EXPECTED RESPONSE TO SELECTION ON STAYABILITY AND ITS ECONOMIC WEIGHT IN A POPULATION OF NELORE CATTLE IN BRAZIL

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INTRODUCTION
Stayability is a categorical trait that can be defined as the ability of a cow to remain in the herd, producing a calf every year, until a specific age (Snelling et al., 1995). An improvement in stayability represents a reduction in the costs with achievement of replacement heifers and an improvement in the economic efficiency of the herd. However, the performance of the animals can be measured only when they reach the specified age. Therefore, young bulls are expected to have low accuracy breeding values in their stayability evaluations, reducing the response to selection, and bulls with better accuracy of selection are probably old and contribute to increase the generation interval, also reducing the response to selection.

This study aims to estimate the expected response to selection on stayability using various hypothetical generation intervals, and to indicate an approach to estimate the economic weight of this trait as a selection criterion in a multitrait selection index in a population of Nelore cattle in Brazil.

MATERIALS AND METHODS

Genetic analysis. Stayability was studied in a population of Nelore cattle in the Central-West region of Brazil. The data consisted of 3428 birth records, from 1201 cows, between 1991 and 2001, in two farms, forming a total pedigree of 7045 animals. In both farms, the cows were culled in the first year they fail to produce a calf. The cows assigned as successful in stayability were the ones that produced a calf after 6 years of age, and at least three calves until this age. The unsuccessful cows were the ones that were culled before this age, mainly because of a reproduction failure. With this definition of stayability, about 52% of the cows were assigned as successful in this population.

The heritability was obtained with method R (Reverter et al., 1994) in a single-trait analysis using an animal model. A maximum a posteriori probit threshold model (Gianola and Foulley 1983 ; Harville and Mee, 1984) was used in the prediction of the breeding values (BV) of the animals on the underlying scale. The accuracies (AC), as established by the Beef Improvement Federation (BIF, 1996), for all the animals in the pedigree, were calculated according to the following equation : $AC_i = 1 - (PEV_i / \sigma^2)^{0.5}$, where $AC_i$ is the accuracy of the $i^{th}$ individual’s prediction, $PEV_i$ is the error variance of the $i^{th}$ individual’s prediction, and $\sigma^2$ is the estimated genetic variance.
Economic analysis. The economic aspects of stayability were analyzed regarding the genetic expected annual response to selection and the economic value of this trait. An economic value of a 1% increase in the probability of a cow to be classified as successful in stayability (US$0.78) was found by Formigoni (2002). This economic value was used in this study in an example of how to estimate the economic weight of stayability. The expected response to selection was estimated according to the equation presented by Bourdon (2000) : \( R = \frac{r_{IA} \times i \times \sigma_a}{L} \), where \( R \) is the expected response to selection, \( r_{IA} \) is the accuracy of selection, \( i \) is the selection intensity, \( \sigma_a \) is the genetic variation, and \( L \) is the generation interval.

The average accuracy of selection in each age considered as generation interval, obtained in the genetic analysis, was used to estimate the accuracy of selection according to the generation interval. The proportion of males used as progenitors was fixed to 2% for sires of sires and 10% for sires of dams, giving an average selection intensity of 2.08 (Gibson and Arendonk, 1998). The genetic variance of the population, measured by the standard deviation of the expected progeny differences (EPD's), was used as a fixed parameter for the equation. The generation interval for males was considered in eight levels, ranging from 2 to 10 years. Thus, the expected response to selection depends on these four parameters and was estimated in 9 levels of possible generation intervals, varying according to the generation interval and the corresponding accuracy of selection.

The economic importance (weight) of any trait, as a selection criterion in a multiple trait economic index, should be considered as the economic return of an increase equal to the expected genetic response to selection in a standardized unit of time. The following equation can explain better this theory : \( w = v \times R \), where \( w \) is the economic weight of the trait, \( v \) is the economic value of one unit change in the trait, and \( R \) is the expected response to selection in one unit time. The economic weight of stayability, to be used in an economic index, was estimated as the value of the genetic change expected in one year of selection.

RESULTS AND DISCUSSION

Genetic analysis. The mean ± SE estimated heritability was 0.148 ± 0.005. This is in agreement to the heritability of 0.15 found by Doyle et al., (2000) in Angus Females. The analysis of stayability yielded 220 random 50% subsamples, none of them out of parameter space. The estimated breeding values (EBV's) in this study ranged from -15.18 to 23.96 with a mean of 0.62% and a normal distribution. Doyle et al., (2000) results were not very different and ranged from -15.91 to 33.83, showing enough genetic variation to allow improvement from selection on stayability, according to the authors. The mean EBV's, for each year of birth, from 1988 to 2001, are shown in figure 1. The linear regression of the EBV's over the year of birth was taken as the genetic trend for the population, showing a realized annual increase of 0.12% in the successful cows. If it is imagined a ten years period of time, it would be expected an increase of 1.2% in the successful cows, what is a very small increase. Taking into account that this population had no selection on stayability EBV's, this genetic trend in only due to phenotypic selection (i.e. culling of non fertile females).
The accuracies ranged from 0.04 to 0.88, varying with the information available and the age of the animal. The mean accuracies according to the year of birth are shown in figure 2. Because of the observed linear decrease, from 1990 to 1998, a linear regression of the mean accuracies over the year of birth have been chosen to estimate the accuracies of the breeding values according to the generation interval for males. This regression ($R^2=0.94$) showed an increase of 0.0272 in the expected accuracy of selection for each year of increase in the generation interval, ranging from 2 to 10 years.

**Economic analysis.** The economic value of an increase of 1% in the stayability was US$0.78 according to Formigoni (2002). Thus, an animal with an EPD 1% greater is expected to generate an average profitability US$0.78 greater for each of its daughters.

The selection intensity ($i$) used was 2.08, as a result of the mean selection intensities of sires of sires (2.42) and sires of dams (1.75), taking into account only the selection on males. The genetic variance used was the standard deviation of the EPD's ($\sigma^2=2.544$). The hypothetical generation intervals ($L$), its corresponding accuracies of selection ($r_{IA}$) and expected responses to selection are presented in table 1.
Table 1. Expected responses to selection on stayability

<table>
<thead>
<tr>
<th>Accuracy ($r_{IA}$)</th>
<th>$L$ (years)$^A$</th>
<th>$R$ (%/year)$^A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.14</td>
<td>2</td>
<td>0.37</td>
</tr>
<tr>
<td>0.17</td>
<td>3</td>
<td>0.29</td>
</tr>
<tr>
<td>0.19</td>
<td>4</td>
<td>0.25</td>
</tr>
<tr>
<td>0.22</td>
<td>5</td>
<td>0.23</td>
</tr>
<tr>
<td>0.25</td>
<td>6</td>
<td>0.22</td>
</tr>
<tr>
<td>0.27</td>
<td>7</td>
<td>0.21</td>
</tr>
<tr>
<td>0.30</td>
<td>8</td>
<td>0.20</td>
</tr>
<tr>
<td>0.33</td>
<td>9</td>
<td>0.19</td>
</tr>
<tr>
<td>0.36</td>
<td>10</td>
<td>0.19</td>
</tr>
</tbody>
</table>

$^A$Generation interval; $^A$Expected response to selection

Comparing these results with the realized genetic trend observed in the population, it is possible to observe that the genetic gain may be improved with the use of selection on males, based on stayability EBV’s, in addition to the usual selection made just on female’s phenotypes. The annual genetic gain can go from 0.12 to as much as 0.49% annual response, or even more, depending on the accuracies of the EBV’s of the chosen animals.

The calculation of the economic weights should be made according to the following example: considering a generation interval of 5 years, the expected annual response to selection would be 0.23 (see table 1) and stayability should receive an economic weight equal to US$0.18 (w = 0.78 \times 0.23) in a multiple trait economic index. It is worth to be remembered that with this approach all the traits in the economic index should receive economic weights based on its expected annual response to selection.

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REFERENCES