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Simple Method of Converting Egg Weight to Egg Value

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Summary

A polynomial function was employed to convert a classified variable of the market egg prices into a continuous variable of the egg values. The data of egg prices for six grades of egg size in three years (1992, 1993 and 1994) in Hokkaido were used. The fits of the model were high for egg prices in each year and for average egg price of three years with the coefficients of determination ranging from 0.997 to 0.999. The converted egg value is expected to reflect exactly the value of an egg by its weight, and is therefore expected to reflect the biological value of the hen according to her egg weight. The egg income calculated as a product of the converted egg value and total egg number may be considered as an index of egg weight and egg number for the hen being evaluated. The egg income can be obtained easily at any stage of egg production. Therefore, multi - stage selection based on egg income to improve total genetic merit of egg number and egg weight is a possible application.

Key words : egg weight, egg price, egg value, laying hen

Introduction

The annual revenue from egg production of a hen is undoubtedly affected mostly by the total number of eggs and egg weight laid by the hen. A selection index has been conventionally used as an economic index for selecting hens based on the combination of egg number and egg weight. However, estimating relative economic value is a complicated procedure for breeders (Brascamp *et. al.*, 1985 ; Groen and Luiting, 1992). As the economic weights of the traits are often derived subjectively by the breeders rather than objectively by economic analysis, some adjustments are often made after constructing a "tentative index" (Yamada *et. al.*, 1975). Selection based on egg mass is an approximate index of egg number and egg weight. However, in the Japanese egg market, there is a tendency for the price of eggs weighing over 70 grams to decrease. Thus, in Japan, selection based on egg mass may not maximize the economic efficiency of egg production. The total egg number is obtained simply by actual records or by prediction using a mathematical model of egg production (Luc *et. al.*, 1995). If the monetary

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value of an egg is known, the product of egg value and total egg number would refer to total income of the hen being evaluated. Moreover, because egg weight increases with ages of the hen, evaluation of hens at different stages of egg production would be more effective. The value of an egg in practice is the price of the egg determined by its weight. In Japan, eggs are sold according to at least at six grades of egg weight (i.e., LL, L, M, MS, S and SS). However, egg price in the market is a classified variable ; it does not reflect the actual "biological value" of the hen by her egg weight. The formula for converting egg weight to "standardized egg value" has been established under the University of California Single Flock Projection (Bell, 1993 ; Personal communication) for egg production in the United States of America. In the present study, we attempted to convert egg weight to egg value from market prices of eggs in Hokkaido.

Materials and Methods

The data of egg prices in Hokkaido in three years (1992, 1993 and 1994) were obtained from Statistics of Animal Product Circulation published monthly by the Ministry of Agriculture, Forestry and Fisheries. The egg weight of each grade is defined as the middle point of that grade. For example, the egg weight of grade L, which includes egg weights from 64 grams to 69 grams, is determined to be 67 grams. This value is also equal to the mean egg weight in this grade. The prices corresponding to the mid - point egg weight for six market grades in three years are shown in Table 1. The data of egg prices by grades of egg weight were fitted to the polynomial model which has following form :

$$Y = b_0 + b_1 x - b_2 x^2 + b_3 x^3 - b_4 x^4$$

where Y is the egg value in yen of the egg having a weight of x in grams ; and b^0, b^1, b^2, b^3, and b^4 are partial regression coefficients. These model parameters were estimated by the method of GLM in SAS (1985).

Table 1. Grades of egg and prices in Hokkaido[1]

Grade of egg weights	Avg. Egg weight(g)	Number of eggs/kg	Yen/egg (1992)	Yen/egg (1993)	Yen/egg (1994)	Yen/egg (Average)
LL (70-76g)	73	13.70	13.43	12.92	13.72	13.36
L (64-69g)	67	14.93	13.66	13.13	13.86	13.55
M (58-63g)	61	16.39	11.65	11.59	12.51	11.92
MS (52-57g)	55	18.18	8.58	9.19	9.52	9.10
S (46-52g)	49	20.41	7.10	7.55	7.55	7.40
SS (40-45g)	43	23.26	4.77	4.94	4.77	4.83

[1]Source : Ministry of Agriculture, Forestry and Fisheries.

Results and Discussion

The fits of the polynomial model to egg prices by egg weights for each year and the average of egg prices in three years are shown in Figure 1. The general picture of egg prices in Hokkaido shows that egg prices increased from the SS size to the L size in all three years. The price of the LL sized eggs decreased by about 0.2 yen per egg in all three years. The fit of the model was good in all three years and the average with coefficients of determination (R^2) ranging from 0.997 to 0.999, of which the highest value was estimated for egg prices in 1993. As shown in Figure 1, the egg prices in 1993 showed a linear increase from the SS size to the L size and then decreased at the LL size, except for a slight departure from the straight line at the S size. In 1992, the egg prices increased slightly at the S size and decreased at the MS size, while in 1994,

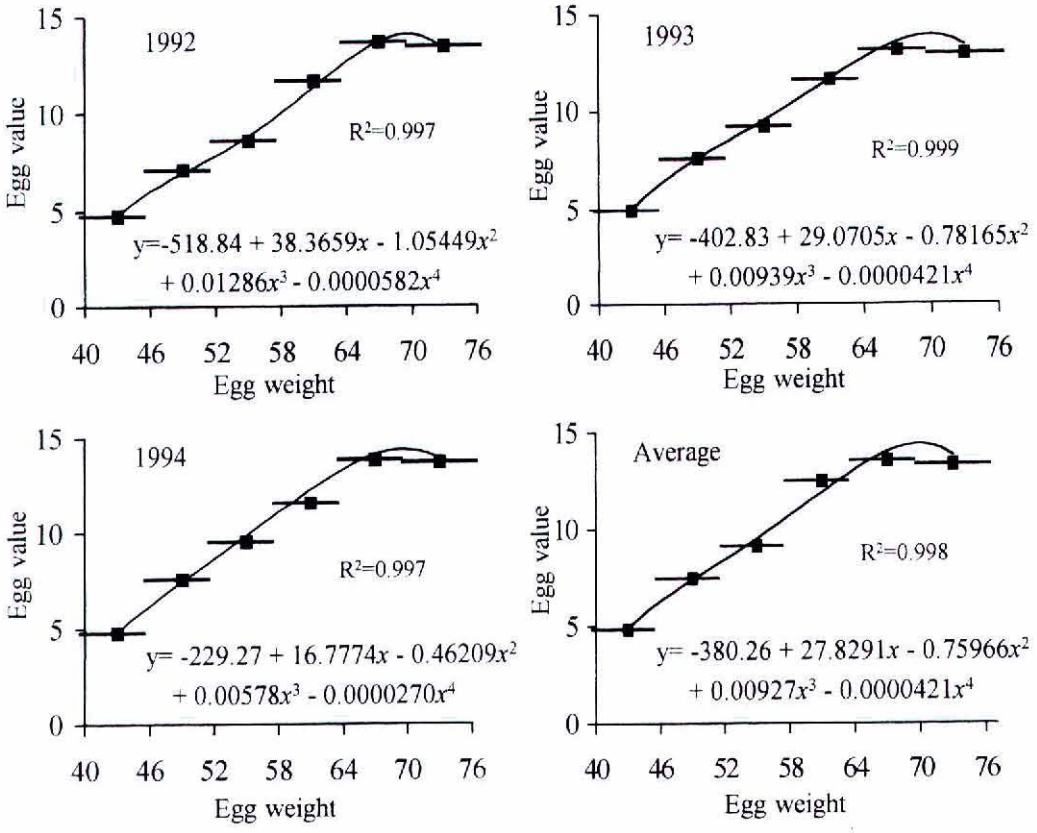

Fig. 1. Fitting the egg prices (y) for six grades of egg weights (x) to th e power 4 polynomial function.

they decreased at the M size. These trends resulted in a slightly lower R^2 for the 1992 and 1994. However, the polynomial model proved to be a useful tool in fitting to egg prices by egg weights. As can be seen in Figure 1, the curve decreased at the LL - sized eggs in all three years as the price of this size decreased. Bell (1993) used the negative exponential function to convert egg weight to egg value for egg production in America, but our pre analyses of egg price data in the present study using a similar logistic model showed that the model could not express the penalty in the price of the LL-sized eggs weighing over 70 grams (Unpublished results). Moreover, three polynomial functions were initially fitted to these data of egg prices. The function of degree 5 showed a singular incidence matrix and bias in parameter estimation. The function of degree 3 could not explain the decline term for the LL-sized eggs. Therefore, the polynomial function of degree 4 was chosen as the most suitable for expressing prices of eggs by their weights for egg markets in Hokkaido. The model also showed a flexible fit for the egg prices used in this study. As shown in Figure 1 for the fits of the model to egg prices in 1992 and 1993, the changes in the predicted curve were in accordance with the changes in egg prices even though there were slight changes in egg prices at the S and MS sizes. However, there was a slight overestimation of the M - sized egg price in 1994.

In conclusion, the egg price in the market is a classified variable with six or fewer classes of egg size, while the egg value converted from the egg price by a mathematical model is a continuous variable. The converted egg value is expected to reflect exactly the value of an egg by its weight and therefore to reflect the "biological value" of the hen by her egg weight. The egg income of a hen (the product of the "biological value" and total number of eggs) can therefore be considered to be an economic index of the egg weight and egg number for that hen. It is expected that the economic efficiency of egg production can be maximized by selection based on egg income. The model parameters are relatively easy to estimate from market egg prices, and therefore the estimates can be updated routinely for current prices. Moreover, egg weight is known to increase with the age of the hen. The egg income of the hen can be obtained at any stage of egg production. Thus multi-stage selection based on egg income can be applied to increase the accuracy and selection responses for total genetic merit of egg number and egg weight. Selection based on egg income in the first laying stage can therefore lead to an increase in both egg number and egg weight, because eggs produced in the first laying stage are small in size. Selection in the last laying stage can increase the egg number while maintaining the optimum egg size, because in the last laying stage eggs are often oversized and the value of these eggs is reduced.

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卵重による鶏卵価値の推定

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不連続変異を示す市場卵価格を多項式を用い，連続変異である鶏卵価値に変換する試みを行った。北海道における1992年から1994年にわたる6段階の卵サイズ（卵重）別の卵価格をデータとして用いた。モデルの適合度は，いずれの年においても高く，その決定係数は0.997から0.999が推定された。それ故に，変換された卵価値はその卵の卵重からより厳密にその価値を予測するものであり，個々の産卵鶏の生物学的価値に関連することが期待される。

変換した卵価値と産卵数とから算出される卵による収益は，各個体の卵重と産卵数とによる指数と考えることが可能である。また，この卵による収益は，どの産卵ステージにおいても簡単に算出することができ，

産卵数と卵重による総合的な鶏の遺伝的メリットを改善するために，多段階的な選抜に応用が可能であろう。

キーワード：卵重，鶏卵価値，鶏卵価格，産卵鶏

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