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Factors affecting longevity in maternal Duroc swine lines

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Abstract

A competing risks approach was used to evaluate the influence of several pre-farrowing factors on risk of culling due to different causes in Duroc swine, these having low fertility, low productivity, lameness and mortality. Culling due to low fertility increased for average daily gains during the growth test lower than 585 g/day, whereas culling due to low productivity and mortality increased with low levels of backfat thickness at the end of the growth test. Lesser loin depths at first farrowing reduced culling due to low productivity but increased culling due to lameness. Furthermore, a higher average daily gain from the end of the growth test to first mating increased culling by all causes. A complementary analysis was carried out to evaluate the influence of these factors on risk of culling without taking into account the specific reason of failure. In this second analysis, the factors were included as time-dependent covariates whose relative importance changed throughout the sows' productive life. Expected survival functions and replacement rates have been calculated in different hypothetical situations in order to determine the optimal animal body type at first farrowing to maximise longevity, which under our production conditions is independent of average daily gain from birth until the end of the growth test, but from the end of the growth test to first mating average daily gain should not be over 485 g/day; backfat thickness should be more than 16 mm at the end of the growth test and maintain this level until the first parturition without exceeding 19 mm; loin depth should be kept below 45 mm at first farrowing.

Keywords: Longevity; Survival analysis; Competing risks; Sow productivity; Duroc swine; Maternal lines

1. Introduction

During the last several years, culling rates of breeding females have climbed to levels approaching 50%. Increased sow mortality, combined with reproductive problems such as failing to cycle in a timely manner, not conceiving, not farrowing, poor performance or physical problems (e.g., lameness) are the major reasons for this increase in replacement rates in commercial sow units (Dial and Koketsu, 1996; Friendship et al., 1996). These high replacement rates result in the need for larger gilt pools and therefore the purchase or production of more breeding gilts. Apart from the cost associated with the mentioned purchases, the producer has to incur further expenses related to the acclimati-

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sation of the new gilts and face the risk of introducing new diseases. Furthermore, high replacement rates may be associated with animal welfare, since some of the causes of culling could be indicators of a welfare compromise for the animals involved (Barnett et al., 2001). A better knowledge of the causes of culling would be useful when providing practical recommendations for the management of gilts in order to increase their productive lifespan.

Productive life span is a trait which has received increasing attention in animal breeding. Ducrocq (1997) has proposed a general strategy for the analysis of a productive life span based on the survival analysis as an adequate method for the genetic evaluation of the length of productive life measurements. In particular, a semiparametric proportional hazards model (Cox, 1972) is usually used to investigate the influence of different covariates on the risk of culling. However, sows being culled for different causes are certainly affected by a distinct set of covariates or by the same covariates in different degrees (Dürr et al., 2002). When causes of failure are of interest and must be accounted for in the analysis, the method of competing risks (Kalbfleisch and Prentice, 1980) offers an intuitive but powerful way of handling survival times. The general concept underlying competing risks analysis is that the occurrence of one type of cause of failure removes the individual from risk of all other causes. In this case, the type-specific hazards can be obtained in the same way as the non-specific hazard function by just regarding all failures of types other than the recorded cause of failure as censored at the individual's failure time (Allison, 1995).

Different aspects of survival analysis applied to sows have been discussed in the literature, but in most cases the cause of failure is not taken into consideration. As explained before, one factor could have a great effect on culling due to a particular cause and no effect on another. Therefore, the effect of this factor on non-specific culling is a balance of its effect on each cause-specific culling. As the relative importance of each cause in this balance is different throughout a sow's productive life, the effect of the factor on culling may also be different throughout her productive life, suggesting a time-dependent survival analysis.

The first aim of this study is to evaluate the influence of several pre-farrowing factors on cause-specific hazards in maternal Duroc swine by a competing risk approach. These factors were average daily gain from birth to the end of the growth test and from this test to first mating, backfat thickness at the end of the growth test and at first farrowing, and loin depth at first farrowing. After estimating all of the cause-specific hazards, we have established the dependence of the non-specific hazard function (mixture of all the cause-specific hazards) on the mentioned factors using a time-dependent proportional hazards model. This analysis allowed us to estimate the expected survival functions in different hypothetical situations accounting for this dependence, as well as replacement rates in order to determine the optimal animal body type at first parturition to maximize longevity.

2. Material and methods

2.1. Animals

A total of 467 Duroc purebred gilts from Selección Batallé S.A. were used for this study. These gilts founded a new nucleus herd in 1999. At the end of the growth period (at 167 days of age on average), the gilts weighed 96.2 kg on average. During the period from the end of the test to the first mating, the gilts were fed a restricted concentrate diet (2 kg/day) containing 16.65% crude protein, 0.73% digestible lysine and 2995 kcal/kg ME. All gilts were mated within a 5-month period. At first effective mating, gilts weighed 133.8 kg on average and were 257 days old. Average age at first farrowing was 372 days.

Gilts were weighed at the end of the growth period and at first mating. These measurements were used to calculate average daily gains from birth to the end of the growth test (ADGt) and from the end of the growth test to first mating (ADGm). Backfat thickness was measured at the last rib level (P2) at the end of the growth test (BFt) and at first farrowing (BFf) using ultrasound equipment (Piglog 105, SFK®, Denmark). In addition, loin depth was also measured at the last rib level (P2) using the same ultrasound equipment as at first farrowing (LDf).

2.2. Survival analysis

The length of the productive life t of a sow was calculated as the difference in days between the date