Estimation of economic values for longevity and somatic cell score in New Zealand dairy goats

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Summary

A deterministic bio-economic farm model was developed to estimate economic values (EVs) for functional traits affecting profitability and to propose a breeding objective for New Zealand dairy goats. The Saanen-type dairy goats used in this study were kept indoors. All farms supplied milk to the New Zealand Dairy Goat Cooperative Ltd, (DGC-NZ), which produces milk powder for export. The payment system is based on the total amount of milk-solids. Longevity was defined as the probability of an individual animal surviving an extra day in the milking herd. The probability of surviving one year, and the cumulative survival from 0 to 10 years of age, was calculated according to the Kaplan-Meier Method. Somatic cell count (SCC) was transformed to somatic cell score (SCS) and defined as . Up to 2014, three SCC (and SCS) thresholds were organised based on monthly and penalty values provided by the DGC-NZ. The EVs for longevity and somatic cell score were $0.04 and -$8.22, respectively. The estimated EVs will assist the New Zealand dairy goat industry to define a breeding objective for optimising genetic gain across a range of traits impacting on farm profit.

Keywords: dairy goats, economic values, breeding objective, functional traits.

Introduction

The breeding goal indicates the direction of an animal genetic improvement programme. For New Zealand dairy goats a breeding objective could be formulated as the combination of breeding and economic values of important traits affecting the breeding goal (Harris et al., 1984). Economic values are needed for each trait in the breeding objective to ensure that selection emphasis is proportional to the economic importance of each of these traits (Hazel, 1943).

Health or functional traits like longevity and somatic cell count should be included in a breeding objective due to their impact on profitability (Van Arendonk, 1991; VanRaden, 2004). The objective of the present study was to estimate the economic values for longevity and somatic cell score to help the definition of a breeding objective for New Zealand dairy goats.

Materials and methods

Dairy goat production systems in the Waikato region of New Zealand were described by Solis-Ramirez et al. (2011). The farms were located throughout the Waikato region and supplied milk to the Dairy Goat Cooperative of New Zealand (DGC-NZ). Animals were kept indoors and liquid milk was used to produce milk powder for export. Using all available
information from the farming and payment system (PS), a bioeconomic farm model was
developed to help the estimation of EV for longevity and SCS. Up to 2014, the DGC-NZ
payment system applied a discrete penalty to the value of milk-solids, depending on SCC
levels per month throughout the year. Monthly values for SCC used in the payment system
were provided by the DGC-NZ and were transformed to a SCS as, where: = natural
logarithm base 2. Three SCC and SCS thresholds were set based on monthly and penalty
values provided by the DGC-NZ. The first range was for SCC from 0 to <900,000 (no
penalty), the second range was from 900,000 to <1,800,000 (the first penalty threshold) and
>1,800,000 to <3,500,000 (the second penalty threshold). For threshold >3,500,000 SCC, the
previous penalty was assumed to continue as a third penalty threshold. These SCS levels
were used to calculate the costs and economic value associated with SCC in bulk milk per kg
MS.

The farmers were paid on a per kilogram of milk-solids basis. The price received from
the DGC was NZ$13.00 per kg of milk-solids, and the value of culled mature animals was
NZ$5.00 per doe or per buck, while surplus male and female kids are culled.

Diet was assumed to contain 18.4 MJ gross energy and 10.94 MJ/kgDM metabolisable
energy (ME) per kilogram in a mixed diet with fresh grass, grass hay and concentrates. The
amount of DMI required per milking doe was calculated using the energy requirements given
by AFRC (1993) equations. Does were offered a diet consisting of concentrates for dairy
goats (60%), fresh grass (30%) and grass hay (10%) on a dry matter basis. Profit was
expressed per milking doe, calculated as the total income minus the total cost per milking
doe; (Ponzoni, 1986).

The EV for longevity (LGTY) was obtained by adapting the population survival curve
(Kaplan and Meier, 1958) to a bioeconomic farm model. This used the information available
from the production system and the payment system to calculate profit before and after
adding an extra day of life to the doe in the herd.

For Somatic cell score, the cost was calculated according to the threshold model
described by Meijering (1986) for dystocia in dairy cattle but applied to SCS by Charfeddine
et al. (1997) and Sadeghi-Sefidmazgi et al. (2011) for the estimation of economic values in
dairy cattle. The cost of SCS () was calculated as , where: n=number of thresholds (i=1, 2
and 3); ; and the normal cumulative distribution function (probability of the variable SCS
has a value less than threshold value, ) is expressed as with threshold that separates SCS
class i from class i+1(i=1, 2, 3); and the penalty associated with an SCS in class I; average
SCS, standard deviation SCS; e = base of the natural logarithms base e; and π = 2.14159365359.

The economic value for SCS was calculated as , where: was defined before; is the
standard normal density function that shows the vertical height on the normal distribution,
and can be expressed as , where terms were previously defined.

Results and discussion

Dairy does culling and deaths are due to many reasons (Solis-Ramirez et al. 2011). The most
critical stage is around birth, because most deaths occur during the first months of life. The
survival rate improves as does age. However, in milking does, the higher culling rate is based
on productive performance and health status. High culling occurs after the first lactation, and
this high rate continues for 4-5 lactations. This trend in deaths and culling is similar to the
estimated survival trend estimated using the Kaplan-Meier method (Kaplan & Meier, 1958)
for the percentage of animals culled each year as is shown in Table 1.

The survival information analysis for the dairy goat herd is presented in Table 1. The
highest culling/dead rates occurred in 5 to 8-year old does (average = 33.7%), and the lowest was for does older than 8 years (2.8%). For does from 0 to 4 years old, an intermediate value between the two previous groups of 15.2% was estimated.

The SCC ranges, frequency and penalty values are presented in Table 2. About 81% of SCC are equal to or less than 1,800,000 (or 6.8 SCS), while 19% were between 6.8 and 8.16 SCS.

In a previous study, EVs for productive traits of New Zealand dairy goats were reported Solis-Ramirez et al. (2012). In this study, the EV for an extra day of life for a doe in the herd was $0.04. Bett et al. (2007) reported higher EVs ($0.08-$0.30) in dual-purpose goats than those found in this study, while a similar economic value of $0.03 was estimated for dairy cattle by (Harris, 1998; NZAEL, 2012). It is likely that the economic importance of LGTY is different for different production systems (e.g. dairy versus dual-purpose, but similar within a system (e.g. dairying).

The negative EV for SCS (-NZ$8.22) reflected the significant loss of revenue for an increase in SCS. EVs for SCS in dairy goats published by Bett et al. (2012) and Lopes et al. (2012) in dairy goats are lower (from -US$1.34 to -US$4.50) than the value estimated in this study. Other values estimated in dairy sheep (Legarra et al., 2007) were also lower (from -US$1.91 to -US$4.28) than the values in this study. The bio-economic farm model structured in this study avoids double counting due to independency of the modules involved to estimate changes in traits, but also economic values are expected to change with particular conditions of each production system due to feed costs, management and revenue and they need to be updated periodically.

Conclusions

The EVs show the impact on profit of LGTY and SCS, therefore they should be used in the structure of a selection index to increase profit per milking doe in New Zealand dairy goats.

Table 1. Survival analysis in the dairy goat herd using the Kaplan-Meier (1958) method.

<table>
<thead>
<tr>
<th>Year</th>
<th>Surviving Number</th>
<th>%</th>
<th>Not surviving Number</th>
<th>%</th>
<th>C.S1 (%)</th>
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<tbody>
<tr>
<td>0</td>
<td>183</td>
<td>83.2</td>
<td>37</td>
<td>16.8</td>
<td>83.2</td>
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<tr>
<td>1</td>
<td>159</td>
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<td>24</td>
<td>13.1</td>
<td>72.3</td>
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<tr>
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<td>88.7</td>
<td>18</td>
<td>11.3</td>
<td>64.1</td>
</tr>
<tr>
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<td>83.0</td>
<td>24</td>
<td>17.0</td>
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<td>82.1</td>
<td>21</td>
<td>17.9</td>
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</tbody>
</table>

1Cumulative survival, 2Out of 220 replacement kids. 3Censored data.

Table 2. Range, frequencies and penalties for somatic cell count (SCC) and somatic cell score (SCS)1 levels in dairy goats.
### List of References


Mejéring, A, 1986. Dystocia in dairy cattle breeding with special attention to sire evaluation for categorical traits. PhD, Wageningen Agr University, Wageningen.


