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Short Communication

Methodology to estimate the cost of delayed pregnancy for dairy cows. An example for Argentina

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ABSTRACT - The objectives of the present study were to develop a methodology that implies the use of an electronic spreadsheet to calculate the financial losses of involuntary days open (IDO; every additional day open beyond an optimal calving-to-conception interval) and to show an example of the cost of days open using the proposed methodology. The costs accounted for in the methodology were: milk yield loss, calf crop loss, additional reproductive interventions, and cow replacement costs due to infertility. An example for Argentinean dairy cows in grazing year-round calving systems is presented. Results suggest that milk yield loss and cow replacement due to infertility are the main components determining the final cost of the delayed pregnancy. The methodology presented in this study is simpler than previous methodologies, and can be applied in a wide range of scenarios, using different cow types and regional costs.

Key Words: dairy system, day open, financial losses

Introduction

Reproductive performance plays a major role in determining the profitability of dairy herds (Plazier et al., 1997; Arbel et al., 2001; Meadows et al., 2005; De Vries, 2006). Several authors have demonstrated that delayed pregnancy, i.e., additional days open beyond the optimal calving-to-conception interval (CCI), are expensive to the system (Groenendaal et al., 2004; Meadows et al., 2005; De Vries, 2006). De Vries (2006) calculated an economic value of US$ 3.2 to US$ 5.1 per cow per day in US dairy farms, when average days open increased from 112 to 166, heifer replacement being the main determinant of the total value. Lower costs have been reported in a study from Pennsylvania (US), with a range between US$ 0.1 and 3.0 per cow per day, depending on the availability of replacement heifers, average herd lactation number, milk production level, and calving interval (Groenendaal et al., 2004).

Argentina has a grazing-based dairy system with few dairy farms using feedlots (Haumann and Wattiaux, 1999; Capellini, 2011). The average diet is composed of pasture (56%), maize silage (17%), and grain concentrates (27%) (Capellini, 2011).The Argentine dairy herd is composed almost exclusively (98%) of a national Holstein breed, the Holando Argentino (Capellini, 2011), which derived mainly from artificial insemination using US and Canadian semen (Haumann and Wattiaux, 1999). On most dairy farms, calving takes place all year round, and the calving interval is about 13-14 months (CCI of 110 to 140 days) (Haumann and Wattiaux, 1999).

There are no published data predicting the costs of delayed pregnancy in grazing-based dairy herds like those typically found in Argentina. The objectives of this study were to develop a simple methodology, using an electronic spreadsheet, to estimate financial losses caused by involuntary days open (IDO), and to show an example of these financial losses for dairy cows in year-round calving systems of Argentina.

Material and Methods

Involuntary days open are defined as those days exceeding an optimum CCI. The optimum CCI can be defined for the user of this methodology for each

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system. To estimate the total cost of delayed pregnancy, the following items are considered in the proposed methodology: milk yield loss due to involuntary extended lactation (MILKloss); calf crop loss (CALFloss); additional reproductive interventions such as: inseminations, gynecological examinations, and medical treatments costs (ADDinterv); additional labor costs (ADDlab); and cow replacement costs due to infertility (COWrep). The sum of all these items represents the financial losses due to delayed pregnancy (DELPregCost), which is expressed in US$ per cow per day, US$ per cow per lactation, and equivalent kg of milk per lactation.

Daily milk yield loss (MILKloss; US$/cow/day), due to involuntary extended lactation, is calculated as the difference, in milk yield, between the period of extended lactation being considered and the average of the whole lactation (the user must define the optimum lactation length) times the price of milk (Equation 1).Therefore, this item expresses the economic loss due to reduced milk yield as lactation is extended.

$$MILKloss = (Mean\ milk\ yield - Period\ milk\ yield) \times milk\ price$$

Equation 1

in which *Mean milk yield* is the average milk yield of the whole lactation (liters/cow/day), with lactation length defined by the user, and *Period milk yield* is the average milk yield of the period of involuntary extended lactation being considered (liters/cow/day).

The cost associated with the reduction in the number of calves (CALFloss; US$/cow/day), resulting from the extended calving interval, is calculated as the calf economic value (average market price between male and female calf; CALFprice) divided by the desired calving interval (DCI) (Equation 2). The latter is a consequence of the defined optimum calving-to-conception interval (CCI) mentioned above. The CALFloss expresses the economic losses due to reduced calf production as lactation is involuntarily extended.

$$CALFloss = \frac{CALF\ price}{DCI}$$

Equation 2

As lactation is extended due to longer CCI, there is an increase in costs related to additional reproductive interventions (ADDinterv) such as extra artificial inseminations (AIcost), veterinary examinations (VETcost), and medical treatments (MEDcost). These costs are computed by calculating the cost of each of these events divided by the frequency (days) of each event (FREQdays) (Equation 3).

$$ADDinterv = \frac{AIcost}{FREQdays} + \frac{VETcost}{FREQdays} + \frac{MEDcost}{FREQdays}$$

Equation 3

Extra labor costs (ADDlab) were also considered to account for extra activities detailed above. These costs were computed by calculating the cost of the event (LABORcost) divided by the frequency (days) of each event (Equation 4).

$$ADDlab = \frac{LABORcost}{FREQdays}$$

Equation 4

Under a sensible reproductive management, herds with longer CCI end up with higher infertility culling rates. In the present study, the cost of cow replacement (COWrep) due to infertility is calculated as the product between herd average infertility culling rate (CULLrate) and the cost of replacing a cow (difference in average market price between a replacement heifer and a culled cow; COSTrep) divided by IDO (Equation 5). Herd average infertility culling rate can be obtained from empirical data.

$$COWrep = \frac{CULLrate \times COSTrep}{IDO}$$

Equation 5

The cost of delayed pregnancy (DELPregCost) expressed as the economic value of each IDO can be calculated as the sum of all costs describe above (Equation 6):

$$DELPregCost = MILKloss + CALFloss + ADDinterv + ADDlab + COWrep$$

Equation 6

An example for Argentinean dairy system is described below to show the practical use of the proposed methodology. The cost of IDO was calculated for four 30-day-periods, starting 120 days after calving, which was considered in this example an optimal CCI.

To estimate MILKloss, lactations of 340, 370, 400, 430, and 460 days were simulated using the e-Cow animal model (Baudracco et al., 2012) for an Argentine Holstein-Friesian cow of 580 kg body weight, offered 6 kg dry matter (DM) of concentrates per cow per day, 4 kg DM cow per day of corn silage, and a pasture allowance (kg DM offered per cow per day at grazing) of 15 kg DM per cow per day. The e-Cow model predicts milk yield per cow per day, based on the cow's genetic merit and feeds offered. The e-Cow model predicts whole-lactation performance of dairy cows and the main outputs are the daily dry matter intake and daily milk yield.

In the lactation curve predicted with the e-Cow model (Figure 1), a 60-day dry period was considered, irrespective of lactation length for all cows.

The MILKloss was calculated for the 0-30, 31-60, 61-90, and 91-120 IDO periods, respectively. Thus, period 0-30, used to estimate the cost of IDO, corresponds to 340-370 days in milk. Daily milk yield loss, due to involuntary extended lactation, was calculated with Equation 1. For example, with an average lactation milk yield of 22.1 kg milk/cow day^{-1} (without involuntary extended lactation), and average milk yield of 16.8 kg milk/cow day^{-1} in the period of 340-370 days, milk yield loss per day would be 5.3 kg/cow day^{-1} and would cost US$ 1.8/cow day^{-1} (5.3 kg × 0.34 US$ kg^{-1}).

The CULLrate was estimated using empirical data. A database containing information from 22 farms and 4,945 milking cows was used. Dairy herds in the database were stratified according to their average CCI (120-150 d, 151-180 d, 181-210 d, and 211-240 d). The corresponding infertility culling rates were 8%, 13%, 15%, and 21% for IDO intervals 1-30, 31-60, 61-90, and 91-120, respectively.

Other assumptions used in the example are listed as follows: Optimum CCI: 120 days; Milk price: US$ 0.34 kg^{-1}, and 305 days milk yield = 7,500 kg; Desired calving interval (DCI): 402 days; Calf price: US$ 137 calf^{-1} (male/female average); AI cost: US$ 9.9 every 21 days; Gynecological exams: US$ 1.9 every 40 days; Medical treatments: US$ 6.2 per treatment every 40 days; A workload of 30 min/cow month^{-1} was considered. Labor cost: US$ 3.7 h^{-1}; and Culled-cow price: US$ 342. Replacement heifer price: US$ 1,615.

Results and Discussion

Several authors have developed methodologies to estimate the financial cost of delayed pregnancy in dairy systems, based on computer simulation models (Groenendaal et al., 2004; Meadows et al., 2005; De Vries, 2006). Although the use of those models made it possible to achieve quite realistic results, certain degree of complexity is still implicated in their equations, which could make it difficult to comprehend by users. Thus, the methodology presented in this study was focused on developing simpler equations to calculate the economic values proposed. The developed methodology is sensitive to changes in lactation curves (i.e., different production levels and/or persistency), making it useful to analyze different scenarios or systems.

In the example shown in this paper, the infertility culling cost was the main cause of the economic value of the IDO in the first two periods of the analysis (Table 1), whereas milk yield losses became the main determinant in the third and fourth intervals. The lactation curve predicted with the e-Cow model (Figure 1), for the example with grazing cows presented in this study, had an average daily milk yield of 22.1 kg for 340 days, with average daily milk yields of 16.8, 15.4, 13.9, and 12.3 kg for the 340-370, 371-400, 401-430, and 431-460 intervals of days in milk, respectively.

Conversely to previous results (Groenendaal et al., 2004; Meadows et al., 2005), the cost per IDO in our study did not increase consistently as time progressed from calving, but was relatively constant across the four periods analyzed (Table 1). This was related to the nature of the equation used to calculate the cost due to cow replacement.

Table1 - Cost components for involuntary days open (IDO)[1]

	Involuntary days open (beyond 120 days of calving-conception interval)			
IDO interval	1-30	31-60	61-90	90-120
Milk yield loss[a]	1.78	2.27	2.79	3.30
Calf crop loss[b]	0.34	0.34	0.34	0.34
Extra AI, gynecological exams and treatments costs[c]	0.54	0.54	0.54	0.54
Labor cost[d]	0.06	0.06	0.06	0.06
Infertility culling cost[e]	3.40	2.76	2.05	2.18
Total cost/IDO[2]	6.11	5.97	5.77	6.41
Total cost/Lactation	183	358	520	770
Total milk loss (kg)/Lactation	539	1,053	1,529	2,264

AI - artificial insemination.
[1] Aggregated costs were expressed as US$ cow day^{-1} for each period and US$ cow lactation^{-1}.
[2] Total cost in Table 1 based on the following equation:
Total cost/Lactation = (a+b+c+d+e) × IDO = (((340 d milk yield daily average – IDO interval milk yield daily average) × US$ kg milk) + ((US$ female-male calf average price)/402) + ((US$ AI cost/frequency) + (US$ veterinary examination/frequency) + (US$ treatment cost/ frequency) + (0.5 h of labor × US$/h)) + (infertility culling rate × (US$ replacement heifer – US$ cull cow)/ IDO))) × IDO.

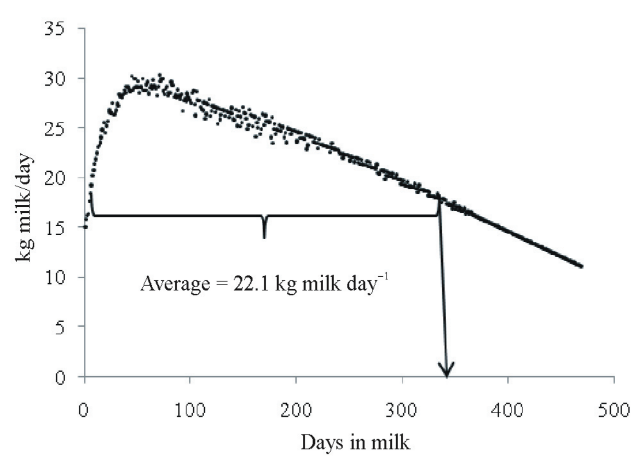

Figure 1 - Estimated curve for 7,500 kg milk per lactation of 340 days using the e-cow animal model (Baudracco et al., 2012).

De Vries (2006) reported that cow replacement cost due to infertility represented the highest proportion of the total cost. In the present research, that was the case for the first 60 involuntary days open. However, losses due to lower milk yield as lactation progressed were the main reason for the economic loss beyond 60 IDO. This discrepancy with the study by De Vries (2006) may be explained by both lower infertility culling rates and lower lactation persistency compared with those of US dairy systems.

The lactation curve required to predict the cost of IDO, using the proposed methodology, may be produced with different equations, models, or empirical data. Similarly, different milk payment systems may be used to estimate the price of milk required as input in the methodology. It is worth noticing that, in the current study, the same milk price was considered for the entire lactation.

In agreement with Meadows et al. (2005), the present methodology uses a single cow to represent the whole herd. In this sense, the model could be considered less robust than others that simulate scenarios based on cow subpopulations with different characteristics within a herd (i.e., number of lactations, production level, etc.).

Another limitation of the proposed methodology is that calculations did not include extra feeding costs due to the expected decrease in feed conversion efficiency (kg milk per kg dry matter consumed) as lactation progresses.

Conclusions

The proposed methodology has demonstrated to be a simple and sensitive tool in monitoring the financial impact of different reproductive scenarios in a dairy herd. The example shown constitutes the first report of the estimation of costs due to delayed pregnancy in the typical grazing-based dairy systems of Argentina.

As it arises from the example, costs due to additional days open are higher than those reported in the literature for other production systems. For these reasons, under conditions described in the example, efforts should be focused on a better management of the transition period and the implementation of a very intensive reproductive program soon after the voluntary waiting period in order to shorten the time to conception.

Even though costs presented in this study are based on current prices, and the example shown referred to a particular situation, the methodology proposed can be applied to predict involuntary days open for different scenarios of physical and economic inputs (i.e., milk yield level, culling rate, and milk price).

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