DECISION ANALYSIS FOR OPTIMIZING THE CALVING INTERVAL IN LARGE SCALE CALIFORNIA DAIRIES

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SUMMARY A mathematical model utilizing individual dairy performance and cost records for analyzing optimal reproductive indices is presented. The model calculates milk outputs adjusted for both parity and condition, feed requirements, probabilities of achieving optional reproductive goals, and produces income over feedcost statements for use in the decision analysis. Opportunity cost minimization based upon current performance is the decision rule for determining optimal reproductive values. For production at a 305 day ME of 7400 KG the model selects the optimal number of Days Open (DO) to be 75. For animals at 305day ME of 8100 KG, the selected optimum DO is 85. As production increases beyond 8100 KG, so too does DO; an animal at 10,000 KG 305 day ME has a DO at 100 days.

INTRODUCTION Heat detection rates, conception rates, average days open, and milk production all play roles in determining calving interval (CI). Numerous authors use a 12 month CI as a goal for all dairies, although the costs, probabilities, and producer capabilities involved are not known (3,5). The most complete economic analysis of calving interval was published by Mackay in 1981 (7). However, it did not address producer capabilities, the reproductive effects of differences in production, or incremental effects of changing lactation lengths; considerations which greatly impact an integrated evaluation. For instance, it has long been recognized that a positive correlation exists between milk production and reproductive anomalies such as cystic ovaries, silent estrus, and conception rates (2,5,8,9), and that management efforts, when quantitated, are positively correlated with profitability (4). However, most studies mention milk production and management practices as asides, but ignore them in final analyses.

The purpose of this work was to account for the above effects in a cohesive model which could estimate valid goals for an individual dairy, based on that dairy's history and current performance.

MATERIALS AND METHODS Literature sources for feeds and feeding (6,10), reproductive performance (1,2,3,7,9,11), and production effects (8) were identified and integrated into a weekly accounting of lactation performance (12). The model uses a dairy's own records for herd size, relative value of milk production based on parity (RV), average 305 day mature equivalent milk production (305ME), average days dry (DD) and days open (DO), services per conception (S/C), average body weight (BW), milking lifespan, and market prices of feed, milk, and money. It allows the herd manager to "force" certain feeds, or to allow the program to calculate all feed inputs. Woods' lactation curve (12) is applied based on the given 305ME (adjusted for any non-optimal dry period length) and RV. From this, and the body weight, total dry matter intake is calculated and partitioned into concentrate and roughage intakes using standard formulae (6,10).

Reproductive indices such as average lifespan, calving interval, births per lifetime, pregnancy status when culled, average cull rates, and average percent of herd in dry-lot are simple extrapolations of the herd information (eg: CI = DO + 283; the calving interval, in days, equals average days open plus average gestation length), as are computations of average days in milk per lactation. Estimates for reduction in potential lifetime milk production are provided by applying Braun's range for an optimal dry period and body score (2) to published effects of such body scores on the resultant lactation (10). "Break-even-point" levels of milk production are produced by setting milk production equal to average feedcosts. Application of Woods' equation (12) then determines individual "break-even-point" DO and dry-off week, adjusted for parity. Finally, the model calculates income minus

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feedcost values on a per cow per period (lifetime, month, or day) basis, and on a per herd per period (lifetime, month, or day) basis. Based on current heat detection rates, calculated from current records as per Barr (1) and the expected proportion of cows exhibiting silent estrus (modified from Morrow (8)), the program calculates the probability of acheiving any DO. With this probability as the current state of nature to adjust the income minus feedcost statements, the model selects DO using a MAXIMAX acceptance criteria.

The model was developed on a 256K RAM COMPAQ(TM) portable microcomputer (COMPAQ COMPUTER CORP., 12330 Perry Road, Houston, Texas, 77070, U.S.A) using the LOTUS 1-2-3(TM) Version 1 electronic spreadsheet software (LOTUS DEVELOPMENT CORPORATION, 55 Wheeler St., Cambridge, Massachusetts, 02138, U.S.A.).

RESULTS RUN1 relates the effect of DO on daily income over feedcosts, without accounting for differential fertility based on production. RUN2 also relates DO to daily income over feedcosts, but applies the results of Morrow (8) when adjusted for production. RUN3 studies the effects of average lifespan on both daily and lifetime income over feedcosts. Average performance values from dairies in the author's practice area are used as input in this report:

Number of milk cows	= 450
Relative value lactation #1 (%ME)	= 92
Relative value lactation #2 (%ME)	= 100
Relative value lactation #3+ (%ME)	= 102
Herd average p'n (305 da KG ME)	= 8,100
Average days dry	= 60
Average days open	= 55 – 145
Average services/conception	= 1.6 – 4.0
Average body weight (KG)	= 700

Milk blend price ($/100KG)	= 5.56
Heifer calf value ($)	= 100.00
Bull calf value ($)	= 45.00
Inside grain ($/100KG DM)	= 4.54
Outside grain ($/100KG DM)	= 3.95
Hay ($/100KG)	= 2.61
Other forage ($/100KG DM)	= 1.02
Dry-cow hay ($/100KG DM)	= 1.59
Current discount rate	= 10%

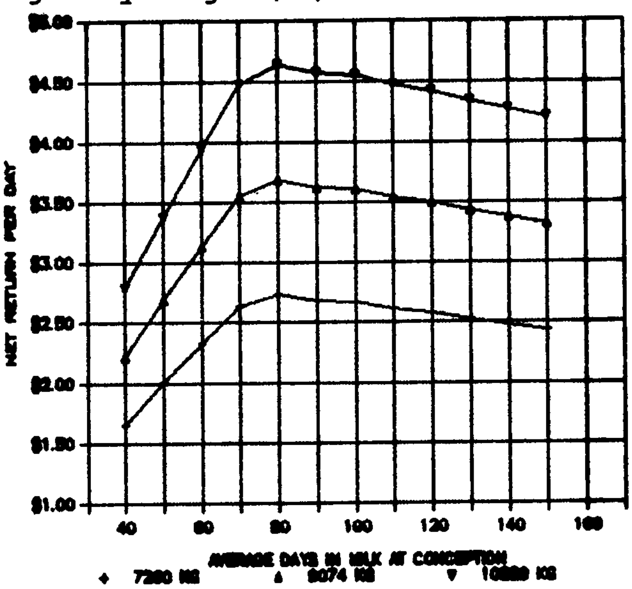

Figure 1: Income – feedcosts per cow-day by 305 day ME over 3.5 lactations

RUN1 FIGURE 1 displays daily income over feedcosts versus average days open without considering milk production's effects. Optimum DO for each production level is 80 days post-partum.

RUN2 FIGURE 2 displays daily income over feedcosts versus average days open when differential reproductive efficiencies due to milk production are considered. Optimum DO is positively correlated to milk production.

RUN3 FIGURE 3 illustrates differing DO over a 3 year lifespan. As DO increases, so does the proportion of life spent at lower production.

DISCUSSION When reproductive efficiency is not considered, as in FIGURE 1, the model's calculations agree with standard recommendations for CI; all optimize at 80 days post-partum; a 12 month CI. Morrow (8) shows cows milking 16% (16K/13.7K) over average undergo silent estrus more than those at the mean. Using 8100 KG 305ME as today's mean, animals at 9400 will display such an increase in silent estrus. The model uses this adjusted factor in FIGURE 2.

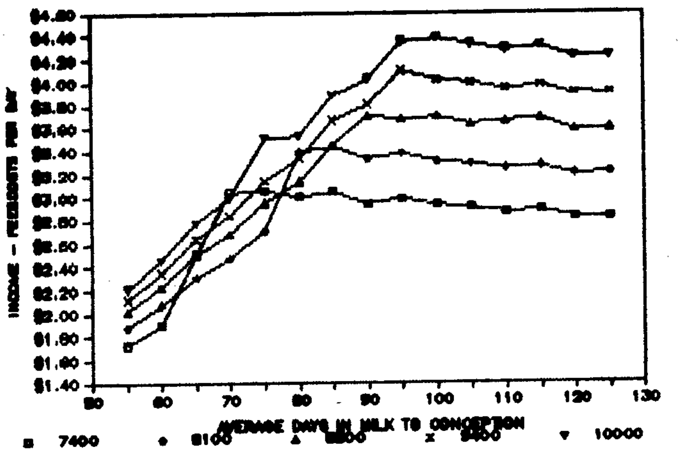

Figure 2: Effect of days open on daily income by 305 day p'n (KQ) over 3.5 lactations.

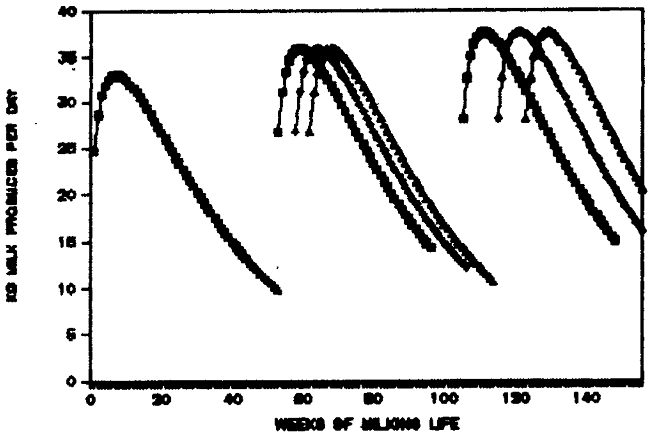

Figure 3: Effect of days open on lifetime p'n Avg p'n = 8100 KG d.o. = 85, 115, 145

FIGURE 2 reflects Morrow's effect on reproductive efficiency. A linear regression on Morrow's data indicates that below average cows (the 7400 KG line) actually should cycle optimally below the usually recommended 80 - 85 days.

FIGURE 3 displays the impact of increasing days open over a milking life of three years. Previously, this impact was viewed negatively (7). However, when Morrow's factor is considered in the problem it turns out that the animal with the DO of 145 has a daily deficit with regards to income over feedcosts compared to the 85 DO animal of $0.01 ($3.176-$3.164) which translates to a lifetime difference of $13.65. It would seem, then, that when the impact of production's depression on fertility is accounted for, a calving interval of 12 months becomes less and less important when one considers the average daily income over feedcosts.

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