CORRELATED RESPONSES OF SELECTION FOR MILK YIELD IN FIRST CALVING AND LIFETIME NET INCOME OF HOLSTEIN COWS

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INTRODUCTION

The animals of major relevance to milk producers are not necessarily the ones that produce more milk, or fat or protein, nor the ones that are more efficient reproductively. The animals of major value to producers are the ones that make more money for the enterprise.

Considering cow profitability as an objective of selection could increase the genetic gain for economic returns. However, not much has been done on this task.

In order to include measures of profitability in animal breeding programs it is important to know their genetic and phenotypic parameters estimates and also to identify the relationship between these measures and biological traits recorded early in the life of animals.

The aims of this study were to estimate genetic parameters of the economic measures of dairy cows, Lifetime net income (LNI), Net income at the end of first lactation (NI1), Income over feed costs at the end of first lactation (IOFC1), and total Milk yield in first lactation (MY1) and also to estimate the correlated response in LNI when using NI1, IOFC1 or MY1 as selection criteria.

MATERIAL AND METHODS

Dairy cow data came from DHIA from herds in the state of Kentucky, U.S.A. After editing, the dataset had 19,565 lifetime records from 269 herds (RIBEIRO, 2001).

The traits studied were LNR, NI1, IOFC1 and MY1 defined as follow :

LNI = LR - LC

NI1 = LNI, but considering revenues and costs until the final of first lactation

IOFC1 = [Revenue from milk yield (carrier + protein + fat)] – Feed cost until the end of first lactation

Costs and revenues used in this research were defined as :

Lifetime revenue (LR) = (lifetime milk yield, including volume and fat and protein contents x value of kg of milk) + (number of calves produced x value of calf's market) + (cow carcass weight at culling, in kg x value of kg of carcass). For dead animals, carcass weight was considered zero. For animals that had been sold for dairy, 50 % was added to the carcass weight and for those ones removed because of low production, 20 % was added. For registered animals and sold as dairy cows, an extra 20 % was added.

Lifetime cost (LC) = (female price at birth) + (age at first calving, in days x rearing cost of heifer from birth to first calving, per day) + [(cow body weight x feed cost for maintenance) + (milk production x feed cost for production) + (number of pregnancies x feed cost for pregnancy)] x number of lactation + [(days in lactation + days dry) x fixed cost] + (lifetime milk yield x average fixed cost for kg of produced milk) + (number of services x cost of service) + (number of mastitis cases x cost of mastitis case) + (number of calving with little aid x cost of intervention of little aid) + (number of calving with moderate aid x cost of intervention of moderate aid) + (number of calving with cesarean surgery x cost of cesarean surgery) + cost of the genealogical register (for registered cows).

The estimation of variance components and heritabilities was done using an animal model by the REstricted Maximum Likelihood method, with MTDFREML program developed by BOLDMAN *et al*. (1993), considering as convergence criterion 10^{-9}.
The genetic correlation estimates were obtained from CORR procedure (SAS, 1996) using the predicted breeding values of animals for each trait. Rank correlation (SPEARMAN, SAS (1996) was estimate to compare sires according to their BV in each trait.

The general model used was :
$y = Xb + Za + e$
Where :
y = Dependent variable ;
b = vector of fixed effects ;
a = vector of genetic effects of animal ;
X = matrix of incidence associated to fixed effects ;
Z = matrix of incidence associated to random effects ; and
e = vector of errors.

This model assumes the following presuppositions :
$E(y) = Xb$;
$E(a) = 0$;
$E(e) = 0$;
$Var[a]=A\sigma^2_a$
$Var[e]=I_N\ \sigma^2_e$.
Where :
A = numerator of relationship matrix ;
σ^2_a = additive genetic variance ;
σ^2_e = residual variance ;
I = identity matrix ; and
N = number of observations.

For dependent variable LNI there were considered the fixed effects of herd, contemporary group (animals born in the same year, 1986 to 1995, and season, summer, autumn, winter, and spring), culling reason (8 classes), order of calving (1 to 6 or greater) within productive life classes, register (registered or grade), and linear and quadratic effects of body weight, in kg.
NI1 and IOFC1 were analyzed considering the fixed effect of herd, contemporary group, genealogical register (registered or grade), and classes of days in lactation (1 to 3).

MY1 was studied considering the fixed effects of herd, contemporary group, register (registered or grade), classes of days in lactation (1 to 3), and linear effect of age at first calving, in days.

RESULTS AND DISCUSSION

Table 1 shows the heritability estimates and Pearson and Spearman correlations between the predicted breeding values of the traits LNI, NI1, IOFC1, and MY1. Heritability estimates varied from 0.07 to 0.08 showing a very small contribution of additive genetic action. These results reflect the importance of the reproductive and survival traits on the profitability measures. Those traits show low values of heritability. Another reason for the small estimates from this research could be the presence of variation due to known environmental effects like age of cow at calving and lactation length. The estimates obtained in this study are similar to those reported by Weigel *et al*. (1995) and Weigel *et al*. (1997) and smaller than those found by Lin and Allaire (1977).

Although the very small values for the estimates of heritability these are very important economic traits and they contain most of the biological measures during cow lifetime. Since some additive genetic variation still remains it could be used to improve these traits by selection.

Genetic and Rank correlation estimates between traits showed moderate to high values (table 1). The genetic and rank correlation estimates were favorable among all traits meaning that focusing selection on NI1 or IOFC1 would achieve response to LNI, a lifetime trait. Considering LNI as the selection objective, using intensity of selection of 1 % and 70 % for males and females, respectively, and generation interval equal to 5 years and direct selection to the goal, one could get an annual profit of US$ 18.44. Using NI1 as a selection criterion, considering the same variables above, one could get a correlated response on LNI equal US$ 10.57per year. Considering IOFC1 or MY1 as selection criteria, the correlated response on LNI would be US$ 9.18 and US$ 6.93 per year, respectively.

Rank correlation estimates indicated that changes would happen when choosing sires according to one or the other criterion. Only 59.1 % of sires would be the same if one picks sires based on BV of NI1 aiming selecting for LNI. Even for measures of profitability take on first lactation, only 89.2 % of sires would be the same for NI1 and IOFC1 and just 69.3 % if the traits were NI1 and MY1.

Table 1. Estimates of heritability (on diagonal), genetic correlation (Below diagonal) and rank correlation (above diagonal) of the economic traits of Holstein cows

	LNI	NI1	IOFC1	MY1
LNI	**0.07***	0.591*	0.501*	0.346*
NI1	0.608*	**0.08***	0.892*	0.693*
IOFC1	0.530*	0.920*	**0.08***	0.821*
MY1	0.404*	0.749*	0.852*	**0.08***

* = P<0,0001

CONCLUSIONS

Small amount of additive genetic variation remains in lifetime measures of profitability. Despite this, these measures could be used to improve profitability in dairy herds.

NI1 could be used as a selection criterion aiming LNI.

Changes in sire rank could happen according to the criterion used to choose sires.

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