Evidence of genetic variability for floor and nest egg laying behavior in floor pens

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Abstract

The use of alternative management systems for laying hens has increased in recent years. It has become a common practice for egg production. Alternative production environments, however, introduce new challenges especially for genetic evaluation, such as evaluation of nesting use behavior. In alternative systems, egg production cost will be more than in traditional cage based systems due to an increase of 5 to 7 percent in downgraded eggs. The introgression of traits such as incidence of floor-laid eggs or nesting behavior in selection practices is necessary to improve production of first quality eggs in alternative systems.

In this study, we investigated the incidence of floor-laid and nest-laid eggs and their genetic background as traits in one of our brown egg pure lines. Birds were housed in multiple floor pens by sire family. There were eighteen sisters in each pen with two replicates. Egg production was recorded daily both for floor-laid and nest-laid eggs. The birds were housed at seventeen weeks of age and data were collected for eleven weeks. The initial trial reported here was repeated in two consecutive generations. Two different data structures were created for the analyses. Daily and weekly production was tested as two different traits to estimate genetic parameters. A sire model was applied to estimate variance components by using expectation-maximization REML. There was a negative correlation (-0.3) estimated between floor-laid eggs and daily or weekly production. This indicates that hens learn nesting behavior over time. Heritabilities for incidence of floor-laid egg were estimated as 0.39 and 0.44 for daily and weekly production, respectively. This study showed that introgression of floor-laid eggs, as a key component of selection for behavioral traits in alternative system production, will result in significant improvement of bird performance.

Keywords: floor-laid egg; nest behavior; heritabilities; pure lines.

Introduction

We can define animal welfare by different parameters such as birds' health, behavior or production. Due to new animal welfare regulations, alternative management systems or cage free environments has becoming a common practice in egg production. In 2012 all battery cages will be banned in Europe. Also, installation of battery cages is no longer possible in Europe. There are few alternative systems introduced to the layer industry. Studies showed that these alternative systems do not affect bird performance (Guedon and Faure, 2004). However, cage free systems bring new challenges to egg production, such as low rate of nest laying and broken eggs due to floor laying, bacteria contamination and high labor cost. It is clear that cost of egg production is much higher in cage free systems because of high number of downgrade eggs (Appleby et al., 2002, Gueston and Faure, 2004). Studies are addressing the management side of the problem such as different cage densities, effect of rearing factors, and different cage or nest types (Appleby et al., 2002, Gunnarsson et al., 1999, Guesdon and Faure, 2004). Cooper and Appleby (1996) were the first who studied individual bird differences on floor laid behavior, and showed that incidence of floor eggs declines with age.

The objectives of this study were to evaluate one of our experimental brown egg layer lines under extreme floor laying conditions and also determine the genetic background of birds' nesting behavior.

Material and Methods

The test line chosen for this study was previously identified in an internal survey for floor laid egg incidence. It was the most problematic line within all brown egg pure lines. All birds were wing banded at the hatch by sire code, were reared in wire cages, and transferred to the experimental house at seventeen weeks of age. The experimental house was environmentally controlled and designed for multiple bird floor pens. Pens were made of wood with a dimension as 1.1m*1.96m*1.51m. Each pen had nipple water system and metal nest box at the back side of the pen. Lighting and feeding regimes were arranged according to Hy-Line Brown Management Guide (Hyline International, 2005). Data collection started with egg production and continued for eleven weeks. Eighteen full and half sib sisters were placed in each pen, and pens were marked with their sire code. There were at least two replicates for each sire code. Egg production was recorded daily 5 days of the week, Monday through Friday, by sire code. Two different data structure were created and daily and weekly productions were tested as both for floor- and nest-laid eggs recorded by sire code. In this work we are presenting two consecutive generation incidence of floor- and nest-laid eggs. Summary of the data used in this work is presented in Table 1.

Correlations calculated on percent floor and nest laid eggs by daily and weekly production for each and overall generation. The eleven weeks of data recording was divided into three periods, and linear regression coefficients were calculated for each time period and also for overall test. Variance components were estimated using a simplified sire model, using restricted maximum likelihood (REML) implemented with expectation-maximization (EM-REML) using REMLF90 (Misztal et al., 2002). Variance components and "BLUP/BLUE" solutions were predicted/estimated for different data sets. In the model, sire code was identified as random, and pen was identified as fixed effect. Three generations of pedigree information were incorporated into the pedigree matrix.

Table 1. Summary of data

Test	2004	2005
Number of birds	5505	8753
Number of sires	69	69
Number of pens	138	155

Results and Discussion

Overall results from two different data structures were in a good agreement. Analyses were carried out within generations. Because the results from within generation analyses were not different, generations were pooled. The results presented here are from merged generation data.

Correlations between percent of floor laid eggs and daily or weekly egg production were significant. Phenotypic correlations were -0.37 from daily, and -0.38 from weekly production data. These numbers are good indicators of learning behavior of nest laying over time. Nest laying learning behavior trend is presented in Table 2 as regression coefficients of incidence (%) of floor laid eggs on time. In general, weekly and daily percent floor eggs decreased -3.6 percent a week. This value indicates 3.6 % less floor eggs for each week during test. The results show that floor laid egg incidence mostly occurs at the beginning of the egg production period. After five weeks of production floor laid eggs incidence slows down rapidly. Same kind of finding was reported by Cooper and Appleby (1996) that floor laid eggs incidence, declined as 25 % in the first week.

There was a significant large variation among families across test. Approximately 11 % of the families laid more than 95 % of their eggs on floor, while 5 % of the families laid in nests throughout the experiment. On individual basis Cooper and Appleby (1996), reported that 80 % of the floor laid eggs were from same birds regardless of production age while some birds laid eggs into nests all the time.

Table 2. Linear regression coefficients of daily and weekly percent floor eggs on week in test

Weeks in test	Weekly (%)	Daily (%)
1-4	-5.5 ± 0.34	-5.5 ± 0.66
5-8	-4.0 ± 0.27	-3.8 ± 0.61
8-11	-1.0 ± 0.56	-1.0 ± 1.17
Overall	-3.6 ± 0.07	-3.6 ± 0.15

There was a large additive genetic variance in daily and weekly floor laid egg production (Table 3). Moderate to higher heritabilities estimated for daily and weekly percent floor laid eggs. Heritability from weekly production data was higher than that from daily production data. No study was found reporting the genetic variation for floor laid eggs incidence.

Table 3. Estimates of variance components for percentage of floor eggs

Data Set	σ^2_a	σ^2_e	h^2
Daily	176.3	272.8	0.39
Weekly	166.8	210.2	0.44

According to the results of the present study nesting behavior is learnt by the birds. In addition, there is a significant additive genetic variance for the traits involved. There was a difference as 70.2 of sire breeding values for percentage floor laid eggs between the best and the worst sires from pooled data. It may be concluded that nesting behavior, as a welfare trait, can be successfully introduced in selection programs to increase productivity in cage free systems.

References

APPLEBY M.C., WALKER A.W., NICOL C.J., LINDBERG A.C., FREIRE R., HUGHES B.O., and ELSON H.A. (2002) Development of furnished cages for laying hens. *British Poultry Science.* 43:489-500.

COOPER J.J. and APPLEBY M.C. (1996) Individual variation in prelaying behavior and the incidence of floor eggs. *British Poultry Science.* 37: 245-253.

GUESDON V. and FAURE J.M. (2004) Laying performance and egg quality in hens kept in standard or furnished cages. *Animal Research.* 53: 45-57.

GUNNARSSON S., KEELING L.J. and SVEDBERG J. (1999) Effect of rearing factors on the prevalence of floor eggs, cloacal cannibalism and feather pecking in commercial flocks of loose house laying hens. British Poultry Science 40: 12-18.

Hy-LINE INTERNATIONAL. (2005) Hy-Line® Variety Brown Commercial Management Guide 2005-2007. *Hy-Line International*. West Des Moines, Iowa, USA.

MISZTAL I., TSURUTA S., STRABEL T., AUVRAY B., DRUET T. and LEE D.H. (2002) BLUPF90 and related programs (BGF90). *Proc. 7thWorld Congress on Genetics Applied to Livestock Production*. Montpellier, France. Communication No 28-07.