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INDIRECT OR NON-GENETIC GENETIC ASPECTS AFFECTING CALF SURVIVAL

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Abstract: The binomial distribution of calf survival (lived or died) usually implies statistical difficulties. In addition, the frequency of pre-weaning deaths of beef cattle, in statistical terms, is often close to or even characterized as a rare event. Thus, the identification of genetic aspects of importance in survival, but which present normal or even categorical data distribution, can optimize the achievement of results in the survival of calves, in terms of genetic improvement and, consequently, in productive or economic terms. In addition, these are characteristics that can be considered when determining the mathematical model to be used in the genetic analysis of the survival of beef calves.
Keywords: behavioral patterns, behavioral genetics, calves, environment

In this article, genetic parameters that indirectly influence the survival of calves will be addressed, as well as some non-genetic parameters intrinsic to the calf, to the cow. Environmental aspects will also be addressed at the time of delivery, under little or no human influence or management.

Among the parameters addressed, the weight of the calf at birth, its sex, the occurrence of dystocia at calf birth, the age of the cow at calving, the conformation of the udder and teats, the production of maternal milk, the presence of mastitis stand out, time of parturition and ambient temperature at the time of parturition.

The binomial distribution of calf survival (lived or died), as a rule, is associated with statistical difficulties, in addition to being often characterized as a rare event, in statistical terms. Thus, the identification of genetic aspects of importance in survival, but which present normal or even categorical data distribution, can optimize the achievement of genetic improvement in the survival of calves. In addition, they are characteristics that can be considered for inclusion in the determination of the mathematical model to be used in the genetic analysis of survival.

BIRTH WEIGHT

Birth weight presents itself as a characteristic closely linked to the vigor and survival of the calf, thus having great economic importance, being often pointed out as the factor of great influence on mortality up to 24 hours of life (BROWN & GALVEZ, 1969; BRADFORD, 1972; NOTTER et al., 1978; BERGER et al., 1992; BLEUL, 2011).

The occurrences of deaths related to birth weight, in cattle and sheep, usually present curvilinear relationships, being associated with extreme weights, that is, very light and very heavy (BRADFORD, 1972; NOTTER et al., 1978). However, it must be noted that, despite the curvilinear relationships described above, there seems to be a consensus in the literature that, for cattle and sheep, reduced birth weights lead to higher mortality rates than those related to very high birth weights.

Lower birth weights, according to HARTSOCK & GRAVES (1976), indicate a situation of worse prenatal nutrition, as well as less advanced development. It was found that individuals with birth weights below 2.5 standards deviations from the mean may present differences in the number of primary muscle fibers (LAWRENCE & FOWLER, 1997). This fact could be related to the results obtained by EDWARDS (1982), who reported a tendency of higher latencies to stand up and to suckle, among lighter calves compared to heavier ones, which could influence the immunoglobulin concentration in the calf, as demonstrated by MACHADO NETO et al. (1997a), who observed a significant and positive linear effect between this parameter and birth weight, with the variation being equivalent between males and females.

In a study with dairy cattle, MARTINEZ et al. (1983) observed that calf mortality was higher for the class of very light calves, comparing all classes of death, including cases of difficult calving, so that among births classified as having no problems, mortality was 12.3% for very light calves, decreasing to 2.6% in relation to medium calves, and being 3.7% for very heavy calves. KATOCH et al. (1994) also observed variation in mortality as a function of birth weight, in which 38.2% of calves born weighing less than 20 kg died, against 17.1% of those born weighing around 31 kg. NOTTER et al. (1978) reported that the mortality from birth to weaning for the lightest calves (20-27 kg) was 32%, while for the heaviest (45-50 kg) it was around 15%, and that the mortality perinatal period (up to 72 hours) was 15% and 0.3% for the lightest and heaviest, respectively. Smith (1977) observed that 90% of the lightest lambs died, against 35% of the heaviest. KOCH et al. (1994) pointed out that even among cows calving at 2 years (whose category had the highest rates of dystocia; 53% in this case), the mortality of their calves was 30% for the heaviest, about 18% for the intermediate ones, and 32% for the lighter ones.

Thus, many studies call attention to the importance of seeking the birth of calves with intermediate birth weights. Among several beef cattle breeds, the lowest mortality rates occurred for birth weights around one standard deviation above the mean, between 35 and 45 kg (NOTTER et al., 1978). For the Angus breed, BERGER et al. (1992) reported that this weight was around 29 kg.

Possibly, there are variations in critical birth weights between breeds and between breeding systems. Analyzing birth weights of beef calves, REYNOLDS et al. (1980) observed that most of the smallest Angus calves survived, while mortality among the smallest Brahman calves was high. In a study with sheep, BRADFORD (1972) concluded that for extensive systems, the birth weights critical to survival were superior to those of more intensive systems, indicating that to present acceptable rates of survival in extensive conditions, the minimum birth weights were 20 to 35% higher than the breed's average birth weight, whereas under good artificial rearing conditions, lambs weighing 50% below the breed's average birth weight showed satisfactory survival rates.

Birth weight can vary due to cow age at calving, calf sex, paternal and maternal breeds, year and season of birth (BRADFORD, 1972; GREGORY et al., 1978b; NOTTER et al., 1978; EDWARDS, 1978; EDWARDS, 1978; 1982; ITULYA et al., 1987; TRUS & WILTON, 1988; AZZAM et al., 1993).

CALF GENDER

Among the studies found in the literature, there is a lot of variation regarding survival and dystocia rate, as a result of the calf's sex. Several authors have indicated a higher prevalence of dystocia for male calves, which was often associated with higher birth weights presented by them (SMITH, 1977; GREGORY et al., 1978b; NOTTER et al., 1978; ERF et al., 1990; GOSH et al., 1996). However, according to RUTTER (1983), there are indications that other factors associated with sex, regardless of birth weight and duration of gestation, lead to higher rates of dystocia in males. 45.5 kg at birth or more, while for females, no significant increase was observed until their weight exceeded 50 kg.

Regarding survival, REYNOLDS et al. (1980), working with beef cattle including Brahman, observed differences in survival ($P<0.01$) between the sexes of calves, with an advantage for males, which was attributed to greater vigor and ability to withstand cold weather at birth. On the contrary, SMITH (1977), studying sheep, reported that the mortality rate was higher ($P<0.01$) for males than for females. MACHADO NETO et al (1997a), evaluating the beef cattle herd, found a higher concentration of immunoglobulins in females, which could give them a greater probability of survival.

DYSTOCIA

The causes of dystocia can be roughly divided into maternal and fetal, in which the maternal causes involve aspects such as age at calving, weight per year of the heifer, cow dystocia score, body condition at calving, pelvic area, failure of cervical dilatation, uterine inertia, calcium deficiency, torsion, rupture and panic; and fetal ones involve size, birth weight, sex, paternal and maternal races, duration of gestation, developmental defects and poor presentation, being often associated with weak or dead calves, which do not actively participate in delivery (RUTTER, 1983; MIALOT). et al., 1992; BELLOWS & STAIGMILLER, 1994; DROST, 1994; PETERS & BALL, 1995; BLEUL, 2011).

According to the researched literature, the effect that presented greater consistency in relation to the occurrence of dystocia was the age of the cow at calving, in which the ages of two and three years have a higher incidence of dystocia; there are reports of herds that presented general averages of around 20% of dystocia, and the two-year-old heifers presented rates of 43 to 57% (BURFENING et al., 1978; BERGER et al., 1992; KOCH et al., 1994; BENNETT & GREGORY, 2001). The measurements of the cow's pelvic area seem to have some relationship with the occurrence of dystocia; however, normally they have not been indicated as accurate predictors of this (LASTER, 1974; RUTTER, 1983). The paternal and maternal races seem to present variability in relation to the incidence of dystocia, mainly in crosses (GREGORY et al., 1978b; LASTER, 1974; NOTTER et al., 1978).

The mortality rate of calves from dystocic births is usually reported to be higher than that of normal births (LASTER & GREGORY, 1973), indicating that it is associated with components related to survival. Dystocia can lead to longer latencies for the calf to stand; reductions in immunoglobulin levels; and abnormal maternal behavior, due to difficult childbirth or the stress of human intervention (EDWARDS, 1982; MUGGLI et al., 1984; DONOVAN et al., 1986).

COW AGE

Maternal behavior can vary with the age of the cow, indicating a high relationship with the experience of the same, having been frequently observed, in primiparous cows, maternal behaviors that increased the latency of the calf to suckle, or even prevented it from suckling, indicating resulting mainly from fear of the calf and sensitivity to udder contact (EDWARDS, 1982; FRASER & BROOM, 1994c).

Although experience-related problems mainly occur at the first calving, it is common to find lower productivity during the first reproductive cycles (around two to four years) compared to older cows, usually related to one or more of the following factors: higher rates of dystocia and stillbirths, lower vigor and survival of calves; lower birth and weaning weights; lower immunoglobulin levels (in cows and calves), higher rates of immunoglobulin disappearance from colostrum (VESLEY & ROBISON, 1971; LASTER & GREGORY, 1973; OYENIYI & HUNTER, 1978; REYNOLDS et al., 1980; NORMAN & HOHENBOKEN, 1980; 1981; MUGGLI et al., 1984; RAY et al., 1989; MACHADO NETO et al., 1997a; KINDAHL et al., 2002; KOCAK et al., 2007).

Although there are studies that prioritize the occurrence of the first delivery at two years, aiming at precocity, this recommendation is not unanimous. CASANOVA et al. (1999)

described a negative experience after a few years using this technique, reporting the return of the first birth at three years of age for reasons of economic efficiency.

Taking into account that heifers have shorter gestation periods (MCGUIRK et al., 1998), generally associated with lower calf birth weights (VESLEY & ROBISON, 1971; ITULYA et al., 1987), and that birth weight can be indicative of its development (HARTSOCK & GRAVES, 1976), it can be hypothesized that characteristics associated with sexual maturity (for example, hormonal profile, smaller uterus size) could be predisposing to "premature" deliveries, with greater chances of dystocia and calf mortality.

UDDER AND TEAT CONFORMATIONS

Unfavorable udder and teat characteristics often have a strong impact on calf survival (BUNTER & JOHNSON, 2012), usually due to longer time to perform the first suckling, with greater latency for udder location and for the calf to seize the teats., as well as on his success in suckling. There have been reports of 43% increases in time looking for teats and 90-minute increases in latency to suckle from the average for udders 40 cm from the ground, and failures to suckle in 49% of cases with high udders and in 92% of cases of hanging udders (EDWARDS, 1982; VENTROP & MICHANEK, 1992). In the case of udders close to the ground, success in suckling depends on the height of the calf (the severity of the situation can be differentiated between a tall calf or a shorter calf), as well as the agility, because in these cases, to be able to suckle, the calf was forced to adopt a crouching position, which is not the normal position for the species (EDWARDS, 1982).

The length of the teats indicates an optimal size, because if they are extremely small, as observed in some heifers, it can be difficult for the calf to grasp and suckle them, and if they are too long, they also become difficult to grasp, because tend to move away as the calf tries to bite them (EDWARDS, 1982; FRISCH, 1982; VENTROP & MICHANEK, 1992; BUENO, 2002).

According to FRISCH (1982), there are indications that longer teats are associated with higher milk yields, with higher weaning weights ($P<0.05$) having been observed among calves born to cows with at least one teat □50 mm, compared to cows with four teats □50 mm. However, the author pointed out that there was significantly higher mortality ($P<0.001$) for calves born to cows with at least one teat □90 mm long (23%) compared to calves with all teats <90 mm (8%)., in addition to the fact that longer ceilings were often thicker (□45 mm) and obstructed. In a study with sheep, this characteristic was significantly related to lamb mortality (KIRK et al., 1980).

The diameter of the teats also influenced the survival of the calves, with the offspring of cows with the four "bottle" type teats (definition attributed to teats with average diameters □35 mm) had a disproportionately high mortality rate ($P<0.001$), There are indications of this characteristic being associated with high milk production, as calves born to cows with "bottle" teats, which survived until weaning, presented weights higher than those of cows with normal teats, drawing the author's attention to the risk of to incorporate this defect in the herd, since, due to the better performance of the offspring of problem cows, there is a greater possibility of these calves being used as reproducers in the future (FRISCH, 1982).

The importance of teats integrity concerns the fact that injured teats and udders can become inflamed, becoming sensitive and increasing the chances of the cow not allowing access to the calf, and the inflammation itself can make the teat thicker. Thus, characteristics that favor their integrity in harsh environments (for example, with coarser vegetation), which has been related to a roof length of less than 6.5 cm, may be advantageous (SEYKORA & MCDANIEL, 1985).

However, CROMBERG & PARANHOS DA COSTA (1997) commented that teat and udder characteristics that are extremely negative for one calf, may not be so negative for another, if it has favorable characteristics in relation to temperament, mouth size and/or agility in movements. of the jaw.

COLOSTRUM AND PASSIVE IMMUNITY

An important fact that must occur within a few hours after birth is the ingestion of colostrum by the calf, so that the absorption of immunoglobulins occurs and an adequate antibody titer is established to resist pathogenic organisms, constituting the most important element of defense. against the establishment of infectious processes during the first months of life, being essential for survival and performance (BRINGNOLE & STOT, 1980; VANN et al., 1995; LAWRENCE & FOWLER, 1997; MACHADO NETO et al., 1997b; PARANHOS DA COSTA et al., 1998).

This immunization is necessary because the newborn calf did not have the necessary immunological history to face the new environment to which it is exposed, receiving antibodies primarily after birth, due to the type of placenta of ungulate animals, which prevents the passage of maternal antibodies to the fetus (CUNDIFF, 1972; CUNNINGHAM, 1993; MACHADO NETO et al, 1997b).

The occurrence of hypo and a-gammaglobulinemic calves is usually interpreted as a result of: ingestion of inadequate amounts of colostrum; low concentration of immunoglobulins in it; late ingestion and early loss of its absorption capacity (STOTT et al., 1979a).

The contact of ingested colostrum immediately excites the pinocytotic activity of the epithelial cells of the small intestine, stimulating rapid absorption of this and other ingested substances, for a certain period, and it is important that the ingestion of sufficient colostrum occurs (□ 2 liters), the so that there is contact, stimulation and satiety of the potential absorptive cells (STOTT et al., 1979b).

The early ingestion of colostrum favors the reduction in the period of absorption of immunoglobulins, which reduces the risks of absorption of pathogens that are accidentally ingested, because if they reach the digestive tract first, they will be absorbed to the detriment of immunoglobulins (STOTT et al., 1979a; VENTROP & MICHANEK, 1992).

The need for rapid colostrum intake is also related to the fact that the concentration of immunoglobulins in colostrum decreases with time after calving, even if the cow is not milked (KOLB, 1984), as well as the ability to calf in absorbing antibodies also decrease over time. Maximum absorption occurs during the first four hours of life, declining gradually over time, making a calf that suckles for the first time after 10 to 12 hours of life very susceptible to colibacillosis (LUCCI, 1989; DROST, 1994).

Latency for the calf to stand after birth and the latency between the calf to stand and suckle are normally negatively correlated with the concentration of immunoglobulins in the serum of calves (EDWARDS, 1982; VENTROP & MICHANEK, 1992; PIRES et al., 1993; BUENO, 2002).

Factors that affect calf immunization may be calf-dependent (vigor, physical activity level, birth weight, sex, and dystocia), cow (number of lactations, breed, weight, ability to synthesize immunoglobulins) and environment (extreme temperatures and management practices - highlighting the acquisition of colostrum by the calf from another source (bucket or bottle) other than the mother). In addition, there is evidence that during extremely hot and humid days, people may not have the same motivation to care for calves as on more thermo-neutral days (SMITH et al., 1967; STOTT et al., 1979c; NORMAN & HOHENBOKEN)., 1981; KOLB, 1984; VANN et al., 1995; DONOVAN et al., 1986; VERMOREL et al., 1989; MACHADO NETO et al., 1997a).

MILK PRODUCTION

Breastfeeding is important as it provides the calf with nutrients and immunity, as well as well-being, through maternal contact. The milk production of beef cows can be influenced by herself and the calf; relating the maternal influence to the size of the cow, its breed, its body condition, its temperament, its conformation of udders and teats, as well as the integrity of these; and the calf's influence on the ability to change the endocrine and metabolic mechanisms that influence the growth of the mammary gland and milk synthesis at the end of pregnancy; as well as through the sucking stimulus, related to the demand for milk and the frequency of feedings, which in turn may be dependent on birth weight and paternal and maternal races (ERB et al., 1980; FRISCH, 1982; MCMORRIS). & WILTON, 1986; TOMAR & SHARMA, 1986; MEZZADRA et al., 1989; ARMSTRONG et al., 1990; BASTOS et al., 1999; DETILLEUX & LEROY, 1999; MILLER & WILTON, 1999; PARANHOS DA COSTA et al., 1998).

There are indications that, for beef cattle, moderate milk productions are more desirable than very low or high productions, given that the capacity to contain a calf's stomach is about three liters, incurring the fact that, in Under very high milk production conditions, the calf may not use all the available milk, normally also resulting in higher maternal energy requirements and longer calving intervals (KOLB, 1984; MCMORRIS & WILTON, 1986; BOURDON, 2000).

MASTITIS

The incidence of mastitis in cattle indicates to be associated, to some degree, with the conformation of the udder and teats, notably those from cows with high milk production (SEYKORA & MCDANIEL, 1985). The occurrence of this pathology, normally associated with bacterial infections, could have a negative effect on the establishment of passive immunity in calves, in addition to causing increases in latency to suckle, as a result of pain caused by the infectious process, making the cow reluctant to let the baby suckle, which may be related to mortality (PERINO & WITTUN, 1995).

Drost (1994) recommended that abnormal colostrum, such as that from cows with acute mastitis, must be discarded from the feeding of suckling neonates.

TIME OF DELIVERY AND AMBIENT TEMPERATURE

These variables are often associated, with temperatures normally lower than the beginning of the day.

BUENO (2002) observed that, although not significant, calves born in the early hours of the day (between 6 and 8 am) had higher latencies to try to get up than those born between 2 and 4 pm, possibly being associated with lower ambient temperatures verified in the first hours of the day.

There is a report of the influence of ambient temperature causing high mortality in Brahman calves, compared to other European breeds evaluated. In this case, this value was due to an extremely cold year, in which mortality was 13%, while in the other evaluated years, it was 4 and 1% (NOTTER et al., 1978). AZZAM et al. (1993) reported that temperature and precipitation on day of birth affected survival in a non-linear way, being dependent on factors such as cow age, sex, calf size and occurrence of dystocia.

CONSIDERATIONS OF THE IMPACT OF CALF MORTALITY ON THE PRODUCTION SYSTEM

According to KLOPFER (1968), death is essential for the evolution of species, because without it, the continuous changes in the characteristics of populations would cease, and thus, there would be no evolution. However, from an economic point of view (and ethically, when animals are in human care), high mortality rates are always undesirable.

The economic problems refer to the loss of the calf, the possible reduced fertility of the mother in the next production cycle, the longer interval between calving and a tendency to have lower milk production (KINDAHL et al., 2002). Any animal present on the property, which does not produce positive cash flow, must be considered as non-productive, because in all cases, these animals not only fail to produce positive cash flow, but also cause a negative cash flow, which can be included in this category cows that did not wean a calf in the production cycle (WILTBANK, 1994).

The knowledge of behavior patterns, such as the maternal one, allows the human being to respond appropriately to the animals' needs and thus avoid errors that can result in economic losses (BUCHENAUER, 1999). According to SELMAN et al. (1970a, b) calves that stood up, located the teats and suckled faster after birth were more likely to survive.

Studies addressing the relative importance of different critical points in breeding systems usually point to calf survival as a determinant, indicating that calf mortality was the most serious economic loss, although reproductive problems were also important (MIALOT et al., 1992b; BOURDON & GOLDEN, 2001). This finding was confirmed by BILBAO & SPATH (1997) who observed that, in financial terms, 82% of economic losses were related to mortality.

STADLER et al. (1998) stated that, due to the economic importance of reproductive traits, the genetic improvement of these traits could help producers of elite and commercial herds to become more efficient. In this context, the selection of bulls is not only a problem in the area of genetics, as genetic and economic factors are interconnected (BOURDON & GOLDEN, 2001).

MARTIN & WIGGINS (1973) developed a mathematical model to investigate and quantify the economic losses associated with calf mortality. Although calculated for milk production conditions, they reported that 20% mortality represented a 38% loss in productivity. In a study with cattle, BILBAO & SPATH (1997) found that the occurrence of morbidity rates of 6.8% and mortality of 3.4% generated costs equivalent to ad libtum supplementation with balanced ration for 20 calves for 90 days.

RILEY et al. (2001), comparing crosses of Bos indicus (Nelore, Gir, Indubrasil, Brahman) with Hereford, Texas, concluded that due to the fact that it presented the highest birth and survival rates of calves, the crosses with nelore also presented the highest rates. of weaning (96.1%) among the evaluated breeds.

RAY et al. (1989), evaluating Hereford on non-supplemented pasture, reported the effect of cow year and age on mortality rate, in which annual variations in climate and forage production were the most important factors for herd performance. BUSATO et al. (1997) found great variability in the mortality rate between properties (0 to 50%).

According to ZANETTI et al. (1982), working with dairy cattle, the mortality rate of calves in Brazil is quite high. Kasari & Wikse (1994) found that the beef calf mortality situation in the USA remains stable over the years, despite technological advances.

Neonatal losses are usually related to dystocia, starvation and poor maternal care, commonly linked to high and low birth weights (DWYER & LAWRENCE, 1998). In a study on lamb mortality, HINCH et al. (1986) stated that lambs that died due to dystocia or delayed parturition died within the first 24 hours of life, while those that died due to starvation survived for about five to six days, while the other categories died on average. at 15 days. LAWRENCE & FOWLER (1997) reported that many of the defects observed in farm animals cause death shortly after birth, and represent abnormal growth sequences under genetic control while still in utero. WOOLIAMS (1983) suggested that the category of "weaker lambs" may be influenced by physiological or metabolic factors. MULEI et al. (1995), evaluating cattle, reported that most deaths were due to diseases in the gastrointestinal tract (31.3%), also presenting a high prevalence of pulmonary (16.8%) and tick-transmitted diseases (13.3%).), with the other causes of death related to the musculoskeletal system (7.0%), septicemia (6.1%), cardiovascular system (3.7%), nervous system (3.2%) and liver (2.6%).

The mortality rate seems to be higher in the first days after birth, decreasing gradually (WILTBANK, 1994). MIALOT et al. (1992a), working with Charolais cows from 86 herds in France, obtained mortality rates of 4.5% in the first 24 hours; 5.6% from day 1 to week three, and 1.1% from week three to weaning. REYNOLDS et al. (1980), evaluating beef cattle, including Brahman, reported that 68.2% of deaths occurred between birth and 72 hours postpartum. According to MULEI et al. (1995), 31.8% of calf deaths occurred during the first month of life, with 13.3% of these in the first two weeks. Similar results were also reported by MARTIN & WIGGINS (1973), KATOCH et al. (1994) and HOLGADO et al. (1992).

When comparing works on this topic, special attention must be given to the definitions used, as well as weights, sizes and reproductive indices presented. The designation "stillborn", for example, is usually interpreted as an animal that was born lifeless. However, due to feasibility, it is often defined as the calf born after 260 days of gestation and dead between birth and the first 24 hours of birth (KINDAHL et al., 2002). Mortality, often divided into early and late, can also vary with respect to definition. Usually, however, early mortality is considered when it occurs between birth and 72 hours of life, and late when it occurs after this age, usually until weaning (NOTTER et al., 1978).

Calf birth weight, as well as cow weights and sizes, are characteristics that vary widely between scientific studies. There is also a high variation between the weights presented in the literature and the weights observed in the field. Thus, recommendations proposed in scientific papers need to be evaluated with caution, as they do not always apply to all cases. For example, ARMSTRONG et al. (1990), working with rotational systems, considered "small" cows with an average live weight of 574 kg, and "large" cows with 694 kg. This way, what is classified as small, in this article, can be considered large, in other conditions. RILEY et al. (2001), working with Angus x Hereford crossbred cows, considered their adult sizes (7 years) similar to those of Hereford crossbred cows with Gir and with Nellore (521, 538, 549 kg, respectively). Another factor that seems to vary a lot refers to dystocia indices.

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