3X milking: its effects on production and profitability

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Increased cash flow is possible . . . so is stress on the herd

Milking cows three times a day (3X) to increase production is not a new idea. The practice has been confined mainly to purebred herds, but with rising costs for facility expansion, increases in labor efficiency through mechanization, and higher herd average production levels, 3X milking may be worth considering as a long-term strategy for many commercial herds. While it may seem inappropriate to consider increasing production when programs have been instituted to reduce milk output, the assessment program and the diversion program are both signs that individual dairy operators may have to become increasingly concerned with production efficiency in the future: 3X milking offers an additional option in this context.

Those considering 3X milking need to know how it affects productivity, feed consumption, health, and fertility, and whether it is economically beneficial to switch from milking two times a day (2X) to 3X. Recent research provides some answers to these questions.

Productivity

Three methods have been used to compare effects of 3X milking with 2X: the "half udder" technique, analyses of Dairy Herd Improvement Association (DHIA) records, and studying "matched" groups of cows from the same herd.

Since the early 1940s, researchers using the half udder technique — milking one side of the udder 3X and the other side 2X — have shown increases in milk yield ranging from 6 to 32 percent. Effects on fat test have varied from no effect to a 12 percent increase. Results are colored by the fact that 3X milking one side of the udder may affect the 2X side. Nevertheless, significant increases in production have been observed consistently.

Advantages of the second method involving analysis of DHIA records from 2X and 3X herds include use of data from very large numbers of cows recorded under commercial conditions. The main disadvantage is that differences in management and genetics between herds are not controlled. Results from such studies, including a recent survey of central California herds, are within the range found with the first method, with increases between 14 and 22 percent for milk and between 9 and 11 percent for fat. Survey analyses have also shown differences between heifers and cows in their response to 3X.

Trials in the third method, using matched groups of cows from the same herd, have been conducted in a commercial herd in California, recently at the University of California, Davis, and elsewhere in the country. These show productivity increases similar to those of the other two methods with most of the increase due to improved persistency in mid to late lactation. The UC Davis trial showed an increase in yield of 18 percent overall for cows milked 3X. With first calf heifers, 3X milking increased production 6 percent overall, but the difference occurred mainly in early lactation; by the fifth month, both 2X and 3X heifers were yielding the same. This result may be due to the relatively high yield of the heifers (17,320 pounds on 2X) and the inability of the 3X heifers to consume any more feed.

Several possible explanations for the effects of 3X milking have been suggested; none is entirely satisfactory. Results from half udder trials suggest that the effect may be local to the mammary gland. A hypothesis that intra-mammary pressure buildup inhibits further milk secretion is contradicted to some extent by evidence that milk secretion remains essentially unchanged for up to 16 hours. However, the latter evidence comes from experiments in which the udder was emptied completely through the use of oxytocin, and experimental milking intervals were not repeated more than a few times. These conditions differ markedly from normal dairy conditions. There is always a certain amount of residual milk left in the udder that might speed onset of inhibitory pressure buildup. Residual milk may also be reabsorbed, and there is some suggestion that the amount of residual milk is related to the milking interval.

Increases in yield from 3X milking may also be the result of some central mechanism. More frequent milking increases a cow's exposure to oxytocin, and in some half udder trials, there has been an initial increase in yield from the 2X side, remaining above pre-experimental levels for about two weeks. Exposure to oxytocin alone, however, does not account for observed increases in yield from 3X milking, because oxytocin injection has been shown to increase yield by only 1 to 1½ percent. It has also been suggested that oxytocin stimulates production of prolactin and growth hormone; both are known to be involved in the maintenance of lactation. This is consistent with the increase in persistency observed with 3X milking. Unfortunately, this explanation is not complete because chronic exposure to oxytocin should produce the same effect, but it does not. Because no single explanation is completely satisfactory, it seems likely that several factors combine to cause the demonstrated increase in yield from 3X milking.

Feed intake, health, fertility

Data on effects of 3X milking on feed intake are more limited than are data on milk yield, but the general pattern is for a small but significant (3 to 5 percent) increase in consumption. Cows compensate for extra production by drawing on body reserves. In the UC Davis study, cows on 2X regained post-calving weight by 26 weeks; those on 3X required 38 to 40 weeks. There was no significant difference between the 3X and 2X heifers in feed intake in this trial, but while the 2X heifers gained an average of 174 pounds by the end of lactation, the 3X heifers gained only 37 pounds. This emphasizes the importance of dry period feeding on 3X, particularly for young animals. Heifers calving at 24 months gain approximately one-third of their mature weight between their first calving and about 5 years of age.

Possible impacts of 3X milking on health and fertility have not been studied in depth. One potential benefit might be a reduction in severity of mastitis infection because of a shorter incubation time in the udder between milkings. A Wisconsin trial showed lower mastitis test scores and 35 percent less milk discarded for antibiotics with 3X, but the differences were not significant because of the small number of animals. A second possible benefit might be

TABLE 1. Operating characteristics of hypothetical dairy

Item	Herd	Heifers	Cows
No. of cows	450	135(30%)	315(70%)
Rolling avg. milk (lb)	17,500	15,191	18,489
Assumed increase on 3X	12%	5%	15%
Overbase milk price ($/cwt) ($1.58/lb fat & $0.708/lb SNF)	$12.00		
Cull price ($/hd)	$575		

TABLE 2. Feed costs and weeks in production strings

String	High	Medium	Low
Cows			
Feed cost ($/hd/day)	$3.43	$2.72	$2.11
Weeks in string 2X	12	13	19
3X	20	13	11
Heifers			
Feed cost ($/hd/day)	$3.17	$2.29	$2.17
Weeks in string 2X	15	15	14
3X	17	16	11

improved heat detection and thus breeding efficiency with 3X milking, but this would only occur if the milkers were responsible for heat detection, which is not always the case. It has been suggested that health and fertility effects of 3X milking depend on the herd's condition before the switch. For a herd already in good health, 3X milking may have some minor benefits; for a poorly managed herd, it may magnify existing problems.

Is switching to 3X profitable?

Individual dairy operators will have to estimate the profitability of a switch to 3X based on evaluating their own herd. Herd size, labor costs, extent of automation, genetic and health status, feed sources and costs, and milk price must be considered. A hypothetical example illustrates the potential of change.

The hypothetical dairy is a 450-cow drylot dairy in the north Central Valley (table 1). The herd is composed of 30 percent first-calf heifers with a first lactation yield based on a mature equivalent production of 19,000 pounds, which is approximately 500 pounds greater than the average for mature cows. The herd is grouped into three production strings and a dry string. Milk price, based on February 1984 prices, is calculated with the assumption that 50 percent of production is shipped as quota and 50 percent as overbase. Average composition is assumed to be 3.7 percent fat and 8.7 percent solids-not-fat (SNF). Marketing costs at $1 per hundredweight include the U.S. Department of Agriculture assessment of 50 cents plus a hauling cost of 50 cents. Cull cow value is based on 1,400 pounds liveweight and an average cow beef price of 41 cents.

Rations for each string were formulated using UC Cooperative Extension's Least Cost Dairy Cow Ration program. Feeds included in production rations are corn silage ($30 per ton) and alfalfa hay ($118 per ton) with a mix of beet pulp ($125 per ton), wheat mill run ($116 per ton), hominy ($150 per ton), and whole cottonseed ($180 per ton), plus salt and limestone. Feed costs per head per day and the number of weeks in each feeding string are given in table 2. Feed for the dry string consists of corn silage, alfalfa hay at $112 per ton and oat hay at $80 for an overall cost of $1.31 per head per day for 2X cows and $1.72 for 3X cows. Dry rations for 3X cows include additional alfalfa hay to restore body weight.

All other costs have been taken from the North Valley Feedback Information provided by the California Bureau of Milk Stabilization, averaged for the year ending June 1983. The feedback information includes data for both 3X and 2X herds. For analysis purposes, we have assumed 5 percent and 15 percent increases in yield from 3X milking for heifers and cows, respectively. Dry matter consumption is assumed to increase by 7 percent over the lactation, and the number of weeks that cows remain in the high, medium, and low production strings is adjusted accordingly.

In view of the current diversion program for milk, several alternative strategies were compared to evaluate the effects of changing to 3X milking. Column 1 of table 3 shows the current situation (base). Column 2 illustrates a switch to 3X milking that results in a 12 percent increase in milk shipment (as overbase). Column 3 illustrates a switch to 3X with a reduction of 67 low producers (15 percent of the herd) to maintain total output at the existing level. Allowing for increases in output over the last three years, it has been estimated that, on average, dairy operators would have to have reduced output by approximately 12 percent to have secured a 10 percent paid cutback under the diversion program. Column 4 shows effects of a 12 percent reduction in output with 2X milking by culling 15 percent of the herd. Column 5 shows effects of switching to 3X, culling 15 percent low producers to bring output down to the existing level, and culling an additional 12 percent (53 animals) to reduce output by 12 percent. Because of the delays involved, the diversion payment is valued at $9.75 per hundredweight instead of $10.

With assumptions used in these evaluations, a switch to 3X milking, with or

TABLE 3. Comparison of annual cash flows

Item	2X	3X	3X reduce 67 cows	2X reduce 67 cows (10% cutback)	3X reduce 120 cows (10% cutback)
Herd size	450	450	383	383	320
Rolling avg. (lb)	17,500	19,600	20,525	18,062	20,975
Milk shipped (cwt)	66,500	74,480	66,500	58,520	58,520
Income			$		
Gross milk sales	863,170	958,930	863,170	767,410	767,410
Marketing @ $1/cwt	-66,500	-74,480	-66,500	-58,520	-58,520
10% diversion payment @ $9.75/cwt	—	—	—	64,837	64,837
Sale of surplus animals (annual)	—	—	4,623	4,623	8,280
Total Income	796,670	884,450	801,293	778,350	782,007
(Change — %)		(+11.0)	(+0.6)	(-2.3)	(-1.8)
Variable costs			$		
Feed	340,200	371,700	316,358	289,548	272,580
Labor	103,500	116,550	99,197	88,090	85,470
Operating expenses	105,300	113,400	96,516	89,622	83,160
Herd replacements	95,850	95,850	81,579	81,579	70,290
Total variable cost	644,850	697,500	593,650	548,839	511,500
(Change — %)		(+8.2)	(-7.9)	(-14.9)	(-20.7)
Cash flow*	151,820	186,950	209,643	229,511	270,507
(Change — %)		(+23.1)	(+36.8)	(+51.2)	(+78.2)

*Cash flow is used to pay overhead costs and return to equity.

without a reduction in herd size, would increase total income over variable costs (cash flow). Changing to 3X milking (column 2) increases cash flow with an increase in both income and variable costs. Changing to 3X and reducing herd size at the same time (column 3) does not change total milk output and therefore has little impact on income, but it does reduce costs and thus increases cash flow more than does a change to 3X on its own. These two options illustrate the likely implications of culling and/or 3X milking without any effects of the current diversion program. With the diversion program in place, a reduction in herd size on its own (column 4) leads to a fairly substantial increase in cash flow. If the herd is changed to 3X and 27 percent (15 plus 12 percent) of the animals are culled (column 5), total milk production drops by 12 percent, income drops by less than 2 percent because of the diversion payment and the sale of surplus animals, and costs are reduced by approximately 20 percent. This strategy leads to the greatest increase in cash flow of nearly 80 percent over the existing situation.

Nonvariable costs (such as cost of capital) are not included in these estimates. These costs vary considerably from dairy to dairy; before any switch to 3X milking is considered, they would have to be calculated and entered into the evaluation.

Conclusion

With the changes occurring in the milk marketing systems, dairy operators more than ever have to be concerned about watching their cash flow situation. The examples given here show that there is the potential to increase cash flow by increasing intensity of management, either by more stringent culling or by changing to 3X milking, or both. Even if a move to 3X milking is not feasible for individual dairy operators within the constraints of the diversion program, 3X milking may be worth considering when the diversion program is terminated in 1985.

While 3X milking appears to be a viable management strategy, switching to it should not be done without recognizing that it will probably place greater stress on a herd and may magnify existing health or management problems. These are perhaps the major reasons why 3X milking has not been adopted more widely to date. The potential additional stress to a herd has not been adequately evaluated, but it is likely that health maintenance expenses would increase. In addition, lower weight gains of cows on 3X mean that feeding during the dry period will require careful attention to ensure good body condition at calving.

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Effect of vitamin B_1 on vegetable transplants

It didn't help in these tests

Demetrios G. Kontaxis ☐ David Cox

Thiamine hydrochloride, vitamin B_1, is widely advertised and sold as a material that will stimulate root development, ensure success in planting and transplanting, and reduce transplant shock of vegetables, ornamentals, and trees.

Studies conducted by other researchers on the use of thiamine in ornamentals and other crops have been reported over the past several years. W. J. Robbins reported in 1922 that thiamine hydrochloride was "beneficial for the growth of isolated corn roots," and P. R. White (1934) and James Bonner (1937) concluded that the material benefited *in vitro* growth of tomato and pea roots, respectively.

Kentucky Wonder pole bean treated with vitamin B_1 (#1) showed no improvement over untreated control (#2) or #3, treated with B_1 plus minerals.

Physocarpus (ninebark) cuttings treated with thiamine, however, did not root significantly better than nontreated cuttings, according to a report in 1945 by N. H. Grace, and he concluded that thiamine had "no overall effect on any of the rooting responses." Other researchers have found that vitamin B_1 did not significantly increase growth of Valencia citrus planted, bare or balled roots, in good soil (Parker and co-workers, reporting in the Proceedings of the American Society of Horticultural Science in 1941). Roses treated with vitamin B_1 failed to produce larger flowers or longer stems, and chrysanthemums did not benefit from its use (Laurie & Kiplinger, 1941, reporting in the same journal). Snapdragons treated with a vitamin B_1 "root stimulator" containing, in addition to vitamin B_1, alpha naphthalene acetic acid and a 3-10-3 fertilizer, grew larger than nontreated plants but not larger than plants treated with fertilizer alone in a 1982 study by UC Farm Advisor Gary Hickman and co-workers.