Effects of switching to 3X milking

Douglas D. Gisi □ Edward J. DePeters □ Clement L. Pelissier

Greater yield has to be weighed against higher costs and a need for better management

Many dairies are milking three times daily (3X) to increase production per cow and to use facilities more efficiently. In California, 11 percent of the herds and 15 percent of the cows in the Dairy Herd Improvement (DHI) Association were milked 3X in 1984. These numbers reflect a moderate reduction in 3X milking due to the dairy diversion program, but since its termination, some herds may have returned to 3X milking.

The effect of milking frequency on performance has been studied by a variety of techniques. Half-udder studies, in which two quarters were milked twice daily (2X) and the remaining two quarters 3X, have reported increases of 8 to 32 percent in milk yield for 3X compared with 2X milking. Compensation between halves of the udder may have occurred, however. Studies with monozygous twins have shown milk increases of 6 percent with 3X milking.

In research herds elsewhere, milk yield increased approximately 20 percent for cows and 13 percent for first-calf heifers above their 2X counterparts during early lactation. In large drylot dairy herds typical of California, however, 3X milking for a portion of the lactation is impractical, and most cows are milked 3X for their entire lactation. Complete lactation studies have reported milk yield increases of 15 and 19 percent for cows and 6 and 25 percent for first-calf heifers with 3X milking. Field trials involving DHI records have shown increases of 7 to 39 percent in milk yield for animals milked 3X. DHI surveys using different herds milked 2X and 3X, however, may be biased by differing management practices between herds.

The objective of our study was to evaluate the effect of 3X milking on milk yield, reproduction efficiency, and udder health of commercial California herds. We used records for the same herds during 2X milking and after 3X milking began, so that each herd served as its own control in the appraisal of herd response.

Procedures

The study evaluated 28 California Holstein dairy herds that started 3X milking between November 1975 and March 1980. All herds were on official DHI test for the length of the trial, and all data came from DHI monthly herd summaries. Records on each herd were for 3 to 17 months on 2X milking and 36 months on 3X. Data collected included: test-day yields of milk, fat-corrected milk, fat, and solids-not-fat; percentages of fat and solids-not-fat; California Mastitis Test (CMT) scores; and reproductive indexes of calving interval, days open, and services per conception.

We obtained data on first-calf heifers of each herd and on all cows including

TABLE 1. Average production performance of the entire herd and first-calf heifers

	Entire herd				First-calf heifers			
Item	n	2X	3X	Estimated difference†	n	2X	3X	Estimated difference
Milk, lb/day	28	54.4	63.5	6.7*	22	46.9	55.7	6.6*
Fat-corrected milk, lb/day	28	55.3	64.2	6.2*	22	48.1	56.9	5.9*
Fat, lb/day	28	1.96	2.26	.20*	22	1.72	2.02	.19*
Fat, %	28	3.61	3.57	−.06	22	3.67	3.63	−.12*
Solids-not-fat, lb/day	15	4.78	5.72	.65*	12	4.26	5.10	.53*
Solids-not-fat, %	15	8.77	8.84	.04	12	8.93	8.95	−.04

n = the number of herds used in each category.
† Estimated difference is the proportion of the production increase observed for 3X milking that is associated with milking frequency. The remainder of the increase is due to herd-year-season effects and unaccounted factors. For example, milk yield increased 9.1 pounds per day with 3X milking for the entire herd; 6.7 pounds was due to milking cows 3X daily and 2.4 pounds to other factors.
* Significant response due to milking frequency.

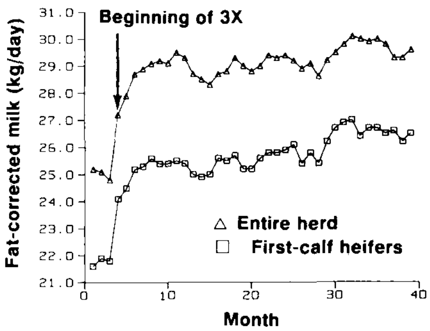

Fig. 1. Average test-day yield of fat-corrected milk increased after the switch to 3X milking. Most of the increase occurred within three months.

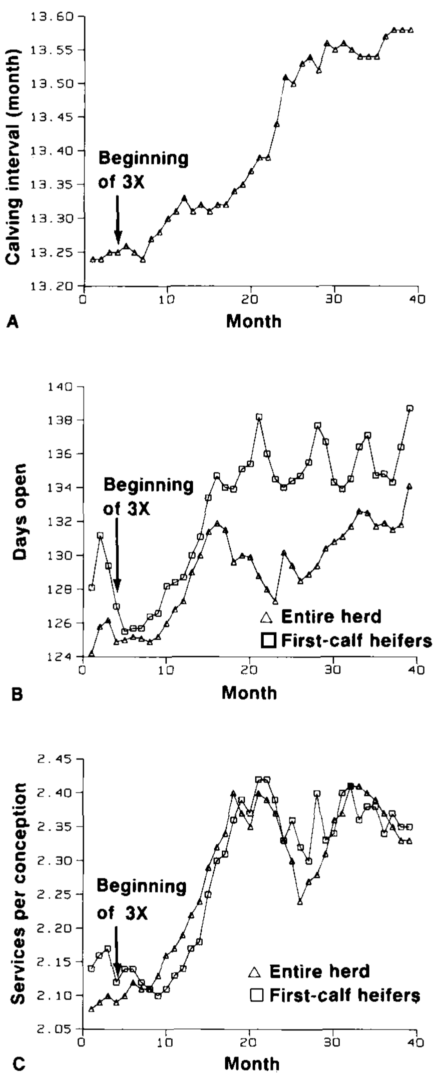

Fig. 2. A tendency toward reduced reproductive efficiency with time on 3X milking was indicated by increasing average (A) calving interval for the entire herd, (B) days open, and (C) services per conception for the entire herd and first-calf heifers.

first-calf heifers (entire herd). Of the 28 herds, 26 reported California Mastitis Test information, and 15 reported solids-not-fat. Heifer reproductive data are from 27 herds. Because of differences in herd summaries from two DHI processing centers, we received first-lactation milk and fat records for 22 herds and solids-not-fat records for 12 herds.

The model used in statistical analysis of the data included an effect for herd-year-season, milking frequency (2X or 3X), and a random error component. Data were evaluated by analysis of variance, and the effect of milking frequency estimated by least squares estimated differences. We analyzed data separately for the entire herd and first-calf heifers.

Results

Cows in the entire herd produced 12 percent more milk and 11 percent more fat-corrected milk on 3X than on 2X milking (table 1). Yields of fat and solids-not-fat were significantly greater when herds were milked 3X daily. Percentages of fat and solids-not-fat were not affected by milking frequency.

Milk yield of first-calf heifers increased 14 percent with 3X milking (table 1). Yields of fat-corrected milk, fat, and solids-not-fat were also significantly greater with 3X than 2X milking. Percentage of solids-not-fat was not altered. There was a small but significant reduction in fat test with 3X milking.

Most of the milk production response to 3X milking for all cows in the herd and first-calf heifers occurred within three months of changing from 2X to 3X (fig. 1). There were no significant differences in yields of milk, fat, and solids-not-fat during the first, second, or third years on 3X (table 2).

Herd fat-corrected milk response to 3X milking, expressed either as a percent or yield above 2X, was not related to herd size or previous production on 2X milking. Culling rate also was not related to percent response or yield response of fat-corrected milk under 3X milking.

Analysis of mastitis test scores used to measure udder health showed that the proportion of animals in the entire herd in categories of CMT negative and trace, CMT 1, and CMT 2 and 3 was not affected by 3X milking (table 3). Similar findings for CMT scores and 3X milking were observed for first-calf heifers.

Calving interval, days open, and services per conception were not significantly affected by milking frequency for either the entire herd or first-calf heifers. Reproductive indexes tended to increase as time on 3X milking increased, indicating reduced reproductive efficiency (fig. 2). Of the 28 herds studied, 19 had an increased calving interval, 20 increased days open, and 22 increased services per conception over the three years on 3X milking. Reproductive indexes were not related to the herd's milk production response observed with 3X milking or level of milk production.

Discussion

Three-times-daily milking resulted in an average increase of 12 percent in milk yield for entire herds and 14 percent for first-calf heifers. This response was lower than that reported by other studies using DHI records. Since we observed each herd

TABLE 2. Yield response of milk, fat-corrected milk (FCM), fat, and solids-not-fat (SNF) of herds and first-calf heifers milked three times daily compared with twice daily

	Entire herd				First-calf heifers			
Period	Milk	FCM	Fat	SNF	Milk	FCM	Fat	SNF
	ib/day							
2X	54.4	55.3	1.96	4.78	46.9	48.1	1.72	4.26
3X:								
Month 1-3†	60.8	61.6	2.16	5.49	53.6	54.3	1.92	4.87
Year 1	62.7	63.3	2.23	5.62	54.4	55.6	1.96	4.94
Year 2	63.4	64.1	2.25	5.71	55.5	56.6	2.01	5.07
Year 3	64.4	65.2	2.29	5.80	57.3	58.5	2.09	5.27

† First three months on 3X daily milking.

TABLE 3. Average California Mastitis Test (CMT) scores for the entire herd and for first-lactation heifers

	Proportion of animals in each category					
	Entire herd			First-calf heifer		
CMT	n	2X	3X	n	2X	3X
		%	%		%	%
CMT N & T	26	84.4	85.4	26	92.2	92.7
CMT 1	26	10.8	10.1	26	6.1	5.5
CMT 2 & 3	26	4.8	4.5	26	1.7	1.8

†CMT negative and trace approximately indicate less than 500,000 somatic cells per milliliter of milk. CMT 1 indicates 400,000 to 1,500,000 cells per ml. CMT 2 and 3 indicate greater than 800,000 cells per ml.

on both 2X and 3X milking, however, advantages attributable to management differences were minimized. The average herd in our study achieved a response in milk production within three months of beginning 3X milking and maintained the response during the three-year period.

Herds showed a range of responses to 3X milking. Among individual herds, the response ranged from −2 to +32 percent more fat-corrected milk with 3X than 2X milking, indicating the importance of a total herd management program. Better nutrition, including improved forage quality and increased feeding frequency, may be necessary to maintain response to 3X milking and minimize body weight loss during lactation. Cows should be fed according to body condition in addition to nutrient requirements of production; this will allow them to maintain lactational persistence and replace reserves before the dry period and subsequent lactation. If these reserves are not replaced during lactation, nutrition during the dry period must allow for their replacement.

First-calf heifers exhibited a greater production response to 3X milking than the entire herd or predominantly cows of second or later lactation. This complicates the management and feeding of first-calf heifers, because they have not reached mature size. On large dairies, grouping and feeding heifers together may simplify their management.

Udder health, as measured by California Mastitis Test scores, was not affected by milking frequency. Reproductive indexes were not significantly different with 3X milking; these figures were rolling herd averages, however, and will change slowly. These indexes tended to increase with 3X milking, indicating poorer reproductive status. An optimum calving interval for 3X herds has not been determined, however; it may be longer than recommended for 2X herds because of the higher milk production.

Milking dairy herds 3X will, in most cases, increase milk yield. Nutrition and reproduction management will have to be improved to maintain the production advantage. Before milking 3X, the dairy operator must weigh the increased yield against the longer milking time, increased costs of utilities, labor, feed, and milking supplies, and the demand for greater management skills.

Douglas D. Gisi is Farm Advisor, Cooperative Extension, Merced County; Edward J. DePeters is Assistant Professor, Department of Animal Science, University of California, Davis; and Clement L. Pellissier is Extension Dairy Scientist, Emeritus, Animal Science Extension, University of California, Davis. *This research was supported by a grant from the California Milk Advisory Board. The authors express their appreciation to cooperating dairymen and dairy farm advisors (N. Peterson, G. Hutton, R. Knight, and R. Eide) for their assistance.*

Residual available phosporus in soils

Parker F. Pratt □ Robert M. Lippert

Present tests fall short of needs

After decades of applications of inorganic phosphate fertilizers and animal manures, many cultivated soils have accumulated residual available phosphorus exceeding levels needed for maximum crop yields. A soil test for available phosphorus can readily identify these areas but cannot indicate how much can be removed in harvested crops before more fertilizer phosphorus is needed to maintain yields. At present, we have no quick way to estimate the amount of residual available phosphorus and must rely on cropping experiments to measure it. That is, the soil test can identify areas with excess residual available phosphorus but cannot be used to find out just how much is present.

To measure amounts of residual available phosphorus in southern California soils, we conducted two field trials and a greenhouse trial involving seven soils. The objectives of all trials were to measure the reduction in soil test values, using the sodium bicarbonate ($NaHCO_3$) test as phosphorus was removed in harvested crops and to determine the effects of soil properties on phosphorus-supplying capacity. The greenhouse experiment compared soils derived from granitic parent materials (upper Santa Ana River Basin) with soils from Colorado River sediments (Imperial and Palo Verde valleys).

Field trials

The field trials were on the University Moreno Valley farm about 10 miles south of Riverside. We established plots in March 1978 on a Hanford sandy loam and a Domino loam, both of which are derived from granitic parent materials. The trials consisted of treatments with 0, 20, 40, 80, and 120 kg of phosphorus per hectare per year except during the second year of alfalfa in the middle of the seven-year cropping sequence. The cropping sequence was corn, wheat, alfalfa, alfalfa, corn, wheat, and alfalfa.

We measured field weights of yields and took samples for laboratory measurements of dry weights and total phosphorus contents. The total forage was removed from the corn and alfalfa plots, but only the grain from the wheat plots. During the seven years, we took soil samples from each plot before treatments started and at convenient times between crops. Samples were composites of 40 cores per plot taken from the cultivated layer. Analyses of profile samples by the sodium bicarbonate soil test (HCO_3-P, bicarbonate-phosphorus) indicated very little available phosphorus below the cultivated depth.

No yield responses to phosphorus applications occurred during the first six years of these trials. In the seventh year, the alfalfa crop responded to phosphorus applications to the Hanford soil in which the bicarbonate-phosphorus had decreased from the original level of 17.6 to 7.2 mg per kg. There were no responses to phosphorus applications, however, on the Domino soil in which the bicarbonate-phosphorus had decreased from 50.4 to 12.4 mg per kg. A level of 10 mg per kg is usually considered to be the critical level for agronomic crops, so these results were expected.

In 1978, before treatments were started, the available phosphorus was relatively uniform in each field (table 1). During cropping the bicarbonate-phosphorus decreased by 10.4 and 38 mg per kg, respectively, for the Hanford and Domino soils.

The cumulative removal in the Hanford soil was 206 kg per hectare with a reduction of 10.4 mg of bicarbonate-phosphorus per kg; for the Domino soil, corresponding values were 229 kg per hectare and 38 mg per kg. The slopes of the regression lines in figure 1 suggest that considerable quantities of phosphorus were released from forms insoluble in the sodium-bicarbonate extractant during the cropping period.