January 1980

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ABSTRACT

Effects of twinning on lactation and days open in Holsteins were studied from calving records compiled by member surveys of Eastern Artificial Insemination Cooperative. Records of cows with 305-day mature-equivalent records from the Northeast Dairy Records Processing Laboratory were grouped according to whether the twin calving was associated with dystocia. Records of each cow that had a twin calving were paired with records of a single-calving control herdmate. In the twin group of 175 cows associated with dystocia, twin pregnancy had no effect on production; milk and fat production in the lactation initiated by twinning was depressed (137 kg and 7 kg) although not significantly; and days open following twin calving was increased. In the twinning group of 367 cows with no dystocia at twinning, milk and fat production were depressed by 285 kg and 14 kg in the lactation initiated by the twinning. Days open after twinning were increased by about 22 days. These results indicate a negative economic effect of twinning on lactation performance in Holstein cattle. Increased rates of twinning via selection or artificial induction of twinning dairy cattle appear not to be desirable.

INTRODUCTION

Before artificial induction of twinning via ova transfer or hormonal induction of multiple ovulations (6) can be recommended for dairy management systems, effects of twinning on production of dairy cattle must be known. Twinning has decreased milk yield in some studies (2, 11, 14) but in others has increased yield (1, 12, 15). Effects of increased dystocia (5, 9) or of prolonged calving interval following twinning (2, 4, 9, 11) also are important considerations. The purpose of this study was to examine production of Holsteins that produced twins to estimate effects of twin pregnancy on milk and fat yields, on the subsequent lactation, and on calving interval.

MATERIALS AND METHODS

Data from the Eastern Artificial Insemination Cooperative, Inc. (EAIC) survey of calving difficulty indicated herds that reported twin births from July, 1974, to January, 1979. Dairymen listed herd identification numbers; identification of cow, dam, sire, and maternal grandsire of the calf; parity number; dates of breeding and calving; and number and sex of calves. Also included were the dairymen's evaluations of size of dam, vigor of calf, and dystocia score. Dystocia was rated from 1 to 5, with 1 being no problem; 2, slight difficulty; 3, needed assistance; 4, considerable force; and 5, extreme difficulty. Herd identification numbers for herds reporting twin births then were matched by hand to a computer file supplied by the Dairy Records Processing Laboratory (DRPL) in Ithaca, NY, to obtain corresponding Northeast Dairy Herd Improvement (DHI) herd identification numbers. The 305-day, mature-equivalent (ME) lactation records were obtained for all cows actively enrolled in DHI programs. These records were hand-matched with cows reported on the EAIC survey of calving difficulty as having twinned. Twin calving cows were identified by cross-matching sires' registration numbers and calving dates within each herd. Twin calvers were divided into two groups, a difficult twinning group if dystocia had been scored 2 through 5 by the dairyman or a nondifficult twinning group if the twin birth had been scored as 1 (no problem).

Received December 31, 1979.

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A control herdmate was selected for each twin-calving cow on age and freshening date with both as close to the corresponding age and freshening date of the twinner as possible. Controls that were paternal half-sisters of the twinners were preferred but were not available in most cases.

To maximize sample size, those twin-calving cows identified by their DHI cow index numbers on the EAIC calving survey, but not appearing on the active DHI file, also were recorded. Paired control herdmates were selected from the active DHI file.

Individual cow performance (ICP) sheets of lifetime production records were obtained for each twin-calving cow successfully matched to a DHI herd and cow index number. These records, paired with records of control herdmates, were divided into two groups – those with twinners associated with dystocia and those not associated with dystocia at the time of twinning.

Performance data for each category were recorded as follows. The 305-day, ME lactation yields for milk and fat were recorded for the lactation during which twin pregnancy occurred (yr 1). Also recorded were milk and fat for the lactation which had been initiated by a twin birth (yr 2). If a subsequent lactation followed, data for that year were recorded (yr 3). If no record followed the lactation from twinning, a record prior to the yr-1 record was obtained. The yr-3 record was defined as a record that was not affected directly by twinning. Corresponding records of lactations of nontwinning herdmate controls for those years also were recorded. Analyses were separate for pairs that included yr 1, 2, and 3, yr 1 and 2, and yr 2 and 3.

For number of days open, yr 3 was defined as the number of days open following a twinning. Year 2 was defined as the year in which the cow had conceived twins, hence days open prior to the twinning conception. Year 1 was defined as the year prior to yr 2. In other words, yr 1 should show no effect of twin calving or on conception of twins since the record was prior to these effects. The corresponding years were assigned to the corresponding days open of the herdmate control.

Data were discarded on pairs with insufficient information. Records on twin calvers that twinned more than once in the 3 yr also were discarded as were pairs where the control animal had twinned but had not been reported in the original EAIC survey of calving difficulty. However, to preserve as much data as possible, editing for records of each trait was separate (Table 1). Fat records numbered less than milk records as some herds were not participating in a fat test DHI program. Number of days open appeared on ICP sheets of even fewer cows because many breedings were unreported.

Analysis of variance was applied separately to the two groups of twin calvers and their controls according to the model:

$$\text{Record}_{ijk} = \mu + P_i + S_j + L_k + PS_{ij} + PL_{ik} + SL_{jk} + E_{ijk}$$

where

P_i = herd(pair) effect,
S_j = status effect (control or twinner),
L_k = lactation effect (year 1, 2, or 3),
PS_{ij}, PL_{ik}, SL_{jk} = interaction terms, and
E_{ijk} = residual.

Herd effects were random as were interactions with herd effects. All other effects were fixed except the residual. Subclass means were calculated. The S × L mean square, which indicated whether the difference between twinner and control was the same for all three lactations, was tested for statistical significance by F test at $P<.05$. The balanced analysis of variance program of Henderson was used (8).

RESULTS

Table 2 shows that twinning associated with dystocia apparently depressed subsequent milk yield as compared to controls and that twin calvers outproduced their herdmates in yr 1 and 3. The S × L interaction mean square, however, was not significant ($P>.05$) (Table 3). Separate analysis of the 172 pairs with milk records for yr 1 and 2 gave means for yr 1 of 7848 kg for twin calvers and 7722 kg for the controls. For yr 2, the mean for twin calvers was 7794 kg compared to a mean of 7811 kg for controls. Although these means also indicate a depressive effect of twinning, the mean square for S × L

TABLE 1. Numbers of pairs considered in analyses of variance.

Years	Group 1 (dystocia)			Group 2 (no dystocia)		
	Milk[a]	Fat[a]	Days open[b]	Milk[a]	Fat[a]	Days open[b]
1, 2, 3	147	131	100	333	305	212
1, 2 only	172	156	103	364	330	217
2, 3 only	150	134	157	336	308	316

[a]Year 1 is the lactation in which the twin calver was twin pregnant; year 2 is the lactation initiated by twin calving; year 3 is a lactation not directly affected by a twinning.

[b]Year 1 is the days open prior to the pregnancy which resulted in the lactation in which a twin pregnancy occurred (no effect of twinning); year 2 is the number of days open prior to the conception which resulted in a twin pregnancy; year 3 is the number of days open prior to the conception following twinning.

interactions was not significant ($P>.05$). Results for 150 pairs with records for yr 2 and 3 were nearly identical to those in Table 2.

Means in Table 2 also show that twinning not associated with dystocia also depressed subsequent milk yield. The twin calvers outproduced their herdmates in yr 1 and 3. The S × L mean square was significant ($P<.05$) (Table 4). No depression was noted for milk yield in the twin pregnancy lactation (yr 1). Analysis of the 364 pairs with records for yr 1 and 2 showed similar means and an S × L mean square that was significant ($P<.05$). The 336 pairs of cows with records in yr 2 and 3 also had means which were nearly identical to those in Table 2, and the S × L mean square was also significant ($P<.05$).

Depression in fat percentage with twinning (Table 2) combined with depression in milk yield to depress fat yield (Table 2). Records of

TABLE 2. Mean 305-day mature equivalent milk yield, fat yield, and number of days open of twin calvers and their control herdmates for twin births accompanied by dystocia and by no dystocia.

Year	Twin calvers				Controls			
	Milk yield (kg)[a]	Fat (%)[a]	Fat yield (kg)[a]	Days open[b]	Milk yield (kg)[a]	Fat (%)[a]	Fat yield (kg)[a]	Days open[b]
	Twin calvers with dystocia							
1	7705.7	3.62	377.6	106	7583.7	3.62	273.5	95
2	7711.6	3.55	273.1	104	7718.4	3.64	279.4	101
3	7889.0	3.55	279.4	133	7750.6	3.61	277.6	114
No. of pairs	147	131	131	100				
	Twin calvers without dystocia							
1	7803.2	3.57	277.6	100	7692.6	3.64	279.9	104
2	7737.5	3.57	276.7	97	7912.1	3.66	288.9	106
3	7947.5	3.63	288.0	132	7837.2	3.60	281.7	100
No. of pairs	333	305	305	212				

[a]Year 1 is the lactation in which the twin calver was twin pregnant; year 2 is the lactation initiated by twin calving; year 3 is a lactation not directly affected by a twinning.

[b]Year 1 is the days open prior to the pregnancy which resulted in the lactation in which a twin pregnancy occurred (no effect of twinning); year 2 is the number of days open prior to the conception which resulted in a twin pregnancy; year 3 is the number of days open prior to the conception following twinning.

TABLE 3. Analysis of variance, 305-day mature equivalent milk and fat yields (kg) and days open of twin calvers with dystocia versus controls.

Source	Milk			Fat			Days open			Denominator MS
	df	MS	F	df	MS	F	df	MS	F	
Pair (P)	146	7,167,964	2.65	130	10,529	3.30	99	3,893	1.47	PS + PL - PSL
Status (S)	1	1,573,091	.67	1	.01	.00	1	18,939	6.73	PS
P X S	146	2,349,999	4.28	130	2,685	3.86	99	2,813	1.57	PSL
Lactation (L)	2	2,275,762	2.52	2	626	.52	2	31,577	19.43	PL
P X L	292	903,163	1.64	260	1,197	1.72	198	1,625	.91	PSL
S X L	2	466,796	.85[a]	2	1,972	2.84[a]	2	3,316	1.85[a]	PSL
P X S X L	292	549,244		260	695		198	1,795		

[a]Not significant ($P>.05$).

131 twin calvers that exhibited dystocia indicated twin calving depressed fat yields, although the S X L mean square was not significant ($P>.05$).

In the group of 305 pairs in which no dystocia with twinning was observed, fat yield (Table 2) also was depressed in the twin pregnancy lactation. Twin calvers outproduced their herdmates in yr 3, the year not directly affected by a twinning. The S X L mean square was significant ($P<.05$) (Table 4).

Both groups showed approximately the same effect of twinning on the number of days open following a twinning (Table 2). The 100 twinners associated with dystocia indicated a pronounced increase in the number of days open following twinning, although the S X L mean square was not significant ($P>.05$). The 157 twin calvers with records on yr 2 and 3 were open for an average of 105 days prior to conception of twins and 132 days after birth of twins as compared to means for the controls of 101 and 106 days. The S X L mean square was significant ($P<.05$). Analysis of 103 pairs with records for yr 1 and 2 showed means nearly identical to those in Table 2, and the S X L mean square was not statistically significant ($P>.05$).

Analysis of 212 pairs of cows in which twin calvers had no dystocia with twinning showed that conceptions with twins averaged 9 days earlier than conceptions of singles by the herdmate controls (Table 2). After the twin birth, twin calvers took 22 days longer to conceive than their herdmates. The S X L mean square was significant ($P<.05$). However, when 217 pairs were analyzed for yr 1 and 2 only, the S X L mean square was not significant

TABLE 4. Analysis of variance – 305-day mature equivalent milk and fat yields (kg) and days open of twin calvers with no dystocia versus controls.

Source	Milk			Fat			Days open			Denominator MS
	df	MS	F	df	MS	F	df	MS	F	
Pair (P)	332	6,583,287	2.25	304	9,022	2.40	211	4,231	1.29	PS + PL - PSL
Status (S)	1	120,623	.05	1	3,428	1.07	1	3,715	1.23	PS
P X S	332	2,672,438	2.93	304	3,211	3.94	211	3,021	1.30	PSL
Lactation (L)	2	3,477,360	2.98	2	5,971	4.39	2	53,104	20.42	PL
P X L	664	1,165,105	1.28	608	1,361	1.67	422	2,600	1.12	PSL
S X L	2	4,526,828	4.97[a]	2	12,961	15.90[a]	2	29,204	12.52[a]	PSL
P X S X L	664	911,467		608	815		422	2,332		

[a]Significant ($P<.05$).

($P>.05$). When 316 pairs were analyzed for yr 2 and 3 only, twin calvers showed a mean number of days open prior to conception of twins of 100 days and a mean of 131 days to conception following the twinning as compared to means of the controls of 105 and 108 days. The S × L mean square was significant ($P<.05$).

DISCUSSION

Results in Tables 2, 3, and 4 are summarized further in Table 5 by expressing the yearly records as differences from controls. Depression in 305-day, ME milk yield following a twin birth was evident ($P<.05$) in twin calvers that gave birth to twins without dystocia and, although not significant ($P>.05$), in those that showed dystocia with the twin birth. This result agrees with (2, 4, 9, 11). However, no depression in milk yield was in the twin pregnancy lactation of either group, contrary to (14). In both groups, twin calvers outproduced their herdmates in years other than in the lactation following twin calving. Dystocia does not appear to add to this depression since the depression in this sample was greater for the no-dystocia group.

Fat yield also was depressed by depression of milk yield and by depression of fat percentage following twin calving. In the group not exhibiting dystocia, fat percentage was depressed in the lactation with twin pregnancy (yr 1). In the year not affected by twinning, cows in the group not associated with dystocia outproduced their herdmates and had higher fat percentages. This result appears to support previous work which indicated twin-calving cows were genetically superior to their herdmates (2) for production.

While there were no differences in number of days open prior to the breeding which resulted in twins ($P>.05$), there were differences following the twinning in both groups of twin calvers ($P<.05$), such that calving interval was prolonged by 19 and 22 days. There is also the possibility that a larger fraction of cows having twins were never rebred than of cows having singles. The estimate of the increase in calving interval may be too small. Another important implication is that depression in milk and fat yield in twin calvers occurred in lactations in which cows were open for 19 to 22 days longer than their herdmates. If the ME records had

TABLE 5. Means of twin calvers minus means of controls.

Year	Milk yield (kg)[a]	Fat (%)[a]	Fat yield (kg)[a]	Days open[b]
	Twin calvers with dystocia			
1	122.0	.0	4.1	11
2	−6.8	−.09	−6.3	3
3	138.4	−.06	−1.8	19
No. of pairs	147	131	131	100
	Twin calvers without dystocia			
1	110.6	−.07	−2.3	−4
2	−174.6	−.09	−12.2	−9
3	110.3	.03	6.3	22
No. of pairs	333	305	305	212

[a]Year 1 is the lactation in which the twin calver was twin pregnant; year 2 is the lactation initiated by a twin calving; year 3 is a lactation which is not directly affected by a twinning.

[b]Year 1 is the number of days prior to the pregnancy which resulted in the lactation in which a twin pregnancy occurred (no effect of twinning); year 2 is the number of days open prior to the conception which resulted in a twin pregnancy; year 3 is the number of days open prior to the conception following the twinning.

been corrected for number of days open, the depressive effect of twinning would be more dramatic in terms of milk and fat yield than what has been shown.

These results cannot be explained by theories of multiple births and placental lactogen as they show effects contradicting those in dairy goats (7). Twin gestations are shortened by 5 to 6 days. There is some thought that lobulo-alveolar duct development in a twin calver is not as extensive as it may be in the single calver due to the shortened gestation (5, 10).

Although the heritability of twinning is too low to allow for easy selection for or against the occurrence (3, 5, 13), with a rise in production from both improved management schemes and genetic superiorities, the incidence of twinning can be expected to increase (1). Since there are no clear advantages to twinning and, in fact, disadvantages as shown in this study, induction of twinning in dairy cattle cannot be recommended.

NOTE ADDED IN PROOF

Due to an oversight, results of an early study (Meadows, C. E., and J. L. Lush. 1957. Twinning in dairy cattle and its relation to production. J. Dairy Sci. 40:1430) were not included in the original text. Their study indicated a depression in fat yield of about 10 kg after twinning but no superiority of the twin calvers in lactations not affected by twinning.

ACKNOWLEDGMENTS

The contribution of data by the Eastern Artificial Insemination Cooperative, Inc., and the assistance of the Northeast DHI Dairy Records Processing Laboratory are acknowledged gratefully. The authors also wish to thank Roger A. Cady and Jennifer Timms for their technical assistance.

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