Can a relative net income become a selection criterion in laying hens?

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Single trait analysis based on relative net income was considered as an alternative approach to multitrait genetic evaluation of laying hens. The objective of the study was to estimate heritability of relative net income and its relationship with other production traits in selected population of laying hens. The data of 4797 hens from M55 strain (Rhode Island White) hatched in 2002 in the Center for Nucleus Breeding "MESSA" Ltd., Mienia were analysed. Multitrait animal model was applied including the following traits: body weight (BW), initial egg production (IEP), egg weight (EW), percentage of cracked eggs (%CR), age at first egg (AFE), egg production rate (EPR), relative net income (RNI). RNI was calculated as modification of formula given by Skotarczak *et al.* (2003): RNI_i= approximate revenue from eggs of i-th hen + value of culled hen – cost of chick – feed cost of i-th hen. Feed cost was calculated using regression on body weight, whereas revenues of eggs were assumed according to egg size classes. AI-REML algorithm was applied to estimate variance components in the DFREML program (Meyer, 2001). Heritability estimates of the traits were equal to: BW - 0.30, EW - 0.19, AFE - 0.67, IEP - 0.75, %CR - 0.08, EPR - 0.31, RNI - 0.27. Genetic correlations between RNI and other traits were equal to: 0.4753, 0.2802, -0.7532, 0.7798, -0.3764, 0.7214 for BW, EW, AFE, IEP, %CR and EPR, respectively. The signs of relationships were confirmed by phenotypic correlations. The results indicate possibility to use relative net income as direct selection criterion in laying hens.

Key words: laying hens; relative net income; heritability; genetic correlation; selection criterion

Introduction

The main objective of poultry breeding is to improve overall profitability or production efficiency. Increased market demands especially related to products quality have influenced poultry breeding objectives. Over last years increasing number of traits must have been included in the selection criterion to retain competitive position. Extension of selection indices makes the derivation of economic values and breeding value estimation computationally demanding. Single trait analysis based on relative net income could be considered as an alternative approach. The objective of the study was to estimate heritability of relative net income and its relationship with other production traits in selected population of laying hens.

Material and methods

The data of 4797 hens from M55 strain (Rhode Island White) were analysed. Pedigree included 5128 records. Birds were hatched in 2002 and kept in the Center for Nucleus Breeding "MESSA" Ltd., Mienia (Poland). Environmental conditions were automatically controlled according to standard schedule. The following traits were recorded: body weight (BW), initial egg production (IEP), egg weight (EW), percentage of cracked eggs (%CR), age at first egg (AFE), egg production rate (EPR). Description of the traits was given in Table 1.

Table 1. Means and standard deviations of the studied traits

	BW	EW	AFE	%CR	IEP	EPR	RNI
mean	1595.87	60.78	157.63	0.01	84.70	91.58	15.21
SD	122.18	4.10	9.06	0.03	11.06	6.66	2.87

Relative net income (RNI) was calculated as modification of formula given by Skotarczak *et al.* (2003):
RNI_i= approximate revenue from eggs of i-th hen + value of culled hen – cost of chick – feed cost of i-th hen.

Feed cost was calculated using linear regression on body weight, whereas revenues of eggs were assumed according to egg size classes.

The analysis was performed based on multitrait animal models:

$$\mathbf{y} = (\mathbf{X} \otimes \mathbf{I}_t)\mathbf{b} + (\mathbf{Z} \otimes \mathbf{I}_t)\mathbf{a} + \mathbf{e},$$

where:
y is the nt*1 vector of phenotypic observations on t traits,
b is the pt*1 vector of fixed effects (periods of hatching)
a is the qt*1 vector of random additive genetic effects,
e is the nt*1 vector of random errors,
X is the nt*pt design matrix of fixed effects,
Z is the nt*qt design matrix of random effects,
$\mathbf{I}_t$ is the identity matrix of size t,
$\otimes$ denotes Kroneckers product.
AI-REML algorithm was applied to estimate variance components in the DFREML program (Meyer, 2001).

Results and discussion

Heritability estimates of the traits under multitrait model were given on Figure 1.

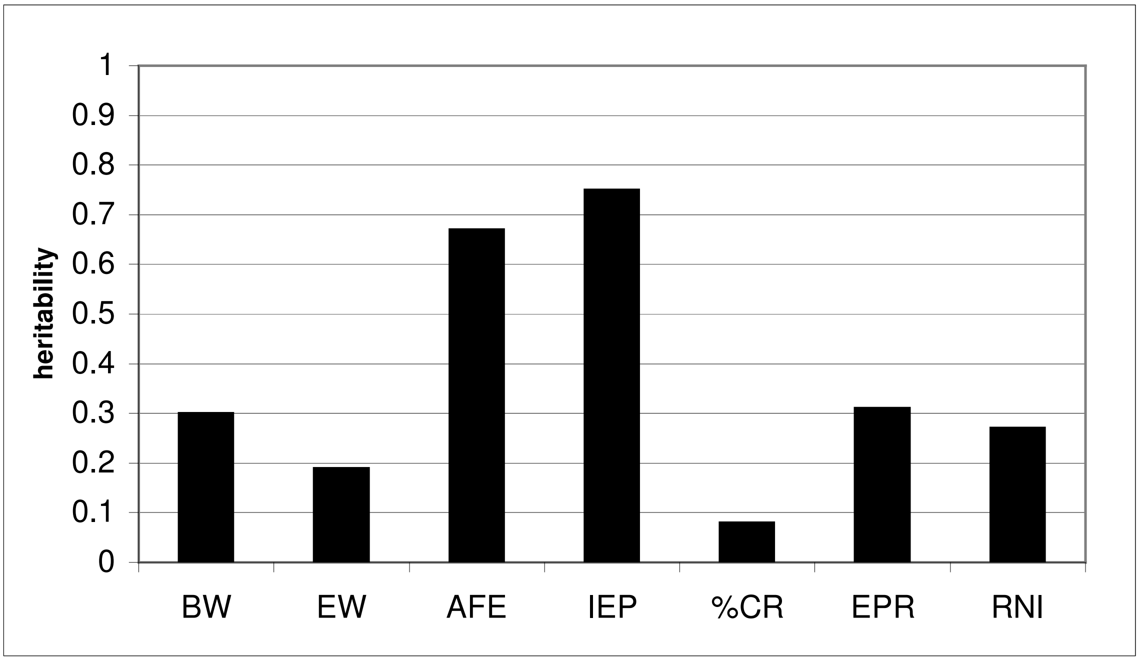

Figure 1. Heritability of the studied traits

The literature estimates of heritability of production traits vary in wide range according to population and methodology. The heritability of body weight in the studied population was moderate, slightly lower than the results for White Leghorn line (h^2=0.49) reported by Hartmann *et al*. (2003) and much lower than estimates of Miguel *et al*. (2006) for Black Castilian Breed (h^2=0.83). Proportion of genetic variance to total variance for egg weight was estimated on a low level (h^2<0.2) which confirms the results of Szydłowski and Szwaczkowski (2001) for other commercial Polish populations. High heritability of IEP and AFE might have resulted from highly negative correlations (Table 2) between these traits which might have contributed to overestimation of heritability and failure of sampling variances approximation. Although, in most of studies these traits are characterized by lower heritability it must be noticed that in some populations also high heritability of these traits was found (Calik, 2004). Johansson *et al*. (1998) reported heritability of 0.06 for shell cracks frequency, higher estimates were obtained in the selection experiment by Nirasawa *et al.* (1998). The study confirmed low heritability of % of cracked eggs also obtained by Wolc *et al*. (2005) under linear model. The results of EPR were similar to other polish populations (Calik, 2004). Heritability of 0.27 was estimated for relative net income which is slightly higher than the results of Skotarczak *et al*. (2003). Moderate heritability shows the chance to improve the trait by selection. It was also shown by Skotarczak *et al*. (2003) that selection on traditional traits leads to response in positive genetic trends for RNI. The idea to use relative net income for genetic evaluation was proposed for dairy cattle (VanRaden, 2004).

Table 2. Genetic (above diagonal) and phenotypic (below diagonal) correlation between the studied traits

	BW	EW	AFE	IEP	%CR	EPR	RNI
BW		0.161	-0.155	0.334	-0.397	0.615	0.475
EW	0.217		0.373	-0.382	0.241	-0.349	0.280
AFE	-0.124	0.124		-0.974	0.371	-0.797	-0.753
IEP	0.163	-0.085	-0.826		-0.495	0.912	0.780
%CR	-0.013	0.048	0.014	-0.201		-0.651	-0.376
EPR	0.135	0.008	-0.198	0.713	-0.330		0.721
RNI	0.269	0.701	-0.413	0.561	-0.189	0.465	

Genetic correlations between RNI and other traits under study were positive except from AFE and %CR which results from the formulation of RNI function. The signs of relationships were confirmed by phenotypic correlations. The results indicate possibility to use relative net income as selection criterion in laying hens.

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