for increased milking frequency. Indeed, even if cows are typically milked 3X (or more) for the entire lactation, managers may want to consider penning lame cows separately and reducing the number of milkings for that group in order to maximize their ability to rest and feed.

Milking frequency is just one of a number of management options to increase milk yield per cow so how does it impact responses to other techniques such as bST or photoperiod? There is evidence that increasing milking frequency, either early or throughout lactation can be effectively combined with bST with the expectation of an additive response. Many producers use long day photoperiod to increase milk yield, yet there are no studies that have directly examined the combination of greater milking frequency and extended light exposure. While there is no reason to believe that well-fed cows would not respond to higher frequency milking and long days, it is critical that lights not be left on continuously to sustain the response. That is, the increased milking frequency must be accomplished within the constraints of an 18 hr light period so that cows will continue to have a 6 hr period of darkness. Heat abatement that prevents declines in milk yield can also be combined with greater frequency, though again care should be taken to ensure that cows are exposed to fans and soakers in holding pens if they are spending more time there.

A number of milking system and performance factors need to be evaluated before increasing milking frequency. The first question should relate to parlor capacity and flow dynamics. If parlor capacity is already maximized, then increasing milking frequency early or throughout lactation may not be an option. But milking cows more frequently in early lactation requires less capacity than if the frequency is maintained throughout lactation, because only 8 to 12% of the herd will be fresh at any point. Another important area to evaluate is milking system settings. Particularly when milking at 4X or 6X, the additional milkings may lead to teat end damage if they are continued to long into lactation. If the extra milkings are not at even intervals, the cows may experience a less robust oxytocin release, and milk ejection may be delayed. This can lead to periods of low flow at the beginning of milking. At the end of milking care must be taken to avoid excess manipulation of the teats from over milking. Thus, flow rates for automatic take-offs should be set at the higher rather than lower end of the scale so that teat end strain is avoided.

Examples

Given the previous discussion it is useful to develop some examples for the decision process producers may encounter as they consider a management shift from 2X to another milking scheme. First, let's examine a herd of 100 cows, where all labor is provided by the owner and the family; a typical situation on many dairy farms in the upper Midwest and Canada. Parlor size is sufficient to support additional throughput of cows, and feed resources are adequate for more cows or greater intake of cows already on the farm. With a desire to optimize cash flow and production efficiency, the question becomes should they go from 2X to 3X or 2X/4X fresh cows? Or, should more cows be added? Critical areas to review for the decision are housing and labor. In the case of housing, the barn has 100 freestalls, so even though additional cows could likely be accommodated in the parlor, overstocking would be necessary in the barn. Labor is the larger issue, as there is no extra labor to assist with the third milking, and even with hiring a milker the revenues of 2X/4X are expected to be about 70% of all cows being milked 3X (Table 1). Therefore, 2X/4X is likely to be the choice for this producer over 3X, even though the daily cost of the extra milkings in early lactation is not profitable. That is because the cost is recovered from milk revenues after frequent milking ends at 21 days, whereas 3X milking requires sustained input throughout lactation.

Table 1. Comparison of predicted milk response and potential economic benefit from derived from milking all cows 4X for the first 21 days of lactation, or milking all cows 3X for the entire 305 day lactation, in a 100 cow herd. Note that labor and supply costs are presented on a per day of treatment basis (i.e. for 21 d in 2X/4X), but are spread over 305 days for the calculation of lactation returns.

	2X/4X Day	2X/4X 305 Day	3X Day	3X 305 Day
Additional milk/cow	4 lb	1220	8 lbs	2440 lbs
Labor[a]	$0.42	$17.50	$0.20	$61.00
Feed[b]	0.14	$42.70	0.28	85.40
Supplies, utilities[c]	0.12	$2.52	0.06	18.30
Milk revenue[d]	0.44	$134.2	0.88	268.40
Marginal profit/cow[e]	-0.24	71.48	0.34	103.70
Marginal profit/farm[f]	$-24.00	$7,148	34.00	$10,370

[a] Labor cost of $10/hour and 4 turns/hr; 2 parlor turns/d for 2X/4X of 12 cows, 8 turns/d for 3X of 100 cows.
[b] Dry matter at $0.07/lb; 0.5 lb DM for each lb of milk increase.
[c] Cost for supplies for an extra milkings including dip, towels, utilities, detergent, and sanitizer.
[d] Milk at $11.00/cwt.
[e] Estimate is for each day of a typical 305 day lactation, during and after milking frequency treatment is imposed.
[f] Calculated from profit/cow for 305 day lactation for 100-cow herd.

Next let's look at a herd of 600 cows milked in a double 20 parlor. Cows are currently milked 2X, but the herd size will be doubled over the next 12 months to better utilize the facilities on hand. Milking parlor capacity is in excess now, and a good labor force is available. As indicated in Table 2, the best option now is to milk 3X and milk fresh cows at the higher frequency because facilities are overbuilt and that scenario maximizes cash flow and efficiency. However, parlor capacity will be limited after expansion to 1200 cows (i.e. it will take 7.5 hrs to complete each milking), so 3X/6X would not be an option after expansion. In addition, animal movement and time away from stalls may become a negative factor after expansion because of the relatively low parlor throughput, and that would potentially limit the effectiveness of the additional milkings in early lactation.

Table 2. Comparison of predicted milk response and potential economic benefit from derived from milking all cows 4X for the first 21 days of lactation, or milking all cows 3X for the entire 305 day lactation, in a 600 cow herd. Note that labor and supply costs are presented on a per day of treatment basis (i.e. for 21 d in 2X/4X), but are spread over 305 days for the calculation of lactation returns.

	2X/4X Day	2X/4X 305 Day	3X Day	3X 305 Day
Additional milk/cow	4 lb	1220	8 lbs	2440 lbs
Labor[a]	$0.19	$3.94	$0.07	$21.35
Feed[b]	0.14	$42.70	0.28	85.40
Supplies, utilities[c]	0.12	$2.52	0.06	18.30
Milk revenue[d]	0.44	$134.2	0.88	268.40
Marginal profit/cow[e]	-0.01	85.04	0.47	143.35
Marginal profit/farm[f]	$-6.00	$51,024	34.00	$86,010

[a] Labor cost of $10/hour and 4 turns/hr; 6 parlor turns/d for 3X/6X of 80 cows, 15 turns/d for 3X of 600 cows.
[b] Dry matter at $0.07/lb; 0.5 lb DM for each lb of milk increase.
[c] Cost for supplies for an extra milkings including dip, towels, utilities, detergent, and sanitizer.
[d] Milk at $11.00/cwt.
[e] Estimate is for each day of a typical 305 day lactation, during and after milking frequency treatment is imposed.
[f] Calculated from profit/cow for 305 day lactation for 600-cow herd.

Four Control Points in Dairy Replacement Heifer Management

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Take Home Message

- Monitor heifer performance with collection, tracking and evaluating data.
- Improve heifer growth by improving early neonatal nutrition.
- Manage the variation in heifer growth as averages alone can be misleading.
- Control heifer feeding costs by feeding to needs and not over-feeding or wasting feed.

Introduction

The goal of feeding dairy replacement heifer management is to produce high quality replacement heifers at a low cost. It is difficult to detail all of the business and biological aspects of developing information based quality control management programs for dairy replacements in this paper; therefore, the following key control points will be offered.

Control Point # 1 – Monitoring Systems

Heifer growth should be monitored using modern technology. Basic components of a high-efficiency monitoring system include: an animal handling area, electronic scale, and a digital or computerized recording device. In these systems, heifers can be handled, sorted, and moved efficiently. Data, such as heifer weights, should be collected during routine management task in a form that is easily downloaded for computer software applications. To be of value, data collected from monitoring systems need to be evaluated. While plotting or calculating mean or average growth rates is of value it tends to fall into the affirmation category of information. Heifer weights should be graphed with numerous categorical fields (such as pen, owner, failed passive transfer, pneumonia, heel warts, degree of inbreeding, season, etc.) to determine what factors are causing variance in growth rates.

Control Point # 2 – Improve Neonatal Nutrition

Recent research has demonstrated that traditional neonatal nutrition programs maybe limiting growth potential of calves. The dairy calf is extremely efficient at converting dietary protein intake to body protein deposition with efficiencies near 60% compared to protein deposition efficiencies in bred heifers of 15%. Simply stated, if dairy producers want to improve heifer growth and calve heifers 15-30 days earlier, the greatest opportunity to improve the management system lies in the very early phases of growth.

In studies at the University of Illinois (Drackley, 2003) calves were fed milk replacer solids at 10, 14, and 18% of BW for 7 wks. Calf growth rates were improved from a low of 0.60 lbs/d to a high of 2.25 lbs/d. Special formulation of milk replacer is required when additional milk powder is fed because growth is increased by feeding more milk replacer energy, thus more protein is required in the milk replacer to meet growth demand. For example, if milk replacer is fed at 1, 2, or 3 lbs/d, the milk replacer should contain 20, 25, and 30% CP, respectively, to meet increased growth demand. There have been numerous studies conducted on these practices, and commercial products are now widely available in the United States and field results have been generally positive.

On-farm milk pasteurization systems are now economically viable for dairy producers and calf growers (see accompanying paper in these proceedings). Our laboratory recently evaluated the nutrient density of pasteurized waste milk and on a comparative basis the mean protein and fat content of pasteurized waste milk would be the equivalent of a 28.0% CP and 31.0% fat milk replacer. Feeding calves 1 gallon of pasteurized waste milk per day supplies 50.0 and 65 g more protein and fat per day, respectively, as compared to feeding a calf 1 lb of 20:20 milk replacer powder per day. Research by Godden, 2003 at the University of Minnesota has demonstrated improvement is calf growth and health when pasteurized waste milk was fed in lieu of 1-1.25 lbs of 20:20 milk replacer.

Critical Point # 3 – Manage Sources of Non-nutritional Variance

Once data or information has been collected from the monitoring system, growth/weights, etc., of the heifers should be evaluated. It is common to evaluate the average daily gain of heifers or to plot the weights, heights, lengths of heifers on a graph for comparative purposes. While evaluating the average growth of heifers is useful, evaluating variances of heifer growth probably has greater day-to-day management utility. Growth of heifers varies for two reasons – genetics or a breach of management. The heifer monitoring and evaluation system should be able to capture any or all heifers that exceed variance tolerances. Presented in Figure 1 is a plot of heifer weights from a Wisconsin dairy producer with 77% of the heifers falling within the large and small Holstein genetic ranges as defined by Hoffman et al., 1992. Presented in Figure 2 is a plot of heifer weights from a second Wisconsin dairy producer with only 41% of the heifers falling within acceptable genetic variance limits. Interestingly, the mean heifer growth rates for both operations are identical.

Figure 1. Comparison of individual herd heifer growth rates to desired variance.

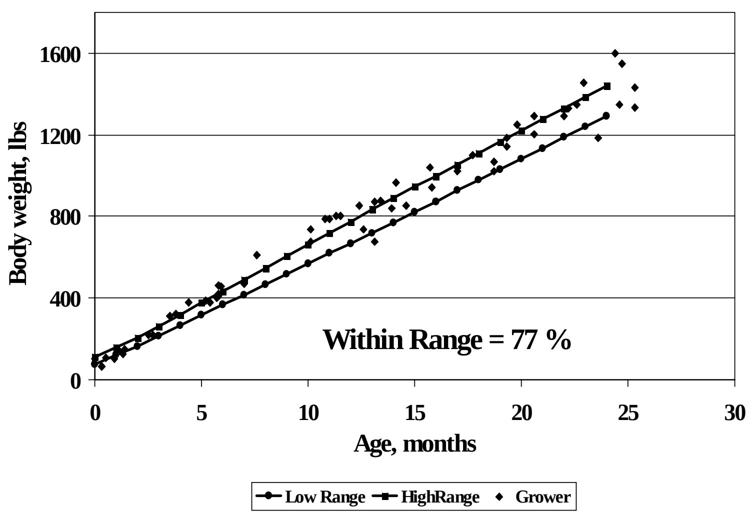
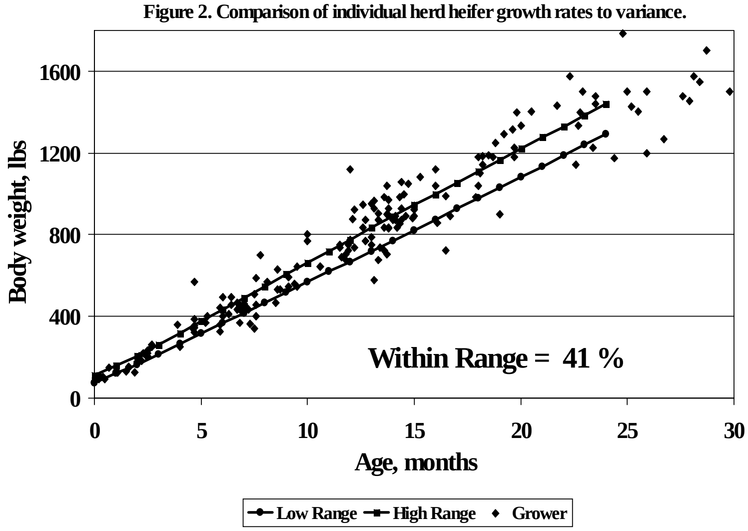


Figure 2. Comparison of individual herd heifer growth rates to variance.



The utility of a good heifer monitoring program is to find heifers that are varying from the system -- not to justify appropriate means. Once found, a specific plan of action should be implemented for heifers with excessive variance. Specific heifers that vary from growth objectives should be found and both the animal and records thoroughly examined. Listed in Table 1 are non-nutritional sources of variance that could cause growth variance to occur.

Table 1. Factors with the potential to cause variance in replacement heifer growth.

Pneumonia	Excessive dietary energy	Inbreeding
Hoof disease	Deficient dietary energy	BVD
Respiratory health	Deficient dietary protein	Acidosis
Salmonella db	Injury/trauma	Comfort
Parasites	Crypto/Coccidiosis	Twins
Bunk space	Abrupt diet transition	Low birth BW
Crowding	Liver abscess	Dystocia
Failed passive transfer	Hardware	Harsh environmental conditions

Critical Point # 4 – Control Feed Cost

Presented in Table 2 are feed cost data for heifers broken down into specific cost categories. These data represent the average feed cost of a heifer for 62 Wisconsin dairy herds and can be used as a set of dairy calf and heifer feed cost benchmarks. The new publication “Raising Dairy Replacements” from Midwest Plan Service contains a complete system to monitor feed cost of any group of replacement heifers

Good heifer nutrition starts with an understanding of the heifer’s base nutrient requirements. The nutritional requirements and philosophies of feeding a growing animal are significantly different from feeding lactating cows and should be recognized as such. Dietary energy, protein, mineral, and vitamin feeding guidelines for large-breed dairy heifers gaining 1.8 pounds per day are available in the 2001 NRC and appear to be reasonable under most management situations.

Table 2. Survey of feed cost of 287 heifer groups from 62 commercial dairies. Hoffman et al., 1999, University of Wisconsin.

		Feed Cost		
Body weight, lbs	Age, mo	Mean $/day	Minimum $/day	Maximum $/day
218.9	3.0	0.66	0.34	1.18
403.3	6.1	0.76	0.39	1.43
601.4	10.0	0.74	0.48	1.21
809.6	14.2	0.92	0.54	1.75
1020.4	19.1	1.00	0.77	1.33
1196.1	21.8	1.37	0.84	2.08

Because heifers are frequently reared in conditions outside of thermal neutrality—such as heat stress or cold stress—heifer nutrition programs need to be adjusted to the heifers’ environment. Specifically, heifers will require more energy in the diet when the following conditions or combination of conditions exist: temperatures below 50°F; wet conditions; dirty haircoats; cold, wet, non-insulative resting areas; wind chill; or the absence of solar radiation. These conditions require more maintenance energy to be used by the animal. Therefore, more energy is needed in the diet for growth to occur.

The effects of environmental conditions on dietary energy needs are more profound on 300 pound heifers when compared to those heifers weighing more than 1,000 pounds. As heifers gain body mass and rumen capacity, they are much more adept at handling cold, wet environmental conditions. In most situations with young heifers, producers should opt to improve the environment and provide optimal resting areas rather than trying to feed more energy in the diet to overcome poor conditions. A simple tool to monitor heifer environments is a monthly checklist of environmental conditions by pen. The checklist should include, body weight, temperature, coat conditions, crowding, lot conditions etc. This information should be collected objectively and shared with the nutritionist and herd veterinarian to facilitate nutrition and management adjustments.

While it is often necessary to vary dietary energy to maintain optimal heifer growth, feeding excessive dietary energy is the principal cause of over conditioning heifers. At calving, over-conditioned heifers will be more prone to calving difficulties and metabolic diseases. Dietary protein does play a minor role in heifer body condition, but overfeeding energy remains the biggest culprit. When heifers become over-conditioned, dietary energy should be reduced by including low energy forage, such as straw, into the diet or limiting the amount of feed offered. Maintaining an inventory of low quality forages is critical to control situations when feed inventories provide excessive energy.

As with energy, protein requirements of heifers are dynamic. The younger a heifer is and the faster a heifer grows, the more protein required in the ration to meet growth demands; however, feeding excessive protein to heifers does not prevent over-conditioning or enhance stature growth. When excess protein is fed, heifers simply excrete it as nitrogen in the urine. Excessive protein (nitrogen) is not economically prudent and can create environmental concerns. To prevent over-conditioning, heifer rations should be balanced using appropriate growth rates with energy densities appropriate for the heifers' environmental conditions.

Field studies have demonstrated heifer raisers commonly over supplement minerals and vitamins to dairy heifers in an effort to assure dietary adequacy (Table 3). Over supplementing minerals and vitamins increases heifer rearing cost. To ensure proper levels of minerals and vitamins are fed, test forages and feeds for their mineral content using precision wet chemistry procedures and then provide supplements to reach requirements with modest overages allowed. If possible, free choice mineral and vitamin supplementation should be avoided. Specifically, heifer raisers should be sure to feed precise levels of dietary phosphorus because over supplementation results in excessive levels of the mineral in manure, which is an environmental concern.

Feeding heifers is expensive and great care should be taken not to waste feed. Feed bunks should be designed and managed to control feed waste. Properly adjusting neck rails, throat heights, or installing slant bars in the feed alley can often dramatically reduce feed wastage. Hay racks, portable bunkers, or other make-do feeders should not be used as too much feed is lost on the ground. Do not feed heifers forages or grains placed on the ground. In addition, do not provide heifers unlimited feed. Precisely monitoring feed intakes and feeding heifers as needed should reduce feed wastage and increase feed efficiency.

Table 3. Percent of Wisconsin dairy herds feeding excess minerals to 660 lb replacement dairy heifers. Zygarlicke and Hoffman, 2002.

	NRC (Adequacy)[1]		Mineral Nutrition Status[2]		
Mineral	Lower	Upper	Deficient	Adequate	Excess
Macro-mineral, % of DM					
Ca	0.41	0.51	3	4	93
P	0.23	0.29	7	7	86
Mg	0.11	0.14	0	7	93
Cl	0.12	0.15	0	0	100
K	0.48	0.60	0	0	100
Na	0.08	0.10	27	10	63
S	0.20	0.25	37	47	16
Micro-mineral, mg/kg					
Cu	10	13	13	14	73
Fe	31	39	0	0	100
Mn	20	25	0	0	100
Zn	27	34	10	10	80

[1] The upper level is the NRC, 2001 requirement plus overage (25%).
[2] Percent of diets.

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Evaluating the Role of Distillers Grains in Dairy Rations

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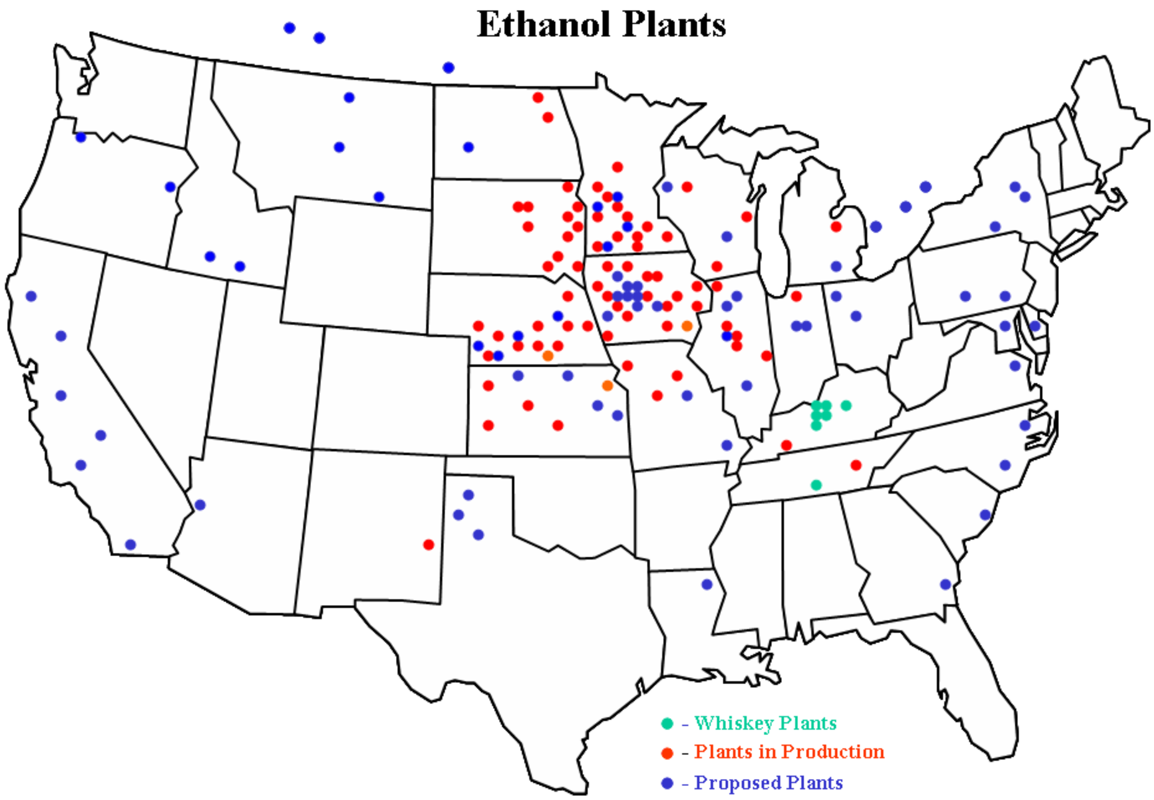
Take Home Message

- Distillers grains can be a very cost effective feedstuff to use in diets for lactating dairy cows.
- Both wet and dry distillers grains can be fed at 20% of the diet DM without any decline in milk yield.
- Producers should be aware of the differences in nutrient composition between products coming from different ethanol plants and from the same plant at different times, and monitor quality closely.

Corn distillers grains (DG) are becoming more readily available in the upper Midwest, due primarily to the rapid growth in the number of ethanol plants. Currently, there are approximately 50 ethanol plants in operation, or under construction, in the 4-State area with additional plants in the planning stage.



Wet milling of corn is designed to produce pure starch and capture the maximum value from each kernel of corn. Each bushel of corn yields on average 31.5 lb of starch, 12.5 lb of gluten feed, 2.5 lb of gluten meal, and 1.6 lb of oil. Four major types of livestock feedstuffs are produced: corn steep liquor (25% CP on a 50% solids basis), corn germ meal (20% CP, 2% fat, and 9.5% fiber), corn gluten feed (21% CP, 2.5% fat, and 8% fiber), and corn gluten meal (60% CP, 2.5% fat, and 1% fiber).

Dry milling of corn is designed primarily to produce either ethyl alcohol for beverages, or ethanol for addition to gasoline. The dry milling and fermentation of a bushel of corn grain produces on average 2.7 gallons of ethanol, 18 lb of dried distillers grains with solubles, and 18 lb of CO_2. Since only the fermentable starch is removed during the production of ethanol, the remaining products contain approximately three times more nutrients than corn. Typical nutrient composition values for corn and DG are in Table 1.

Table 1. Typical nutrient composition of corn and corn distillers grains.

	Corn	Distillers[1]	
Crude protein, %	9.4	31	(28.45-33.74)
RUP, % of CP		47-63	
NE-l, Mcal/lb	0.89	1.03	
ADF, %	3.4	13.8	(8.03-20.95)
NDF, %	9.5	39.0	
Fat, %	4.2	10.6	(3.52-12.83)
Ca, %	0.04	0.08	(0.02-0.51)
P, %	0.30	0.75	(0.43-0.99)
Lysine, %		0.90	(0.61-1.06)
Methionine, %		0.65	(0.54-0.76)

[1]Adapted from http://www.ddgs.umn.edu/nutrientprofiles.htm revised 11-6-04.

Most of the dry milling plants in the upper Midwest are relatively new (built since 1990) and are more efficient than the older plants. By incorporating different enzymes in the fermentation process, plant operators have been able to increase the yield of ethanol from the traditional 2.65 gal/bu of corn to at least 2.8 gal/bu. Consequently, the nutrient content of DG being produced by these newer Midwestern ethanol plants is higher than most "book values" which are based on products produced from older, less efficient plants. Nutrient values for DG from newer Midwestern ethanol plants (NMP), older Midwestern ethanol plants (OMP) and book values from the 2001 NRC are in Table 2.

Table 2. Typical "book values" for corn distillers grains.

	NMP[1]	OMP[1]	NRC[2]
Dry matter, %	88.9	88.3	90.2
Crude protein, %	30.2	28.1	29.7
Fat, %	10.9	8.2	10.0
Acid Detergent Fiber, %	16.2	16.7	19.7
Neutral Detergent Fiber, %	42.1	35.4	38.8
Ash, %	5.8	6.3	5.2
Calcium, %	0.06	0.44	0.22
Phosphorus, %	0.89	0.90	0.83
Lysine, %	0.85	0.53	0.66
Methionine, %	0.55	0.50	0.54

[1] Adapted from Spiehs et al. 2002 J. Anim. Sci. 80:2639.
[2] NRC (2001).

However, there can be considerable variation in the DG produced within a plant on different days and between plants (see Table 1). Dairy producers need to be aware of this potential variation and monitor supplies closely to avoid dramatic changes in animal performance due to poor product quality. Distillers grains are a good source of rumen undegradable protein (around 57% of CP) although the value is slightly less for the wet product than for the dried product. Distillers grains that are heated too much during the drying process will be darker in color and more of the protein will be in the unavailable form. As with other corn products, the amino acid profile is quite good with lysine being the first limiting amino acid. Removal of the starch in the corn kernel results in the other nutrients becoming more concentrated, with the higher levels of fat and phosphorus being of greatest concern in ration formulation. Consequently, producers should monitor levels of these nutrients closely, especially when including other sources of supplemental fat in the diet.

Production Response

Several studies have been conducted to quantify the production response of lactating dairy cows fed DG. Most were designed to look at DG primarily as a protein source, but some have considered it as an energy source as well. Nearly all research shows that cows produce as much milk or more when DG are in the ration compared to when soybean meal is the protein supplement. However, milk production did not always increase when ruminally protected lysine and methionine were added to diets containing DG. For example, one trial (Nichols et al.) compared soybean meal with corn DG, both with and without ruminally protected lysine (Table 3). Both DMI and milk yield were increased significantly ($P < 0.01$) by feeding corn DG compared to soybean meal. Supplementing the diets with rumen protected lysine and methionine did not enhance intake or milk yield with either protein source. In a subsequent trial (Liu et al.), DG and a blend of other protein sources (fish meal and soybean meal) with DG were fed, with and without ruminally protected lysine and methionine (Table 4). Again, there was no response to the added amino acids, and in this trial there was no difference in response to DG versus the protein blend.

Table 3. Response of feeding soybean meal based diets vs. distillers grains.

	SBM	SBM + RPLM	CDG	CDG + RPLM
DMI, lb/d	63.3	61.1	64.8	66.1
Milk, lb/d	75.6	75.0	77.8	80.9
4.0% FCM, lb/d	71.9	71.2	72.6	75.4
Fat, %	3.63	3.71	3.59	3.58
Protein, %	2.99	3.06	3.02	3.08

Taken from Nichols et al. 1998. J. Dairy Sci. 81:482.

Table 4. Response from feeding corn distillers grains or a protein blend.

	CDG	CDG + RPLM	Blend	Blend + RPLM
DMI, lb/d	62.6	61.1	61.3	60.2
Milk, lb/d	71.9	69.9	72.3	72.3
3.5% FCM, lb/d	73.9	72.3	74.1	73.2
Fat, %	3.72	3.76	3.67	3.63
Protein, %	3.23	3.26	3.25	3.26

Taken from Liu et al. 2000. J. Dairy Sci. 83:2075.

Feeding Levels

Historically, most nutritionists have recommended feeding up to 20% of the diet dry matter as DG. This would equate to 10-13 lb/d of dry DG and 30-40 lb/d of the wet product. Few studies have been conducted to evaluate the effects of feeding much higher levels. Hippen et al. fed wet DG at 10%, 20%, 30%, and 40% of the diet dry matter (Table 5), then in a related study fed dry DG at 0, 13%, 26%, and 40% of the diet dry matter (Table 6). They found that dry matter intake ($P < 0.01$) and milk yield ($P < 0.05$) decreased significantly when wet DG comprised more than 20% of the diet. Similar results were observed when dry DG comprised more than 13% of the diet dry matter. Schingoethe et al. fed wet DG at 31.2% of the diet DM and saw a significant reduction in dry matter intake ($P < 0.01$), but not in milk yield (Table 7) when wet DG was included at this level. Neither milk fat percentage nor milk protein percentage changed as a result of feeding increasing amounts of wet DG, although the yield of milk fat decreased ($P < 0.05$). However, when feeding dry DG, milk fat percentage decreased when more than 13% DG was included in the diet.

Table 5. Response from feeding various levels of wet corn distillers grain.

	Wet DG, % of DM			
	10%	20%	30%	40%
Diet DM, %	49.5	45.8	41.9	40.4
DMI, lb/d	50.5[a]	50.7[a]	42.8[b]	37.9[b]
Milk, lb/d	60.2[c]	59.3[cd]	55.1[d]	56.2[d]
Fat, %	2.80	2.90	2.80	2.72
Protein, %	3.45	3.55	3.57	3.52

[a,b] $P < 0.01$.
[c,d] $P < 0.05$.
Taken from Hippen et al. 2003. J. Dairy Sci. 86 (Suppl. 1):340.

Table 6. Response from feeding various levels of dry corn distillers grain.

	Dry DG, % of DM			
	0%	13%	27%	40%
DMI, lb/d	59.3[a]	65.9[b]	58.9[a]	55.6[a]
Milk, lb/d	89.7[c]	91.9[c]	86.2[d]	80.0[d]
Fat, %	3.40[e]	3.18[f]	3.19[f]	3.10[f]

[a,b] $P < 0.01$.
[c,d] $P < 0.02$.
[e,f] $P < 0.04$.
Taken from Hippen et al. 2004. Midwest Section ADSA/ASAS Abstracts, pg. 68.

Table 7. Response from feeding wet corn distillers grain.

	Wet DG, % of DM	
	0%	31.2
DMI, lb/d	48.7[a]	43.4[b]
Milk, lb/d	67.7	67.9
Fat, %	3.60	3.85
Protein, %	3.06[a]	2.84[b]

[a,b] $P < 0.01$.
Taken from Schingoethe et al. 1999. J. Dairy Sci. 82:574.

When feeding diets based on equal proportions of corn silage and alfalfa, DG can usually replace most if not all of the protein supplement. However, when corn silage is the only or predominant forage, the diet could contain more than 20% DG. In this case, an additional source of supplemental protein may be needed as well as additional lysine. Finally, when feeding diets consisting of mostly alfalfa, levels of DG will need to be limited, due to the dietary protein needs being met more easily.

Concerns

As mentioned previously, one of the major concerns regarding DG is the variation that can occur between DG coming from different plants and between products coming from the same plant, but produced at different times or on different days. Producers will need to monitor supplies closely and adjust their diets to reflect changes in product quality.

The variation in fat and phosphorus content is the greatest concern to dairy nutritionists and producers. Distillers grains are considered a moderate fat source, running around 10% ether extract on a DM basis. The general limit is to feed not more than 1.5 lb. of free fat, and if other sources of free fats, especially whole oilseeds such as soybeans or cottonseeds are included in the diet, the maximal amount of DG that should be included will be reduced. Phosphorus supplementation can be reduced or eliminated when feeding DG. Again, producers should monitor these levels carefully, especially since phosphorus is the basis for most nutrient management plans.

Other concerns relate to the storage life (usually 5-7 days, longer in colder times of the year) of the wet product. Wet DG can be ensiled in silage bags or a preservative can be added to lengthen storage life. A third option would be to mix the wet DG with another feedstuff such as soyhulls, corn silage, corn stalks, or beet pulp, then ensile the mixture in a bag.

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Crossbreeding: Why the Interest? What to Expect

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Take Home Message

- Crossbreeding is the opposite of inbreeding depression.
- Inbreeding depression and hybrid vigor should be greatest for cow fertility in dairy cattle.
- Crossbreeding is NOT genetic improvement.
- Continuous use of top progeny-tested A.I. sires is essential for genetic improvement.
- Hybrid vigor is a bonus that dairy producers can expect on top of the individual gene effects from the use of top A.I. sires within breed.
- The bonus from hybrid vigor should be about 6.5% for production and at least 10% for fertility, health, and survival of dairy cows.
- Crossbreeding systems should use <u>three</u> breeds to allow for an adequate level of hybrid vigor, without the complication involved with using more breeds.

Circumstances Have Changed

Interest in crossbreeding is at perhaps an all-time high among commercial dairy producers internationally. Over the past 50 years, North American Holsteins have steadily increased as a percentage of the national dairy herd in most countries. However, circumstances have changed regarding the historical superiority of pure Holsteins compared to crossbreds. In recent years, milk pricing in most markets has continued to place an increasing emphasis on solids in milk rather than the fluid carrier. The reproductive decline of Holsteins, on both an observed and a genetic basis, has been clearly documented in most countries of the world including the U.S. Post-partum complications of Holsteins have become more pronounced in recent years in most environments. The typical Holstein cow has become too large for optimum longevity, and sometimes she has difficulty fitting in stalls that are inadequate in size.

Perhaps, most importantly, Holsteins have become more inbred over time. At this time, two bulls (Chief and Elevation) make up about 30% of the gene pool of U.S. Holsteins. Globally, the problem with the “narrowing of the genetic base” is almost as severe as in the U.S., because U.S. Holstein genetics has replaced native breeding stock internationally. As an example, one bull (Starbuck – a son of Elevation out of an Astronaut – both American) has a 20% relationship to Canadian Holsteins. Inbreeding is increasing at a constant rate of about 0.1% per year for U.S. Holsteins, and heifers born in 2004 had an average inbreeding of 5.0%. The recommendation for commercial milk production is that inbreeding shouldn’t surpass 6.25%. With an average of 5.0%, many individual Holsteins surpass the 6.25% threshold. The first negative consequence of inbreeding should be reduced cow fertility, because an inbred embryo is more likely to be non-viable and sloughed.

Introduction

The perceived decline in fertility and survival of pure Holsteins led owners of seven large dairies in California to mate Holstein heifers and cows with imported semen of the Normande and Montbeliarde breeds from France and of the Norwegian Red and Swedish Red breeds. Because the Swedish Red (SRB) and Norwegian Red (NRF) share similar Ayrshire ancestry and exchange some sires of sons, we have regarded the two breeds collectively as "Scandinavian Red". Crossbred cows began calving in June 2002, and all early crossbreds were Normande-Holstein. Montbeliarde-Holstein and Scandinavian Red-Holstein crossbreds began calving about one year later than the Normande-Holstein crossbreds. Some cows in the seven California dairies remained pure Holstein, which has permitted comparison of pure Holsteins and crossbreds.

Production

All cows calved from June 2002 to December 2004 for a study of the production of crossbreds versus pure Holsteins. Sires of all cows were A.I. sires with assigned sire codes. Furthermore, the Holstein maternal grandsires of all cows (both purebred and crossbred) were likewise required to be A.I. sires with assigned sire codes. This edit removed all cows from the study that had natural service Holstein sires or maternal grandsires and provided for fairer comparisons. Test days for cows with 3X milking were pre-adjusted to 2X milking.

The analysis of daily production data from milk recording included adjustment for stage of lactation within breed (five 30-day intervals from calving to 150 days postpartum), age at calving, herd-year-season of calving (3-month seasons), and transmitting ability (PTA) of each cow's Holstein maternal grandsire. Effects of breed composition, sire, and cow (within breed and sire) were key factors in the statistical analysis. Table 1 has a summary of the number of daily observations from milk recording, cows, and sires represented in the production data.

Table 1. Number of observations for production.

Breed	Milk recording observations	Cows	Sires
Holstein	1,855	419	73
Normande-Holstein	1,033	231	24
Montebeliarde-Holstein	2,034	468	22
Scandinavian Red-Holstein	1,356	305	13

Results for production during the first 150 days of lactation of first lactation cows are provided in Table 2. Only results for the first 150 days of lactation are reported to date, because 305-day lactational production of cows will need to be adjusted for differences in reproductive status. Cows with very short days open are penalized for 305-day production, and cows with long days open or do not become pregnant have inflated 305-day production. Results for 305-day production adjusted for days open will be available later in 2005.

Table 2. Average daily production (2X basis) for the first 150 days of first lactation.

	Holstein	Normande-Holstein	Montebeliarde-Holstein	Scandinavian Red-Holstein
Milk (lb)	66.0	58.4	63.4	65.6
Fat (lb)	2.32	2.16	2.29	2.37
Protein (lb)	2.02	1.88	1.99	2.06
Fat + Protein (lb)	4.34[a]	4.04[b]	4.28[a]	4.43[a]
% of Holstein		-7%	-1%	+2%

[a, b] Different letters of superscripts indicate significant differences ($P < 0.05$)

Production was gauged as fat plus protein (lb) on a daily basis. The Scandinavian Red-Holstein crossbreds (+2%) and Montbeliarde-Holstein crossbreds (-1%) were not significantly different from pure Holsteins for production; however, Normande-Holstein crossbreds had 7% less production than pure Holsteins. Some have questioned the genetic level of the sires of the pure Holsteins; however, these California dairy producers historically have used high-ranking Holstein A.I. sires. The current PTA (November 2004) of the sires of the pure Holstein cows in this study are +1224 lb milk, +34 lb fat, +40 lb protein, despite the fact that these cows were born several years ago.

Calving Difficulty and Stillbirths

Number of observations for births was much greater than for production. Calving difficulty was measured on a 1 to 5 scale, with 1 representing a quick and easy birth without assistance and 5 representing an extremely difficult birth that required a mechanical puller. Scores of 1 to 3 were combined and regarded as no calving difficulty, and scores of 4 and 5 were combined and represented calving difficulty. Stillbirths were recorded as alive or dead within 24 hours of birth. It is important to keep in mind that calving difficulty and stillbirth are traits of both the sire and the dam.

Breed of Sire

For analyzing effects of breed of sire, dams of calves were separated into first calving heifers versus cows calving for the 2nd to 5th time. Adjustments were made for sex of calf and herd-year-season of calving. Across breed of sire for first-calf heifers, calving difficulty averaged 15.5% for bull calves and 7.3% for heifer calves, and stillbirth rates were 18.8% for bull calves and 5.6% for heifer calves. Clearly, the bulk of calving difficulty and stillbirths were for bull calves. Table 3 provides the number of births, calving difficulty rate, and stillbirth rate by breed of sire. Inadequate numbers prevented the use of Normande sires. Scandinavian Red sires had significantly less calving difficulty and stillbirth than Holstein sires when dams of calves were first-calf pure Holsteins.

Table 3. Calving difficulty and stillbirths for breed of sire when pure Holstein dams calved for the first time.

Breed of sire	Number of births	Calving difficulty (%)	Stillbirth rate (%)
Holstein	371	16.0^{a}	15.7^{a}
Montebeliarde	158	12.0^{a}	$13.2^{a,b}$
Brown Swiss	224	$11.9^{a,b}$	$12.0^{a,b}$
Scandinavian Red	1,016	5.5^{b}	7.9^{b}

[a, b] Different letters of superscripts indicate significant differences ($P < 0.05$)

As expected, cows calving for the 2nd to 5th time had much lower rates of calving difficulty and stillbirth than first-calf heifers. Bull calves again were much more of a problem than heifer calves. Bull calves had almost twice the rate of calving difficulty (7.9% versus 4.4%) and twice the rate of stillbirth (8.4% versus 4.3%) as heifer calves. Table 4 has number of births, calving difficulty rate, and stillbirth rate for multiparous cows. Again, calves sired by Scandinavian Red sires had significantly less calving difficulty than Holstein-sired calves. Furthermore, Holstein-sired calves had significantly greater stillbirth than all other breeds of sire.

Table 4. Calving difficulty and stillbirths for breed of sire when pure Holstein dams calved from the 2nd to 5th time.

Breed of sire	Number of births	Calving difficulty (%)	Stillbirth rate (%)
Holstein	1,241	7.7[a,b]	11.8[a]
Normande	327	9.1[b]	6.5[b]
Montebeliarde	2,385	5.7[a]	4.4[b]
Brown Swiss	527	5.4[a,c]	4.9[b]
Scandinavian Red	516	2.6[c]	4.2[b]

[a, b, c] Different letters of superscripts indicate significant differences ($P < 0.05$)

All breeds of sire had (for first-calf heifers) or tended to have (for 2nd to 5th lactation cows) fewer stillbirths than Holstein sires. Dams of all calves for the breed of sire analysis were pure Holsteins, so calves sired by Holstein sires were purebreds, whereas calves sired by bulls from the other breeds were crossbreds. Therefore, inbreeding probably caused the remarkably higher stillbirth rate for Holstein-sired calves.

Breed of Dam

To estimate differences in breed composition of dam for calving difficulty and stillbirths, breeds of sire were limited to Brown Swiss, Montbeliarde, and Scandinavian Red, because numbers of births by sires of other breeds were small and not well distributed across breed composition of dam. Therefore, all births analyzed for breed of dam were for crossbred calves. Adjustments were made for breed of sire, sex of calf, and herd-year-season of calving. Cows calving for the first time were analyzed separately. Across breed composition of dam, calving difficulty rates were 11.4% for bull calves and 4.2% for heifer calves, and stillbirth rates were 13.6% for bull calves and 2.2% for heifer calves for cows calving the first time. Table 5 has number of births, calving difficulty rate, and stillbirth rate for 2,301 first births of cows.

Table 5. Calving difficulty and stillbirths for breed of dam at first calving.

Breed of dam	Number of births	Calving difficulty (%)	Stillbirth rate (%)
Holstein	1,398	9.3[a]	11.8[a]
Normande-Holstein	269	9.2[a,b]	7.8[a,b]
Montebeliarde-Holstein	370	8.1[a,b]	7.1[a,b]
Scandinavian Red-Holstein	264	4.7[b]	4.9[b]

[a, b] Different letters of superscripts indicate significant differences ($P < 0.05$)

Scandinavian Red-Holstein crossbreds (4.7%) had significantly less calving difficulty than pure Holsteins (9.3%) at first calving. Stillbirth rates tended to follow the averages for calving difficulty respective to breed composition of dam, and Scandinavian Red-Holstein dams had a significantly lower stillbirth rate than pure Holstein dams at first calving.

Survival

First-lactation cows in the seven California dairies that calved from June 2002 to October 2004 were compared for survival to 30 days postpartum, 50 days postpartum, and 305 days postpartum. Survival rates were adjusted for herd-year of calving. Table 6 has the survival rates for pure Holsteins and crossbreds. These survival rates are for 692 pure Holsteins and 1,554 crossbreds. Pure Holsteins left these dairies sooner than crossbreds, with 86% of pure Holsteins remaining 305 days postpartum compared to 92% to 93% of crossbreds.

Table 6. Survival during first lactation.

Breed	Number	30 days	150 days	305 days
		(%)	(%)	(%)
Holstein	692	95[a]	91[a]	86[a]
Normande-Holstein	465	98[b]	96[b]	93[b]
Montbeliarde-Holstein	655	98[b]	96[b]	92[b]
Scandinavian Red-Holstein	434	98[b]	96[b]	93[b]

[a, b] Different letters of superscripts indicate significant differences ($P < 0.05$)

Reason for disposal was recorded and 1.7% of pure Holsteins died by 30 days postpartum. Death percentage grew for Holsteins to 3.1% by 305 days postpartum and was more than double any of the crossbred combinations.

Normande-Holstein crossbreds (n = 118) were compared to pure Holsteins (n = 283) for percentage that calved a second time within 20 months of first calving. Only 66% of pure Holsteins re-calved within 20 months; however, 82% of Normande-Holstein crossbreds had a second calf within 20 months of first calving. This is a huge difference from an economic point of view, and likely easily compensates for the 7% lower production of Normande-Holstein crossbreds compared to pure Holsteins.

Fertility

Fertility of the pure Holsteins and crossbreds was measured as actual days open for cows that had a subsequent calving or had pregnancy status confirmed by a veterinarian. To be included in the analysis, cows were required to have at least 250 days in lactation, which means the Holsteins were a more highly selected group compared to the crossbreds, because a smaller percentage of them survived to 250 days postpartum. Cows with more than 250 days open had days open set to 250. Adjustment was made for herd-year of calving.

The 520 pure Holsteins had average days open of 150 days (Table 7), and all of the crossbred groups had significantly fewer days open. The 375 Normande-Holstein crossbreds had average days open of 123, which is a difference of 27 days from the pure Holsteins. A difference of this magnitude for fertility, coupled with the difference for survival, certainly more than compensates, economically, for the somewhat lower production of Normande-Holstein crossbreds than pure Holsteins.

The distribution of days open for cows indicated 38% of the pure Holsteins versus 52% of the Normande-Holstein crossbreds, 43% of the Montbeliarde-Holstein crossbreds, and 44% of the Scandinavian Red-Holstein crossbreds had 35 to 99 days open. Furthermore, 21% of the pure Holsteins versus only 14% of the Normande-Holstein and the Scandinavian Red-Holstein crossbreds had at least 250 days open.

Table 7. Days open during first lactation with a maximum of 250 days.

Breed	Number of cows	Number of sires	Days open
Holstein	520	76	150[a]
Normande-Holstein	375	24	123[b]
Montbeliarde-Holstein	371	22	131[b]
Scandinavian Red-Holstein	257	10	129[b]

[a, b] Different letters of superscripts indicate significant differences ($P < 0.05$)

First service conception rate was 22% for pure Holsteins compared to 35% for the Normande-Holstein crossbreds, 31% for the Montbeliarde-Holstein crossbreds, and 30% for the Scandinavian Red-Holstein crossbreds. All three crossbred groups were significantly different from the pure Holsteins for first service conception rate.

Conclusions and Recommendations

Dairy producers must not regard crossbreeding as a genetic improvement program – it is not! Continuous use of high-ranking progeny tested A.I. sires within breeds is essential for genetic improvement. Unfortunately, some dairy producers have viewed crossbreeding as an excuse to turn to natural service. That would be an unfortunate consequence of renewed interest in crossbreeding.

Hybrid vigor is a bonus that dairy producers can expect on top of the individual gene effects acquired by the use of top A.I. sires within breed. The bonus from hybrid vigor should be about 6.5% for production and at least 10% for fertility, health, and survival of dairy cows. Therefore, the impact on profit could be substantial for commercial milk production. Research on crossbreeding has been initiated at many of the major agricultural universities in the U.S. and around the world. The rate of increase in inbreeding of U.S. Holsteins (+0.1% per year) might make crossbreeding almost essential at some point in the future.

Crossbreeding systems should make use of three breeds. Use of two breeds limits the long-term impact of hybrid vigor, and the use of four breeds limits the long-term contribution of any single breed to herd composition and makes the mating system more complex. The three breeds should be carefully chosen for the unique conditions (facilities, climate, nutritional regime, management system, and level of management) of a specific dairy operation to optimize a crossbreeding system.

National Animal Identification Update

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Take Home Message

- Illinois, Minnesota and Wisconsin are currently enrolling animal production units for premise ID.
- Premise ID is the foundation for individual animal identification which may begin by July 2006.
- Individual identification will initially be by visual methods, but that will transition to electronic methods.

Who is paying for premise ID?

Currently 43 states are enrolling animal production units in a premises ID system, Illinois, Minnesota and Wisconsin are included in that total, although specifics of each state's program vary. USDA has provided $11.6 million to determine the best system to use for the National ID system. $33 million has been proposed for animal ID in the 2005 USDA budget.

Why do we need a National ID system?

The economic impacts of animal diseases are easier to see today than they were one year ago. We have seen a reduction in beef exports as well as a reduction in replacement animals coming across the Canadian border due to the case of BSE identified in December, 2003. For the dairy industry, some of that has translated into higher milk prices, but the lasting effect is much more important than the short term gains. Although the food production industry appears to have bounced back, we can not afford to lose consumer confidence. A national ID system allows for swift traceback throughout the entire food chain, quick containment of disease, and will ensure consumer confidence in agricultural products in the U.S. and abroad.

Who is running the program and is it mandatory?

The National Institute for Animal Agriculture (NIAA) has teamed up with producers and industry leaders to develop a working animal ID plan. The NIAA has offered the plan, as a guideline, to the Animal and Plant Health Inspection Service (APHIS) of USDA, which is responsible for the development and implementation of the animal identification system. The USDA has specifically made this program voluntary. With time, it will likely be in the best interest of the entire industry to have 100% compliance.

What will it cost me to participate in this program?

Currently the USDA has set aside some funding to evaluate certain technologies and systems that appear to be cost effective. Ultimately all participants (consumers, government, producers, packers) will share the cost of the system. Most dairy producers are following an ID system that is compatible with the proposed system and, in the near future, integrating the new program will be as easy as buying official U.S. ID system tags.

Who will supply the tags?

It is anticipated that there will be a few private sector companies that will provide tags. The manufacturing process will be overseen by APHIS, but multiple companies will ensure competition and fair prices.

What is required for a premise ID?

This varies by state. For example in Illinois, online registration requires you to establish a user ID and a password. To register a location you will need a primary contact, an identifiable mailing address, the business type (i.e. production unit), a valid phone number, an email address, and the species housed on the specified property.

If I register my premise, do I have to register my animals?

Whether premise registration is mandatory varies by state, but animal registration is not yet linked to the national premise system. Wisconsin has a mandatory premise ID program whereas in Illinois, premise registration is encouraged to establish a database that can be used in the future. Eventually premise registration will be linked to individual identification in dairy cattle.

I raise a steer for my own use and own a horse, will they have to be identified too?

Although the individual identification phase has not started and is not mandatory, the current plan states that only animals leaving the premise would need identification in the future.

I bring animals to shows, do they have to be identified?

Again, the individual identification phase has not started and is not mandatory, but animals leaving the premise and commingling with animals from other premises will likely need individual identification in the future.

My breed association has a great ID program, can I use their system?

The breed registries have acquired much of the information needed in a national ID system, such as an identifiable address and individual animal numbers. The transition from breed registry to national ID plan should be smooth, although each animal may require a new number and a new form of ID. The National Farm Animal Identification and Records program, administered by the Holstein Association, identifies animals at birth, and utilizes a database to track animals with electronic ear tags from farm to farm, and eventually to slaughter.

Where can I get more information?

The United States Animal Identification Plan web site (**http://www.usaip.info**) is the most comprehensive site and includes more frequently asked questions as well as an overview of the plan and information on individual species plans.

Some other links:

Illinois TRAILL http://www.traill.uiuc.edu//

Illinois Dept. of Agriculture http://www.agr.state.il.us/premiseid/

U of I Food Security Initiative http://foodsecurity.uiuc.edu

National Institute for Animal Agriculture http://www.animalagriculture.org/

USDA Animal ID http://www.aphis.usda.gov/vs/nahps/animal_id/

Canadian ID System http://www.canadaid.com/

National F.A.I.R. http://www.nationalfair.com/

Wisconsin Livestock ID http://www.wiid.org/index.php?action=neednew_efforts

Minnesota Board of Animal Health http://www.bah.state.mn.us

Efficacy of On-Farm Pasteurized Waste Milk Systems on Upper Midwest Dairy and Custom Calf Rearing Operations

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Take Home Message

- Pasteurized waste milk can be an excellent source of nutrients for neonatal calves.
- The protein and fat content of waste milk is variable and testing for fat and protein content is encouraged.
- Pasteurization can effectively reduce bacterial populations in waste milk, but correct system operation and maintenance is necessary.

Introduction

The practice of feeding raw waste milk to neonatal calves has long been discouraged because of the potential for disease transmission. Pasteurization of waste milk on commercial dairy and custom calf rearing operations is currently being considered as an option to feed neonatal calves to reduce disease transmission potential and capture economic efficiencies. Interest has primarily been fueled by the recent availability of reasonably priced on-farm milk pasteurization equipment. Despite new interest and use of pasteurized waste milk systems on commercial dairy and custom calf rearing operations, few monitoring systems are in place for producers and their consultants to evaluate the efficacy of waste milk pasteurization on a routine basis. To date, an economical commercial assay for testing pasteurization efficacy of waste milk fed to calves has not been available. The object of this project was to establish an economical evaluation system for on-farm milk pasteurizers and evaluate their efficacy in a commercial environment.

Methods

Commercial testing procedures to evaluate pasteurizer efficacy in food processing (milk plants) were adapted to fit the needs of commercial dairy producers and calf growers. Basic tests adapted included: measurement of fat and protein by infrared spectroscopy (Combi 30, Foss Electric AS, Denmark), alkaline phosphatase (**AP**) activity, bacterial plate count (**BPC**), and somatic cell count (**SCC**). Samples were plated for *Salmonella* species, *Escherichia coli*, total *Coliform* species, *Streptococcus agalactiae*, *Strep.* species, *Staphylococcus aureus*, *Staph.* species, and *Enterococcus* species. Milk samples were also evaluated for β-lactam and non β-lactam antibiotics by Charm procedures (Charm Sciences, Inc., Lawrence, MA). Energy contents for both raw and pasteurized waste milk were calculated via standard equations (NRC, 2001).

Wisconsin dairy producers and heifer growers were asked to provide samples from a single day's supply of waste milk prior to pasteurization (raw) and after pasteurization (pasteurized). Samples were refrigerated, placed in an insulated mailer with an ice pack, and mailed to Ag Source/CRI, Stratford, WI, for analysis as described above.

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Results

Sixty-two milk samples were evaluated (raw waste milk = 31 and pasteurized waste milk = 31) in the field study. The nutrient compositions of raw waste milk are presented in Table 1; pasteurized waste milk nutrient compositions are presented in Table 2. Fat contents of raw and Pasteurized waste milk (% DM) averaged 35.4 and 31.2 percent, respectively, which is 15.0 and 2.0% higher than fat content of whole milk defined in the Nutrient Requirements of Dairy Cattle (2001). Fat contents of raw and pasteurized waste milk were higher, as compared to whole milk. These results were not unexpected, as waste milk often contains colostrum and transitional milk, which has high solids and fat content, as compared to whole milk (Raising Dairy Replacements, 2003). Likewise, protein contents of raw and pasteurized waste milk were approximately 28.2 (% DM), which is 11.0 percent higher than whole milk (NRC, 2001). Similar to fat, colostrum and transitional milk in waste milk would elevate the protein content of waste milk, as compared to whole milk (Raising Dairy Replacements, 2003). Lactose contents of raw and pasteurized waste milk were similar to whole milk at 4.25 - 4.42 % (as is). Lactose content in milk is not highly variable (Welper and Freeman, 1992); therefore, little variance would be expected. Higher fat and protein, and normal lactose contents of waste milk yielded higher metabolizable energy (5.79 and 5.45 vs. 5.37 Mcal/kg) than typically defined for whole milk (NRC, 2001). Mean profile of waste milk suggests neonatal calves fed an equal amount of DM from waste milk would consume more calories and protein, as compared to a similar amount of DM ingested from whole milk or milk replacer (20 % fat, 20 % protein), (NRC, 2001).

We observed a wide range of fat and protein contents in waste milk. For pasteurized waste milk, fat contents ranged from 22.3 to 37.6 % of DM and protein contents ranged from 23.1 to 40.8 % of DM. These data suggest that there can be wide variations in nutrient content of pasteurized waste milk between farms. Because of singular evaluation of waste milk from a given operation in this study, we do not know if similar within-operation variation of fat and protein content of waste milk exists. These data do; however, suggest that sampling waste milk for nutrient content would lend important inference to neonatal nutrition programs.

Table 1. Nutrient composition of raw waste milk before pasteurization from 31 commercial dairy or custom calf rearing operations.

Nutrient	Mean	Range	SD	SE
Fat, % of DM	35.4	27.3 - 49.5	5.82	1.05
Fat, %	4.42	3.41 - 6.19	0.73	0.13
Protein, % of DM	28.3	23.6 - 41.8	3.47	0.62
Protein, %	3.54	2.95 - 5.23	0.43	0.08
Lactose, % of DM	34.0	27.3 - 38.2	2.69	0.48
Lactose, %	4.25	3.41 - 4.78	0.34	0.06
Energy[1]				
GE[2], Mcal/kg	6.22	5.27 - 7.69	0.65	0.12
ME[3], Mcal/kg	5.79	4.90 - 7.15	0.60	0.11
NEm[4], Mcal/kg	4.97	4.22 - 6.15	0.52	0.09
NEg[5], Mcal/kg	3.99	3.38 - 4.93	0.42	0.07

[1] Calculated (NRC, 2001).
[2] Gross Energy.
[3] Metabolizable Energy.
[4] Net Energy for Maintenance.
[5] Net Energy for Gain.

Table 2. Nutrient composition of pasteurized waste milk from 31 commercial dairy or custom calf rearing operations.

Nutrient	Mean	Range	SD	SE
Fat, % of DM	31.2	22.3 - 37.6	4.26	0.77
Fat, %	3.90	2.79 - 4.70	0.53	0.10
Protein, % of DM	28.1	23.1 - 40.8	3.49	0.63
Protein, %	3.51	2.89 - 5.10	0.44	0.08
Lactose, % of DM	35.3	30.2 - 38.4	1.63	0.29
Lactose, %	4.42	3.78 - 4.80	0.20	0.04
Energy[1]				
GE[2], Mcal/kg	5.86	5.10 - 7.11	0.48	0.09
ME[3], Mcal/kg	5.45	4.75 - 6.61	0.44	0.08
NEm[4], Mcal/kg	4.69	4.08 - 5.69	0.38	0.07
NEg[5], Mcal/kg	3.76	3.27 - 4.56	0.31	0.05

[1] Calculated (NRC, 2001).
[2] Gross Energy.
[3] Metabolizable Energy.
[4] Net Energy for Maintenance.
[5] Net Energy for Gain.

Statistical analysis was conducted on nutrient contents of raw and pasteurized waste milk to assess whether pasteurization altered the nutrient profile of waste milk samples (Data not shown). Fat percentage (% DM) was 4.2 percentage units higher ($P < 0.01$) in raw waste milk, as compared to pasteurized waste milk. We cannot offer a logical explanation for this observation, but speculate that the effect may be caused by alteration of the fatty acid content by the pasteurization process on some commercial operations. Shipe and Senyk, 1981, demonstrated that pasteurization does not totally inhibit lipolysis (fat breakdown) in pasteurized milk; and fatty acid profiles of milk are altered. Lipolysis would change the molecular bonding upon which infrared spectroscopy is dependent to predict any nutrient (Shenk and Westerhaus, 1994). This would suggest that the use of a single infrared spectroscopy equation to predict fat content of raw and pasteurized waste milk may not be analytically valid. It is a problematic assumption; because, in contrast, if fat content of raw waste milk was over predicted due to an unexplainable diagnostic problem, energy contents of raw waste milk would be over predicted. This issue warrants further investigation and fat content of waste milk, either raw or pasteurized, in this study should be interpreted with caution.

Protein content of waste milk did not differ between raw and pasteurized waste milk. Lactose content of pasteurized waste milk was 1.3 (% DM) percentage units higher ($P < 0.05$), compared to raw waste milk. The significant rise in lactose content due to pasteurization is likely a type II statistical error, as there is no valid hypothesis to suggest pasteurization would increase lactose content of milk. Practically, differences in lactose content between raw and pasteurized waste milk are biologically small and are of minor influence on energy content of waste milk. Finally, gross (GE), metabolizable (ME) and net energy (NE_g, NE_m) contents of raw waste milk were higher ($P < 0.05$) than pasteurized waste milk. Similar to lactose, the observation of pasteurization increasing the energy content of waste milk is illogical and most likely tied to the nuances associated with the measurement of fat content in raw and pasteurized waste milk, as define above; which would be codependent with energy content.

Microbial population means and ranges for raw and pasteurized waste milk are presented in Tables 3 and 4. Somatic cell count data are also described in Tables 3 and 4. We observed a large variation in bacterial populations in raw waste milk (Table 3), which was expected, and has been observed in other investigations (Selim et al., 1997).

Table 3. Microbiological composition of raw waste milk from 31 commercial dairy or custom calf rearing operations.

Component	Mean	Range	SD	SE
BPC[1] (1,000 cfu/mL)	8822	6 - 72000	14655	2632
SCC[2] (1,000 ESCC/mL)	1772	110 - 3800	994	179
	- - - - - - - - - - - - - - - - - -	cfu/mL	- - - - - - - - - - - - - - - - - -	
Escherichia Coli	10000	< 10 - 80000	17589	3159
Total *Coliforms*	82052	600 - 800000	148489	26669
Salmonella species	243	< 10 - 2000	611	110
Streptococcus agalactiae	1281	< 10 - 34000	6089	1094
Strep. species	47281	200 - 170000	41762	7501
Staphylococcus aureus	549	< 10 - 11000	2021	363
Staph. species	8426	< 10 - 88000	21992	3950
Enterococcus species	17274	< 10 - 180000	36082	6481

[1] Bacterial Plate Count.
[2] Somatic Cell Count.

Table 4. Microbiological composition of pasteurized waste milk from 31 commercial dairy or custom calf rearing operations.

Nutrient	Mean	Range	SD	SE
BPC[1] (1,000 cfu/mL)	35	0 - 420	89	16
SCC[2] (1,000 ESCC/mL)	1518	240 - 3800	738	132
	- - - - - - - - - - - - - - - - -	cfu/mL	- - - - - - - - - - - - - - - - -	
Escherichia Coli	134	< 10 - 3400	611	110
Total *Coliform* spp.	1805	< 10 - 40000	7231	1299
Salmonella spp.	< 10	< 10 - < 10	0	0
Streptococcus agalactiae	14	< 10 - 200	47	8
Streptococcus spp.	5117	< 10 - 68000	13656	2453
Staphylococcus aureus	< 10	< 10 - < 10	0	0
Staphylococcus spp.	54	< 10 - 700	149	27
Enterococcus spp.	723	< 10 - 9000	2228	400

[1] Bacterial Plate Count.
[2] Somatic Cell Count.

Bacterial populations were substantially reduced by pasteurization (Table 4), which is the net effect and reason for pasteurization. Data is somewhat skewed by pasteurizing systems that failed to denature AP (n = 4), a recognized standard of adequate pasteurization (Pasteurized Milk Ordinance, Appendix G, Section II, 2001). Alkaline phosphatase is an enzyme active in raw milk, but is inactivated when milk is heated to pasteurization temperature (Ludikhuyze et al., 2000). Alkaline phosphatase was active in all raw waste milk samples and pasteurization denatured AP on 27 of 31 operations, indicating adequate temperature was employed for pasteurization. Pasteurizers on 4 of 31 operations (12.9%) did not denature AP, indicating pasteurizing temperature may have been to low; thus, not meeting the AP standard to be considered pasteurized milk (Pasteurized Milk Ordinance, Appendix G, Section II, 2001).

Pasteurizers that did not denature AP (n = 4), did reduce bacterial plate counts, but the net biological effect cannot be completely defined in our study (Table 5). Data needs to be interpreted with caution because the number of pasteurizers failing to denature AP was small (n = 4) and exhibited wide ranges of bacterial plate count and specific bacterial species; inferences are limited. We empirically observed that *Salmonella* spp., *Streptococcus agalactiae* and *Staph. aureus* species seemed to be particularly sensitive to heating, and were reduced significantly in all pasteurizers whether AP was denatured or not (Table 4 and 5). Environmental bacteria, *E. Coli,* total *Coliform* species, *Staphylococcus* spp. and *Streptococcus* spp. were less likely to be inactivated if the pasteurizer did not denature AP (Table 5).

Table 5. Microbiological composition of pasteurized waste milk from 4 commercial dairy or custom calf rearing operations which failed to denature alkaline phosphatase in waste milk.

Nutrient	Mean	Range	SD	SE
BPC[1] (1,000 cfu/mL)	208	40 - 420	19	84
SCC[2] (1,000 ESCC/mL)	910	240 - 1400	492	246
	- - - - - - - - - - - - - - - - - -cfu/mL - - - - - - - - - - - - - - - - - -			
Escherichia Coli	901	< 10 - 3400	1669	834
Total *Coliform* spp.	11925	900 - 40000	18848	9424
Salmonella spp.	< 10	< 10 - < 10	0	0
Streptococcus agalactiae	46	< 10 - 180	90	45
Streptococcus spp.	27300	1200 - 109200	28544	14272
Staphylococcus aureus	< 10	< 10 - < 10	0	0
Staphylococcus spp.	108	< 10 - 430	195	98
Enterococcus spp.	2226	< 10 - 8600	4252	2126

[1] Bacterial Plate Count.
[2] Somatic Cell Count.

Antibiotic residues (β-lactam and non β-lactam) in raw and pasteurized waste milk are presented in Figure 1. Approximately 65.0 % of waste milk samples evaluated were positive for antibiotic residues. Twenty samples tested positive for β-lactam drug residues in both raw and pasteurized waste milk samples. In all cases, milk from the same operation tested positive β-lactam residues in raw and pasteurized waste milk, indicating pasteurization had little influence on antibiotic activity. Similarly, 21 waste milk samples tested positive for non β-lactam drug residues in the corresponding raw and pasteurized milk sample. Because we were unable to quantify the absolute level of antibiotic residues in the waste milk samples specific inferences cannot be made. Issues of feeding pasteurized waste milk containing antibiotic residues were beyond the scope of this study, but warrants further investigation.

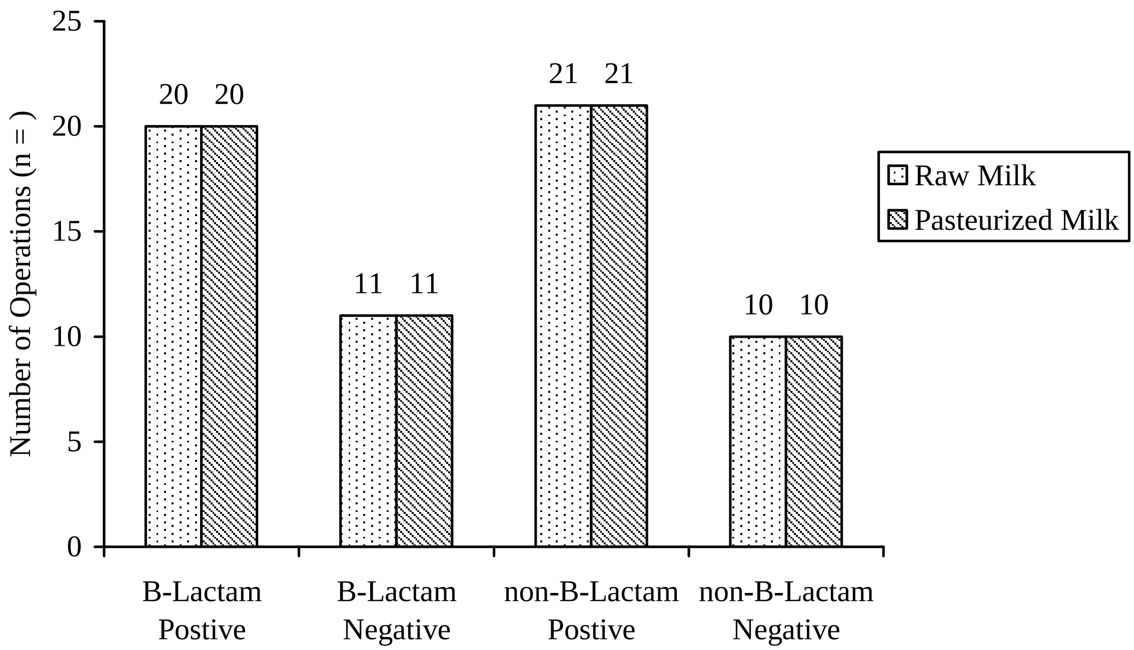

Figure 1. Incidence of antibiotic residues found in raw and pasteurized waste milk from 31 Wisconsin commercial dairy or custom calf rearing operations. Antibiotic residues between raw and pasteurized milk did not differ (P = 1).

Conclusions

Because nutrient content of waste milk is highly variable, routine testing of waste milk for nutrient content should be considered for all operations using an on-farm milk pasteurizer. In general, we observed a high efficacy of on-farm milk pasteurizers, indicated by proper denaturing of AP, a reduction of BPC to Food and Drug Administration grade "A" milk standards, and a reduction of all major specific bacterial pathogens. Simply pasteurizing waste milk; however, does not guarantee proper pasteurization performance. We observed questionable efficacy of waste milk pasteurization on 4 of 31 (12.9%) operations. These observations support producers adopting a routine sample procedure to evaluate pasteurizer performance. We made no attempt to correlate the type of pasteurizer to pasteurization efficacy. We observed successful pasteurization processes in a number of pasteurizer equipment configurations and, likewise, observed questionable pasteurizer performance in operations with totally different pasteurization equipment.

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Feeding Straw to Lactating Cows

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Take Home Message

- Data on the effects of feeding straw to lactating or dry cows is limited.
- Field results suggest feeding 2-8% of the diet DM as straw can provide effective fiber for enhanced rumen health.
- High levels of straw in diets will decrease performance by lowering intakes, increasing rumen fill, and reducing total tract digestibility.

Dairy producers and nutritionists have become increasingly aware and concerned about providing adequate effective fiber in diets fed to high producing dairy cows. As the use of total mixed rations (TMR) has increased, so too has the concern about maintaining adequate particle size of the forage portion of the diet in order to enhance cud chewing and rumination, while minimizing the risk of rumen acidosis. As dairy producers formulate diets for their high producing cows, they rely on high quality forages, primarily alfalfa and corn silage, to provide the effective fiber needed to maintain rumen health and optimize rumen microbial protein production. The amount of fiber in a diet is usually expressed as the concentration of forage, neutral detergent fiber (NDF), acid detergent fiber (ADF), or forage NDF. None of these give any indication of the quality of the forage or the amount of cud chewing elicited by the forage however. Producers are faced with a dilemma of trying to provide highly digestible forages in order to maximize animal performance, yet provide adequate effective fiber for maintaining rumen health. Many producers are adding small amounts of straw to the diet to help meet the effective fiber needs of their cows. In a survey of the top producing herds in Wisconsin (all > 30,000 lb milk), Shaver and Kaiser found that 2 of the 6 herds fed straw to their milking cows and half of the herds fed straw to their dry cows. The range that straw was fed varied from 1-2% of the diet for milking cows to 3-10% for dry cows.

Straw is a byproduct of cereal grain production, with about 68.3, 10.2, 6.7, and 2.3 million tons of wheat, rice, barley, and oat straw respectively produced annually in the US. Therefore, wheat straw is the most abundant, with very limited amounts of oat straw available. Only limited amounts of rice straw is fed to dairy cattle, due primarily to few dairy cows being in close proximity to where the crop is grown in the US. Barley straw would be the second most abundant for feeding dairy cows.

Wheat straw is low in crude protein (< 5%), very high in NDF (> 70%), high in ADF (~ 50%) and in lignin (~ 9%). This would equate to a relative feed value (RFV) of around 65, making it a very low quality forage. The hemicellulose content of wheat straw is similar to many grasses, while its lignin content is similar to alfalfa.

Feeds that provide adequate effective fiber and aid in the formation of a rumen mat are generally not highly digestible, or are digested more slowly, thus including them in the diet has the effect of filling up the rumen with lower quality, less nutrient dense feeds. This in turn can have a depressing effect on animal performance. Thus, the goal is to provide an adequate fiber source that can meet the effective fiber-related needs of the animal while being included in small amounts so as to not fill the rumen with too much bulk. More and more dairy producers are using low inclusion levels of straw to accomplish this objective, with wheat and barley straw being the most common. Most of the straw being fed is either chopped first, then added to the TMR, or added directly to a TMR mixer that has the capability of breaking up the hay or straw particles.

Feeding Straw to Lactating Cows

Most research involving feeding straw has looked at alkaline treatment of the straw to increase its digestibility and at feeding straw at relatively high inclusion rates. Virtually all straw fed to dairy cattle is untreated. There is only limited data of the performance of lactating cows fed low levels of straw. Brown et al. conducted two trials to examine the effect of substituting both treated and ammoniated wheat straw for part of the alfalfa hay in lactating cow diets. The first trial compared diets consisting of half long stem alfalfa hay and the other half either chopped alfalfa hay, untreated chopped wheat straw, or ammoniated chopped wheat straw. Forages comprised 45% of the diets on a DM basis in all cases. The second trial utilized the same three diets plus a fourth diet consisting of all long alfalfa hay as the forage component of the diet. No attempt was made to balance the diets in either trial for concentration of fiber. Dry matter intakes were similar for all groups and milk yields were low (Table 1). The percentage of milk fat was higher for cows fed straw, probably because of the higher fiber level in these diets. The higher milk fat percentages resulted in increased yield of 3.5% fat-corrected milk by cows fed straw. Ruminal acetate levels were increased and propionate levels decreased when straw was included in the diets. Ammoniation of the straw did not affect intake or milk yield in either trial.

Table 1.	Treatment		
	Chopped alfalfa	Untreated straw	Ammoniated straw
CP, %	15.9	15.1	16.1
ADF, %	22.7	28.2	26.3
DMI, lb/d	39.7	40.8	45.2
Milk yield, lb/d	59.5	61.9	61.1
Fat, %	2.4[a]	3.2[b]	3.1[b]
Protein, %	2.8	2.8	2.8

[a,b] $P < 0.05$.
Adapted from Brown et al. 1990. J. Dairy Sci. 73:3172.

Table 2.	Treatment			
	Long stem Alfalfa	Chopped alfalfa	Untreated straw	Ammoniated straw
CP, %	17.4	17.5	16.9	17.3
ADF, %	18.2	18.2	23.9	23.1
DMI, lb/d	38.1	36.6	40.1	38.4
Milk yield, lb/d	56.9	47.8	56.0	51.1
Fat, %	2.9[b,c]	2.6[c]	3.3[a,b]	3.4[a]
Protein, %	2.9[b]	3.2[a]	3.0[b]	3.0[b]

[a,b,c] Means on the same line with unlike superscripts differ ($P < 0.05$)
Adapted from Brown et al. 1990. J. Dairy Sci. 73:3172.

Poore et al. fed diets formulated to contain 30% NDF with forage NDF coming from chopped wheat straw or chopped alfalfa hay in proportions of 0:3, 1:2, 2:1, and 3:0. Steam flaked sorghum was fed as the primary concentrate. As more straw was added to the diet, the amount of straw needed to maintain dietary NDF concentrations decreased, allowing for more concentrates to be included. Thus the level of starch in the diets increased as well with increasing amounts of straw. Neither dry matter intake nor milk yield were affected by the forage source (Table 3). Milk fat percentage decreased and milk protein percentage increased linearly as the amount of straw in the diet was increased. Yield of 3.5% fat-corrected milk and milk protein both showed a quadratic response, with the yield of cows on the 3:0 diet reduced. The proportion of rumen acetate decreased and propionate increased with increasing levels of straw in the diet, due primarily to the increased amount of concentrates and starch in the higher straw diets.

Bucci et al. compared straw versus legume or grass hay when fed on an equivalent forage NDF basis. All diets consisted of a basal amount of corn silage (35.7%) plus alfalfa hay, grass hay, wheat straw or whole, linted cottonseed. The three forage diets were formulated to contain 17% forage NDF. Although dry matter intakes were similar for the four diets, cows fed straw produced less milk (Table 4). Percentages of milk fat and milk protein did not differ between treatments.

Table 3.

	Treatment			
	0:3	1:2	2:1	3:0
Alfalfa hay, % DM	49.0	31.4	15.1	0
Chopped straw, % DM	0	10.1	19.4	28.0
Flaked sorghum, % DM	32.8	36.2	39.2	41.0
Soybean meal, % DM	7.6	12.0	16.0	19.7
CP, %	17.6	17.6	17.2	17.4
NDF, %	30.4	31.3	31.9	30.2
ADF, %	22.0	22.8	21.2	20.4
Starch, %	25.6	26.7	28.3	29.9
DMI, lb/d	49.6	51.4	52.7	49.6
Milk yield, lb/d	84.7	87.1	86.9	79.8
Fat, %	3.22	3.00	2.94	2.60
Protein, %	2.81	2.87	2.93	3.00

Adapted from Poore et al. 1991. J. Dairy Sci. 74:3152

Table 4.

	Treatment			
	Alfalfa hay	Grass hay	Wheat straw	Cottonseed
Corn silage, % DM	35.5	35.7	35.7	35.7
Alfalfa hay, % DM	11.7			
Grass hay, % DM		7.02		
Wheat straw, % DM			5.22	
Cottonseed, % DM				10.0
Concentrate, % DM	52.6	53.5	59.1	54.3
NDF, %	39.3	39.5	39.4	39.5
DMI, lb/d	52.0	53.5	59.1	54.3
Milk yield, lb/d	50.0[a,b]	51.6[a]	47.6[b]	52.8[a]
Fat, %	4.11	4.20	4.48	4.33
Protein, %	3.51	3.47	3.62	3.55

[a,b] Means in the same row with different superscripts differ ($P < 0.05$).
Adapted from Bucci et al. 2004. J. Dairy Sci. 83 (Suppl. 1):466.

Feeding Straw to Dry Cows

Data on feeding low levels of straw to dry cows, especially close-up dry cows is nearly non existent. McNamara et al. fed grass silage and straw (75:25), grass silage, and grass silage plus 6.6 lb of concentrates daily for 4 weeks prepartum to evaluate the effect of energy density on postpartum performance during the first 8 weeks of lactation. Postpartum diets contained grass silage ad libitum plus 8.8 or 17.6 lb of concentrates. Cows fed grass silage and barley straw prepartum consumed less dry matter both pre and postpartum compared to cows fed the other diets (Table 5). Cows fed the additional concentrates prepartum produced more milk postpartum than cows fed either of the other two diets. Dewurst et al. fed grass silage plus barley straw (60:40), grass silage, or grass silage plus 1.1 lb of prairie meal for 6 weeks prepartum to investigate the effect of altering energy and protein supply to dry cows. Cows fed straw had lower dry matter intake at weeks 5 and 1 prepartum compared to the other cows (Table 6). Furthermore, cows fed straw lost body weight between weeks 5 and 1 prepartum while cows fed grass silage alone or with concentrates gained body weight. Rabelo et al. fed a low energy diet, high energy diet, or a high energy diet where straw and cornstalks replaced a portion of the alfalfa silage to determine if the latter diet was more glucogenic and consequently more advantageous for transition cows. Nine far-off dry cows were used in a replicated 3 X 3 Latin square with 21-d periods. Cows used were > 3 wk prepartum at the end of the trial. Cows fed the higher energy diets consumed more DM, but intakes were not different between the high energy diets with and without straw (Table 7). Total tract digestibility of DM ($P < 0.04$) and NDF ($P < 0.06$) was less for the high energy diet with straw than the high energy diet without straw. Concentration of propionate in the rumen was highest and the acetate:propionate ration lowest for the high energy + straw diet.

Table 5.

	Treatment		
	Grass silage + barley straw	Grass silage	Grass silage + concentrate
Grass silage, % forage DM	75	100	100
Barley straw, % forage DM	25	--	--
Concentrate, lb/d prepartum	--	--	6.6
DMI, lb/d prepartum	16.3[a]	17.8[b]	21.8[c]
BW change, lb/d prepartum	0.48	0.22	1.19
BCS change prepartum	-0.09[a]	0.01[ab]	0.12[b]
DMI, lb/d postpartum	29.7[a]	30.4[ab]	31.2[b]
Milk yield, lb/d	53.0[a]	57.6[a]	62.0[b]
Fat, %	3.86[a]	4.03[ab]	4.15[b]
Protein, %	3.16	3.15	3.23
BW change, lb/d postpartum	0.40[a]	0.22[a]	-1.28[b]
BCS change postpartum	0.02[a]	0.06[a]	-0.26[b]

[a,b,c] Means in the same row with different superscripts differ ($P < 0.05$).
Adapted from McNamara et al. 2003. J. Dairy Sci. 86:2397.

Table 6.

	Treatment		
	Grass silage + barley straw	Grass silage	Grass silage + concentrate
Grass silage, % forage DM	60	100	100
Barley straw, % forage DM	40	--	--
Concentrate, lb/d prepartum	--	--	1.1
DMI, lb/d overall	15.8	23.8	22.8
DMI, lb/d 5 wk prepartum	10.3	27.7	27.0
DMI, lb/d 1 wk prepartum	17.1	20.7	20.5
BW change, lb wk 5 to 1	-7.9	22.9	46.6

[a,b,c] Means in the same row with different superscripts differ ($P < 0.05$).
Adapted from Dewhurst et al. 2000. J. Dairy Sci. 83:1782.

Table 7.

	Treatment		
	Low energy	High energy	High energy + straw
Alfalfa silage, % DM	49.5	33.6	14.7
Corn silage, % DM	42.2	28.7	12.7
Straw, % DM	--	--	20.4
Corn starch, % DM	--	--	5.4
Cracked corn, % DM	6.3	31.6	31.6
Soybean meal, % DM	1.2	5.3	14.4
Min, vit., salt, % DM	0.8	0.8	0.8
CP, % DM	14.0	13.9	13.5
NDF, % DM	39.2	34.6	35.8
ADF, % DM	24.9	26.9	26.2
NFC, % DM	33.6	39.5	40.5
DMI, lb/d	31.5	35.6	35.4
Apparent digestibility			
DM, % of intake	53.1	56.5	55.5
NDF, % of intake	38.2	42.9	39.2

Adapted from Rabelo et al. 2001. J. Dairy Sci. 84:2240.

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