STILLBIRTH IN DAIRY CATTLE: REVIEW

AVORTUL LA BOVINE: O TRECERE ÎN REVISTĂ

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Findings of research and experiences gained in commercial practice reveal needs for efforts in order to reinforce further development in the subject matter of calving difficulty and stillbirth in dairy cattle with special emphasis on causes and effects. Direct costs such as loss of calf, death of dam, labour, veterinary assistance and other ones influencing economics in longer term e.g. higher culling rate, reduced milk yield and fertility have to be evaluated and interpreted. The effects of non-genetic factors, parity, sex of calf, age at first calving, season, level of nutrition during gestation and their supposed modes of action has to be considered. In the genetic model for calving traits estimates the following components has to be included such as direct, maternal, and direct-maternal interaction. Thus, accurate and complete reporting of calving ease and stillbirth data is critical for several reasons: increase the accuracy of sire calving ease and daughter calving ease evaluations; allow the development of national stillbirth evaluations; the farmer can enhance future sire selection opportunities for the herd. The aim is to reduce economic losses, improve welfare status of animals, meeting increased concern of consumer acceptance of milk and dairy products. Key words: dairy cattle, stillbirth, genetic and non genetic factors, economic loss animal welfare, consumer acceptance, corrective actions

Introduction

Two of the most larges problem at dairy farm level is calving complications and stillborn calves. Heifers and cows that go through a difficult calving tend to have impaired health, fertility, and production in the following lactation. Death of the calf or its dam can also occur, and calving difficulty or dystocia is a leading cause of stillbirths. In certain cases some of normal-sized calves being born without complications are also stillborn or die shortly after delivery. There are substantial variation between sire families for both the direct (sire of calf) and maternal (sire of cow) aspects of calving difficulty and stillbirth rate. Obviously, dystocia and high stillbirth rate is unacceptable from ethical as well as animal welfare and economical point of view. The most stressful part of a cow’s life cycle is the calving process and its postpartum aftermath. Thus, postnatal mortality of calves is not only costly for cattle producers, but it is also a problem for animal welfare and health. Concerns of on the related issue have been increasing.
Taking into consideration the significance of stillbirth in cattle survey of present knowledge and novel scientific findings on the subject matter seems to be justified. The first report on the problem of stillbirths was presented by Berglund and Philipsson (1992) revealing large variation between sires in stillbirth rates. The traditional view is that stillbirths in general are a result of calving difficulties. Since rates of calving problems reported were rather stable it was difficult to get acceptance of the existence of a growing number of stillbirths not associated with dystocia (Gusstafsson et al., 2007). It is quite clear that calving is a critical time in the cow calf production cycle, and calving problems can be summarized by two traits: dystocia and stillbirth (Philipson et al, 1972; McDermott et al., 1992). Stillbirths and difficult calving may result in direct losses due to calf mortality, dam mortality and premature culling, as well as indirect costs due to additional veterinary services, labour and treatment. For dystocia, individual calf and dam factors have been reviewed by a number of workers. The size of the calf is considered to be the most important determinant. Other factors such as the pelvic diameter of the dam may be also important. The individual calf and dam factors leading to stillbirths have not been clearly understood, yet. Since stillbirths are associated with dystocia, they may be classified as dystocia- and nondystocia-associated. Results in a comprehensive study by McDermott et al. (1992) on calf-cow herds in Canada concluded, that dystocia rates in both cows and heifers were associated with recognized individual dam risk factors, as well as a number of herd level factors. Dystocias, particularly in heifers, were strongly associated with stillbirths and overall incidence of both dystocias and stillbirths were much greater in heifers than in cows. Even though dystocia has long been regarded to be the most significant factor for stillbirth, both stillbirth and calving difficulties are caused by genetic and/or environmental factors. Both the genotype of the calf as direct effect and that of the dam as maternal effect contribute to the risk of both traits. The definition of direct effect is the ability of the calf to be born without problems, whereas the maternal effect is the ability of the dam to calve without problems. Further factors are the birth weight and sex of calf, parity and age of dam as well as season of calving. Causes of stillbirths not related dystocia are infections (e.g. BVD), insufficient placenta development, metabolic disorders of the dam, and congenital malformations of the calf. Problems with the management are e.g. care of the pregnant cow before calving and supervision of the calving process (Gustafsson et al., 2007). Dystocia and stillbirth are related terms, the terms are not the same traits. Approximately 50% of stillborn calves are born without difficulty (Philipsson, 1996). Dystocia is difficult or abnormal labour or delivery. From the Greek "dys" meaning "difficult, painful, disordered, abnormal" & "tokos" meaning "birth." Dystocia or difficult calving is stipulated that the heifer or cow is unable to calve without assistance. Stillbirth is defined as birth in which an animal is born dead or dies during or within 24 hrs time after parturition and
after at least 260 days of gestation. If the dead calf is delivered earlier than 215 days it is categorised as an abortion.

The time being increase of stillbirth rate in cattle populations seems to be a key issue all over the world. Statistics reveal that percentage of stillbirths has been steadily increasing (Murray, 2009). Reports from all over the world including USA (Meyer et al., 2001), Denmark (Hansen, 2004) and the Netherlands (Harbers, 2000) reveal stillbirth rates of 10–13% especially in Holstein-Friesian heifers are comparable with those reported in Sweden (Meyer et al.). Recent figures suggest that stillbirths have been rising, although the reasons still are not clear. In Canadian Holstein-Friesian cows’ stillbirth incidence with first calvings has risen to 12 per cent from 10 per cent over the past five years. The stillbirth rate for cows having their second or later calvings is lower at 6 percent, but still up slightly from the previous 5 percent. Stillbirth data from other parts of the world are similar to Canadian statistics. Data from the Swedish Milk Recording Scheme (Swedish Dairy Association, 2005) show that stillbirth rates in first-calving Swedish Holsteins (SLB) have steadily increased since the middle of the 1980s (Steinbock, 2006). At present the rate is 10.4%, and the proportion of difficult calvings reported is 6.9% (Swedish Dairy Association, 2005). This unfavourable general tendency has been clearly demonstrated in Fig. 1 a and b for stillbirth and dystocia. However in subsequent calvings the incidence of stillbirth drops considerably. Interestingly, this contrast – between stillbirth rates in first and later calvings – is not seen in the Swedish Red and White Breed (SRB). In SRB, calving number makes almost no difference to stillbirth rates (Figure 1 a and b).

![Figure 1a. Annual statistics from the Swedish milk recording scheme for stillbirth (%) for heifers and cows of SRB and SLB](image-url)
Stillbirth incidence in US increased to 13.2 percent in 1996 from 9.5 percent in 1985. In contrast to these results, a recent Norwegian study of calving difficulties and stillbirths in Norwegian Red cattle found that the frequency of stillbirths was 3 percent at first calving and 1.5 percent for second and later calvings. The rate was unchanged between 1978 and 2004. In studies by Hradecká et al. (2004) the frequency and major causes of perinatal mortality were analysed in the dual purpose Czech Pied cows (n = 194,548) and Holstein-Friesian dairy cattle (n = 75,658). The frequency of stillbirths did not differ much according to year of observation and was very similar in both evaluated breeds for Czech Pied (3.55%) and Holstein-Friesian (3.70%) cattle. More than half of stillborn calves (58.54%) came from difficult calvings with close relationship of mortality and calving performance. The frequency of stillbirth was higher in male calves (69.73%) as compared to their female counterparts (30.27%). Stillbirth frequency was two times higher in primiparous cows compared to multiparous ones (5.53 vs. 2.69%).

Factors affecting stillbirth

Genetics

Genetic parameters of postnatal mortality (PM) in dairy cattle were estimated using Danish Holstein calves (n = 841,921) by Hansen et al. (2003). Four binary traits of mortality were considered: D1-14, D15-60, D61-180, and D1-180 with numbers indicating the period of risk in days after birth. Direct h² values for the four mortality traits ranged from 0.001 to 0.008 but were all significant. D61-180 and D1-180 had the highest direct heritabilities. Maternal heritabilities were very low, ranging from 0.0002 to 0.0015 and significant for D1-14 and D1-180 only. In conclusion if PM were of economic importance relative to other traits, PM could be
included in a breeding program for dairy cattle. It is possible to gain fairly reliable predictions of breeding values, as the number of offspring per proven sire in general will be high.

In the study conducted by Thomasen et al. (2006) both direct and maternal genetic components associated with the calving traits were identified in the Danish Holstein cattle population. The heritability ($h^2$) estimates of the calving traits (Hansen, 2004), measured as a direct sire effect ($h^2=0.05-0.19$) were higher than that of calving traits measured as a maternal grand sire effect ($h^2=0.04-0.06$). The genetic correlation between calving traits measured as a direct sire effect (0.69-0.93) were markedly higher than the genetic correlation between calving traits measured as a maternal grand sire effect (0.01–0.62).

The calving traits are genetically affected not only by the calf itself but also, to a large extent, by characteristics of the dam as shown in Figure 2 by Meijering, 1984. The dam’s size – especially her rump-width, pelvic opening and angle of pelvic opening – is an important factor, as is the size and fitness of the calf itself. Additive genetic direct effect is defined as the ability of the calf to be born. This is measured as variation between sires of the calves. The maternal genetic effect is defined as the ability of the dam to give birth, and is largely measured as variation between maternal grandsires of the calves (daughter groups). It is, thus, important to take the maternal grandsire of the calf into account.

The genetic trend for sire effect contains all the young bulls tested e.g. in the Netherlands, thus bulls have already breeding value for stillbirth / dystocia along with maternal effects having stabil trend. The reason of this phenomenon might be the low heritability estimates of these traits as Harbers et al (2000) reported.

Several QTL affecting both direct and maternal calving traits were identified. The multitrait and multiple QTL variance component approach detected two pleiotropic QTL affecting both direct calving size and calving difficulties, and two pleiotropic QTL affecting both direct and maternal stillbirth. The identified QTL could have important implications for the Danish Holstein breeding program because of relative high economic weight in the combined selection index. In particular, QTL affecting survival and stillbirth without affecting size of calf may be an efficient way to improve genetic progress for calving traits (Thomasen et al., 2006).
Non-genetic factors

In the study by Lombard et al. (2007) the aim was to determine the incidence of stillbirth and heifer-calf morbidity and mortality, and their association with dystocia. Dystocia score and calf status (alive vs. dead) were recorded at calving. Heifer calves were monitored for 120 days to evaluate morbidity and mortality. More than half (51.2%) of calves born to primiparous dams, compared with 29.4% of calves born to multiparous dams, required assistance during calving. A larger percentage of bull calves (40.0%) required assistance compared with heifer calves (33.0%).

Crucial non-genetic factors affecting frequency of stillbirths in Czech Pied cows were evaluated by Hradecká at al. (2006) on the database of national milk recoding.
scheme which covered 187,546 calvings of progeny of 907 tested sires in another study. Large differences were found between the calving of heifers and cows (6.97% vs. 3.61%), and also between male and female calves (2.66 % vs. 1.17 %). Overall frequency of stillborn calves was 4.52%. Perinatal mortality show curvilinear relationship to the course of calving (Fig. 3, r = 0.48) and in primiparous and multiparous cows (Fig. 4, r = -0.05), to the gestation days. Both coefficients of correlation were statistically significant (P < 0.001).

![Figure 3. Effect of gestation days on frequency of stillbirths and complications of calvings (Hradecká et al., 2006)](image)

Figures by Lombard et al. (2007) recorded 8.2% stillborn calves with bull calves, twin calves, calves born to primiparous dams, and those born to dams having dystocia having a larger stillbirth percentage compared with heifer calves, singletons, calves born to multiparous dams, and unassisted calvings, respectively. Environmental conditions affecting stillbirth rate and postnatal mortality in beef calves has been studied by Azzam et al. (1993). The effect of climatic conditions, dystocia, age of dam, size of calf, and sex affect calf survival from birth to 1 week of age was monitored. Calves born to cows with dystocia were five times as likely to die neonatally than calves born without assistance. Out of calves that died, 43.6% were born with difficulty. Of these calves, survival was the lowest for those that were small relative to their genetic group, sex, and age of dam. Large calves had markedly increased mortality only when born to 2-yr-old dams. Average ambient temperature and precipitation on day of calving affected survival nonlinearly and the magnitude of the effect depended on age of dam, sex and size of calf, and dystocia incidence. Calves born to 2-yr-old cows were more susceptible to severe weather conditions than calves born to older cows. Lombard et al. (2007) concluded that dystocia was
associated with stillbirths and deaths up to 30 days of age. Results reveal that, relatively simple interventions may have the potential to significantly reduce the impact of dystocia on calf mortality and morbidity on dairy farms. Education of farm management and personnel in strategies to reduce dystocia and its effect on calf health should be a priority according to the results of this study.

![Figure 4. Effect of gestation days on frequency of stillbirths in heifers and cows (Hradecká et al., 2006)](image)

In France, risk factors for stillbirth, defined as birth of a dead calf or a calf dead within 24 h after parturition, were studied by Chassagne et al. (1999) in Holstein heifers. The stillbirth incidence was 6.9%. The predictive indicators of stillbirth risk were: gestation length, prepartum body condition and dirtiness scores, biochemical and hematological blood parameters measured during the last 2 month of gestation, and calving conditions. Multiple logistic regressions were run using herd, calving year, calving season, blood sampling-to-parturition interval, and body scoring-to-parturition interval as the fixed effects. The results, expressed as the ratio of the odds of disease occurrence in the exposed and non-exposed subgroups (OR), indicated that dystocia and a body condition score (BCS) higher than 4 before calving were significant risk factors for stillbirth (OR=14.6, P<0.0001 and OR=2.98, P<0.05, respectively). Prepartum circulating neutrophil counts higher than 1950/mm³ (OR=0.50, P<0.05) were associated with a lower risk of stillbirth. A higher occurrence of placental retention, lower fertility and a lower 305-days milk yield were significant consequences of stillbirth.
The Icelandic example

The stillbirth rate e.g. in the Icelandic dairy cattle population has been increasing rapidly in recent years. In the early 1980s it was around 5% (Jónmundsson, 2005), but as shown in Fig. 5 it has risen from around 10% in the last decade, to an all-time high of over 15% in 2005. Last year it went down for the first time in years (Benjamínsson, 2007).

![Figure 5. Trend in stillbirth rate of Icelandic dairy cattle population (n = 158,704 - 1993–2006) (Benjamínsson, 2007)](image)

![Figure 6. Effect of calving number on stillbirth rate (Benjamínsson, 2007)](image)
The main factors were as follows: (1) calving number, (2) effect of the sex of the calf, multiple births (twins, triplets), (3) effect of age at first calving, (4) length of gestation, (5) sire of calf, (6) effect of degree of inbreeding, both in dam and calf. The stillbirth rate ranged from 1.7% to 29.6%. As shown in Figure 6 the number of calvings has a significant effect on the stillbirth rate, as it is twice as high in first calf heifers as in older cows. The reason why the very old ones are so high remained unexplained, however such old cows were few in the data set.

Effects of sex and multiple births were also considerable (Figure 7). Bull calves tend to be at higher risk of being stillborn than heifer ones and the risk is also considerably higher in multiple births. Recently the rate for first calf heifers has been much higher than shown here, it has been close to 22–25%. The gap between stillbirth rate for single-born bulls and heifers has been increasing during the recent years, too. In 2004 the stillbirth rate for bulls was 17% while it was 13% for heifers.

![Figure 7. Effect of sex and multiple births (Benjaminsson, 2007)](image)

As shown in Figure 8, age at first calving had a significant effect up to 24 months of age, but the stillbirth rate was quite constant after that age.

The length of gestation had a significant effect on the stillbirth rate, too. In the study, the average length of gestation was 286.4 days with a standard deviation of 6.9 days. The more the length of gestation deviated from the mean, the more likely the calf is to be stillborn, especially if the gestation is shorter than normal, as shown in Figure 9.
In this investigation the effect of the sire of calf was huge. For sires with more than 50 recorded offspring, the stillbirth rate varied from <3% to >20%, although one has to take into account that A.I. bulls were used on the minority of virgin heifers in the period that data collection took place. The effect of inbreeding was perhaps the most significant of all in the investigation. As shown in Figure 10 the RR for stillbirth increases linearly quite rapidly as the degree of inbreeding of the calf increases. The effect of degree of inbreeding of the dam was not as clear, although significant.
Implications in commercial practice and breeding

The high stillbirth rate is unacceptable from economical point of view. Although the majority of selection emphasis in dairy cattle breeding is placed on production, many non-production traits are important for reducing losses due to mortality and illness and in maximizing longevity. Even if many non-production traits are influenced more by environment and less by genetic ability there is also maternal genetic effect that complicates evaluation and selection on stillbirth and mortality as it has already been discussed above. Regardless, traits such as stillbirths and dystocia constitute financial losses to the dairy farmer and should be considered in breeding and management programs. The economic value of stillbirths and dystocia is based on losses of calf crop, reduced production, increased culling rate, decreased animal welfare and increased concern on consumer acceptance of dairy products according to Groen et al. (1995).

As Olesen et al. (2000) emphasized animal welfare aspects should also be taken into account in future cattle breeding and production strategies. In Denmark, field recordings of mortality are available for all Danish cattle born since 1997. This offers new possibilities for monitoring and analyzing the mortality in the population. The availability of such information can be valuable when animal health and welfare is discussed. In addition, key issue in the above mentioned approach that to dairymen calving ease has been a “secondary trait.” In breeding plans at decisions selecting sires for individual cows for service to inseminate in addition to breeding value taking into consideration of calving ease has always to be considered especially in heifers. In spite of the significance of this merit, the gradual increase of stillbirth rates in dairy cattle during the last years has until recently received relatively little
attention. For this reason, extension experts such as Kent (2009) suggest that these traits can be included in the genetic selection programs. National genetic evaluations for sire calving ease have been available since 1978 in the Dairy Herd Improvement (DHI) in the USA within the framework of National Association of Animal Breeders (NAAB) calving ease program. Stillbirth data are collected on the bases of scoring system presented in Tab. 1.

Table 1

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<tr>
<th>Status of Calf</th>
<th>Score</th>
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<tr>
<td>Alive</td>
<td>1</td>
</tr>
<tr>
<td>Dead at birth</td>
<td>2</td>
</tr>
<tr>
<td>Dead within 48 hours</td>
<td>3</td>
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Figures gained in a comprehensive study reveal that about 11-13% of calves from first-lactation dams are stillborn, while the stillbirth rate for calves from second or later lactation dams is about half of that. The stillbirth rate is higher in male calves than females, most likely due to greater calving difficulty. Among others accurate and complete reporting of calving ease and stillbirth data is critical for several reasons: (1) increase the accuracy of sire calving ease and daughter calving ease evaluations; (2) allow the development of national stillbirth evaluations; the farmer can enhance future sire selection opportunities for the herd. In line with suggestion by Meijering (1984) in research and commercial practice efforts have to be reinforced for further development in the subject matter of calving difficulty (dystocia) and stillbirth in both dairy and beef cattle with special emphasis on causes and effects. Direct (loss of calf, death of dam, labour, veterinary assistance) and longer term (culling rate, milk yield, fertility) costs have to be evaluated and interpreted. The effects of non-genetic factors (parity, sex of calf, age at first calving, season, level of nutrition during gestation) and their supposed modes of action has to be considered. In the genetic model for calving traits estimates, the following components has to be included such as direct, maternal, and direct-maternal interaction. To understand the possible contribution of traits of the sire such as birth weight, gestation period, body dimensions, performance test results; the alternatives in choice of mates in progeny testing, and methods of evaluation. Alternative strategies in selection against dystocia are to be developed.
References


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