DOI: http://dx.doi.org/10.22201/fmvz.24486760e.2019.1.572
Vol. 6 | No. 1 | January-March | 2019

Veterinaria México OA
Publicación Digital de la Facultad de Medicina Veterinaria y Zootecnia
http://veterinariamexico.unam.mx/

Economic impact of pregnancy loss in an intensive dairy farming system

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Abstract

Occurrence of pregnancy loss and the related economic impact were determined in an intensively managed dairy herd. A total of 3,204 cow and heifer pregnancies were included over a two year period. Pregnancy loss was considered when: (1) cows or heifers that were diagnosed as pregnant by transrectal palpation, on days 50 to 50 postinsemination returned to estrus; (2) animals were found not to be pregnant at diagnosis confirmation on day 90, day 180, or during the drying-off period; and (3) if an abortion was clinically diagnosed. Data were analyzed through descriptive epidemiology and by survival analysis with the Kaplan-Meier method. The estimated cost of a single pregnancy loss was determined by the Monte Carlo methodology. Overall, 17.2% of cows (372/2,162) and 6.5% of heifers (68/1,042) had pregnany losses; the greater risk being in the first 90 days of gestation for cows (5.3/100 and 8.3/100 pregnancies in 2012 and 2013, respectively). Occurrence of pregnancy loss in heifers was also higher during the first trimester of gestation (1.7/100) in 2013. However, the pregnancy loss incidence peaked, between days 120 and 150 of gestation (1.7/100) in 2012. The cost of a single pregnancy loss during the first trimester was estimated at $5,253.00 (Mexican pesos), between days 91 and 180 at $9,674.00; and for over 181 days at $21,984.00. In conclusion, overall pregnancy loss rate in the studied herd was 17.2% for cows and 6.5% for heifers. The highest incidence of pregnancy loss occurred during the first 90 days of pregnancy.Thus, pregnancy loss may be the main reproductive cause affecting profitability of intensive dairy farming systems.

Keywords: pregnancy loss, dairy cow, economics.

Accepted: 2018-12-03
Published: 2019-03-22

Additional information and declarations can be found on page 7

Cite this as:

Albuja C, Ortiz O, López C, Hernández Cerón J. Economic impact of pregnancy loss in an intensive dairy farming system. Veterinaria México OA. 2019;6(1). doi:10.22201/fmvz.24486760e.2019.1.572

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Introduction

Abortion in cattle is tradionally defined as fetal death accompanied by uterine expulsion of the calf.[1] Thus, the diagnosis of an abortion implies the certainty of the physical expulsion of the fetus. However, fetal death may not always be verifiable, and the only observed sign indicating loss of pregnancy is the return of the cow to estrus, or a negative diagnosis at confirmation of pregnancy (in the past referred to as embryonic resorption). Consequently, the term "pregnancy loss" is now favored.[2] The economic consequences of pregancy loss in dairy herds are steep, and even more so when considering the low pregnancy rates attained in regular insemination programs. That is, it takes a lot of time and effort to get a cow pregnant, only to loose its gestation thereafter.[3,4] The global literature mentions that pregnancy loss rate fluctuates between 15% and 23% in dairy herds.[5-7] The estimated economic impact of loosing a single pregnancy in other countries varies from 550 to 1280 US dollars, depending on the gestational age at which fetal death occurs.[3,8] Despite the magnitude of this problem and of the economic relevance for dairy herds, there is little information on its incidence or its economic impact in Mexico. In this study, the incidence of pregnancy loss, the period of peak occurrence, and the associated economic consequences are determined in an intensively managed dairy herd.

Materials and methods

The study was conducted in Holstein cows from a dairy herd located in the Mexican Plateau. The herd has 1,400 cows in production, with a two times per day milking system. The average yield per lactation is 11,500 kg of milk. Animal feeding is based on a total mixed ration, which is offered three times a day. It is a brucellosis free herd, where the RB51 Brucella strain is used for heifers. The vaccination program also includes bovine viral diarrhea (BVD), infectious bovine rhinotracheitis (IBR), bovine parainfluenza, bovine respiratory syncytial virus and bovine leptospirosis (Cattle Master Gold FP 5 L5® Zoetis), which are applied to 3 to 6 month old heifers, with a reimmunization at 21 days in primary-vaccination animals, and in adult cattle at days 30-35 postpartum.

Epidemiological analysis

Data from 3,204 pregnancies (2,162 cows and 1,042 heifers) registered from January 1st, 2012 to December 31, 2013 were analyzed. Pregnancy loss was considered when: (1) cows or heifers that were diagnosed as pregnant by transrectal palpation, on days 50 to 50 postinsemination; (2) animals were found not to be pregnant at diagnosis confirmation on day 90, day 180, or during the drying-off period; and (3) an abortion was clinically diagnosed. The analysis was performed by descriptive epidemiology. The annual and monthly incidences of pregnancy loss were determined in both cows and heifers. A survival analysis by the Kaplan-Meier method was used to determine the risk of fetal death by gestational age. The curves were compared using the Log-Rank test (SPSS).

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Vol. 6 No. 1 January-March 2019

Economic losses and reproductive efficiency

The epidemiological study was conducted in 2012 and 2013, and the estimated economic losses were recalculated to update costs to August 2017.

The Monte Carlo methodology was used to estimate the economic cost of fetal death.[9] The model included main variables affecting general performance of the studied system. For the calculation of each fetal death scenario, 10,000 iterations with prevalences of pregnancy loss from 0 to 18% were run (2,000 dairy herds of 1,400 cows in production, each). To determine the final costs of a single fetal death in each third of gestation, the following variables were considered:

a) Treatment costs for uterine infections in cows and aborted heifers.
b) Costs for additional inseminations to get cows or heifers pregnant after losing their gestation.
c) Depreciation of heifers and cows.
d) Loss of potential to produce calf or heifer replacements.
e) Diet costs in heifers that lost their gestation and exceeded non-productive days.
f) Diet costs through the extra days open.
g) Diet costs through the extended dry period.
h) Milk production loss.

The Monte Carlo methodology was also used to calculate the impact of fetal death on reproductive parameters, considering the following variables:

a) Probability of a uterine infection after pregnancy loss.
b) Days elapsed for resolution of the uterine infection (depends on period of pregnancy loss occurrence).
c) Days elapsed from abortion to conception.
d) Dry-off period: based on a previously established time to dry-off the cow, and considering milk yield decrease. The production balance point for milk yield was established at 16 kg. To reach this value, a projected lactation curve was established. Cows with pregnancy losses during the 2nd or 3rd trimesters are most likely to have a greater number of milking days, and to take fewer months to get pregnant again, which in turn affect the number of days open, the calving interval and the dry-off period.

Results and discussion

A total of 372 pregnancies were lost from 2,162 cows (17.2%), and 68 from 1,042 heifers (6.5%) over 2012 and 2013 jointly. The period of highest risk for pregnancy loss in cows was between days 45 and 90 of gestation, with 5.6 abortions per 100 pregnant cows in 2012, and 8.3 abortions per 100 cows in 2013. The distribution for pregnancy loss in heifers differed for each year, as it peaked between days 120 and 150 of gestation in 2012 (1.7 abortions per 100 pregnant heifers); whereas the highest incidence was found between days 60 and 90 in 2013 (1.7 abortions per 100 heifers).

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Vol. 6 No. 1 January-March 2019

Table 1. Monthly incidence of pregnancy losses in dairy cows and heifers (in 2012 and 2013).

	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cows	2012	0.7	0.7	1.6	1.4	1.3	1.2	1.1	1.7	1.1	2.2	1.1	1.4
	2013	1.1	1.7	0.8	1.6	1.3	2.1	1.4	2.2	1.8	2.3	1.2	1.5
Heifers	2012	0.4	0.6	0.2	1.6	0.2	1.0	0.2	0.6	1.0	0.6	0.8	0.6
	2013	0.0	0.4	0.0	1.5	0.4	0.2	0.9	0.6	0.0	0.2	0.7	0.6

Table 1 shows the monthly distribution of pregnancy losses in cows and heifers. During the two year period of our study, the incidence of abortions in cows showed a similar pattern., The highest numerical incidence was observed in October of 2012 and 2013. Notably, the occurrence of pregnancy loss remained low during the rainy season in 2012 (June to September), which was not the case for 2013, showing an increase during these same months.

The calculated yearly incidence of abortions in a farm is useful to point out the problem globally. However, when this parameter is calculated monthly, a specific characterization of its dynamics can be accomplished. If a peak annual abortion rate of 20% is estimated, a monthly rate higher than 1.6% could be used as a reference to identify outbreaks or abortion storms.[4] In heifers, the monthly abortion rate remained equal to or less than 1% throughout the year except for the months of April 2012 and 2013, were the incidence reached 1.6% and 1.5% respectively; implying the said outbreak or abortion storm from a clinical perspective.

Fetal survival curves differed between cows and heifers over both of the years studied ($p < 0.001$). The likelihood for a cow to give birth was calculated to be of 0.84 from the day when pregnancy was diagnosed; while for heifers the probability was 0.94 (Figure 1).

The highest incidence of pregnancy loss in cows occured within the first trimester, with 52% of all cases in this study. This agrees with literature from the past 20 years, where occurrence of pregnancy loss persistently peaks during the first three months of pregnancy.[10-12] A particular study shows for instance, that over 90% of fetal losses in dairy cattle in Spain, calculated from pregnancy diagnosis at day 30 postinsemination, occur before day 90 of gestation.[11] It is important to note that initial gestational age should be considered when calculating the abortion index, since early embryonic or fetal deaths can go unnoticed when methods for pregancy diagnosis of such as rectal palpation are used (between days 45 and 50 of gestation).

The cause of embryonic and fetal deaths can be multifactorial, entailing infectious and non-infectious factors.[5,13-15] The difference found for incidence of pregnancy loss between heifers and cows in this study, could relate to distinctive traits of the lactating cow, as well as to particular management practices. It has been reported for instance that heifers are less vulnerable to developping mastitis, ruminal acidosis, laminitis or to a high hepatic catabolism of progesterone, which are factors that have been associated with embryonic and fetal deaths.[12]

The overall incidence of pregnancy loss in cows observed in this study was lower (17.2%) than the one found by Mellado et al.,[7] in northern Mexico (23%). This difference could be related to the fact that the cow herd included in our work was free of brucellosis. This allows to reflect on the impact that brucellosis may

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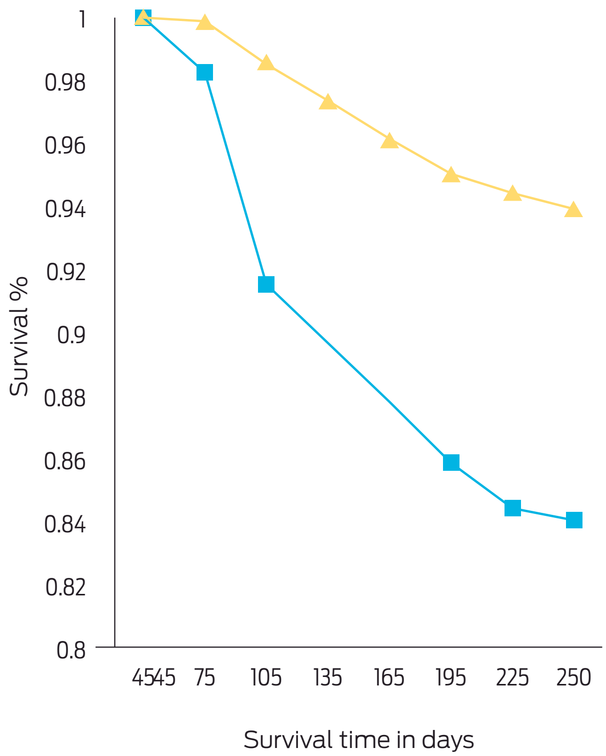

Figure 1. Fetal survival curves in dairy cows (—■—) and heifers (—▲—), after day 45 post-insemination pregnancy diagnosis.

have on dairy farms. Even if a direct contrast of pregnancy losses cannot be made between these two studies, the lower incidence of fetal death in a brucellosis-free herd is worth considering.

Consequences of abortion indices were determined on three reproductive parameters: calving interval (CI), days open (DO) and dry days (DD). Results show a positive correlation between prevalence of simulated abortions with an increased span of average days for all three parameters (Figure 2). With a prevalence of annual abortions of 4%, there is an average of a 423 days calving interval, 141 days open and a 85 days dry period. Whereas with a prevalence of 16%, which is closest to the rate found in our investigation, the average interval between births increased to 439 days, the days open to 157 and the dry period to 96 days. This estimate is in accordance with the reproductive parameters of dairy herds managed in intensive systems.[6,16,17]

The economic cost of a single pregnancy loss in this study was estimated at $5,252.00 Mexican pesos when occurring between days 45 and 90 of gestation; at $9,674.00 Mexican pesos between days 91 and 180; and at $21,984.00 Mexican pesos when abortion occurred over the 181-day span. Costs are considerably higher in this last scenario because an abortion during the 3rd trimester, is usually followed by three possible situations: a) culling of the cow; b) an increased number of unproductive days with the related increase on animal maintenance expenses; or c) the cow is kept in the herd because it starts a new lactation, which does not reach its full potential. The estimated cost of pregnancy loss is consistent with the one observed in other studies in US dollars with data from US dairy herds.[8,18]

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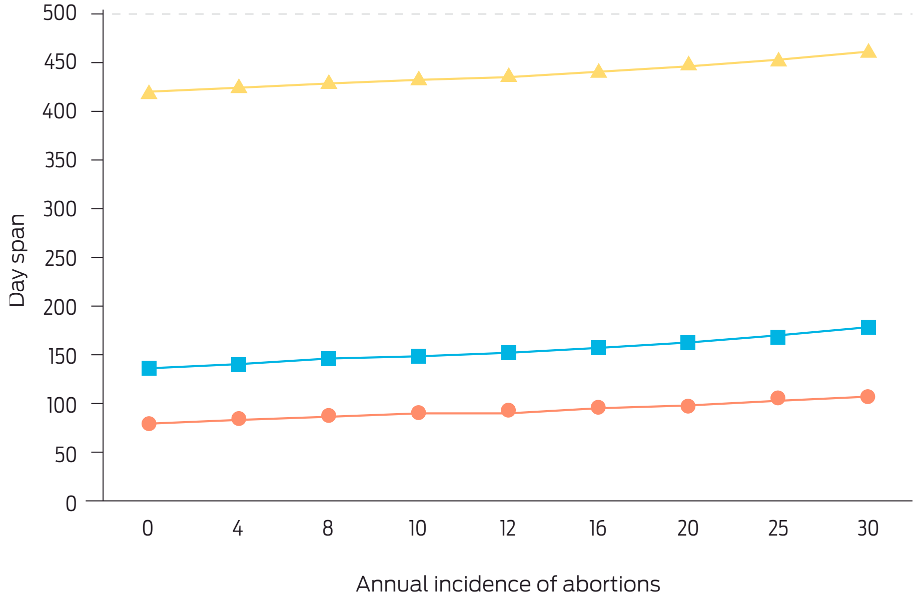

Figure 2. Impact of fetal death on days open (■), days dry (●) and calving interval (▲) of dairy cows.

The economic impact of incidence of pregnancy loss on milk production was also assessed in this study, estimating a 608 kg loss when abortion occurs during the first trimester of pregnancy; 987 kg if it takes place during the second, and 3,978 kg during the third.

To our knowledge, this is the first study where an estimate of the economic consequences of pregnancy loss on a dairy herd in Mexico is presented.

Conclusion

The incidence of pregnancy loss in this study was estimated at 17.2% for cows and 6.5% for heifers; with a peak occurrence between days 45 and 90 of pregnancy. Incidence of pregnancy loss is possibly the main reproductive cause affecting profitability of intensive dairy farming systems.

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Vol. 6 | No. 1 | January-March | 2019

Acknowledgements

The authors would like to thank the owner and employees of Rancho Loma Linda (Querétaro, Mexico) for facilitating access to their databases.

Conflicts of interest

The authors declare no conflicts of interest.

Author contributions

C.A., collected and analyzed data; O.O. collected data; C.L. analyzed data; and J.H.C. designed the study and wrote the manuscript.

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Vol. 6 No. 1 January-March 2019

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