

EVALUATION OF REALIZED SELECTION IN POULTRY POPULATIONS SELECTED FOR EGG PRODUCTION

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TABLE 1. Parameters used for calculating selection indices

Trait	Unit	σ_p	h^2	Correlation(r_p =above diagonal, r_G =below diagonal)						
				1	2	3	4	5	6	
1	EW	1g	4.0	.50						
2	BW	100g	1.8	.40	.40					
3	SM	1 day	12.0	.30	.30	.10				
4	EP	1%	10.0	.30	-.10	0	-.50			
5	EP ⁵⁰⁰	1%	10.0	.20	-.60	0	-.50	.85		
6	FC		0.2	.20	-.40	.30	.20	-.50	-.60	

INTRODUCTION

If the phenotypic and genetic parameters of two strains are of the same magnitudes, the derived selection indices, based on the Smith-Hazel's method, of the two strains must be the same, regardless of their levels of performance. To reflect such a difference in production levels of these strains, one must modify the relative economical weights according to the breeder's preference. Such modifications have no justification, however. Yamada *et al.* (1975) reported the method of constructing a selection index when gains of individual traits are primary concern of the breeder. The idea was arisen to fulfill the desire of breeders dealing with several strains which differed in the level of production in various economically important traits. The index is now widely used in both animal and plant breeding.

We also noticed quite often that actual selections in animal and poultry breeding were not ideally designed experimentations and thus all sorts of attentions to various characteristics were taken into consideration at various stages of reproduction. This means that actual selection could be different substantially from what the breeder first intended, depending on either aware or unaware causes. In this sense, the effectiveness of selection is not fully evaluated, unless the culling variate or the realized selection index is identified. The technique to evaluate such an index was given by Yamada (1977).

In this paper, the results of our poultry breeding, based on index selection, are briefly outlined.

Six populations of the Shirakawa National Poultry Breeding Station and 10 populations which belong to 7 Prefectural Poultry Experiment Stations are included in the analysis. Data from the Governmental station covered 8 generations while those from the Prefectural stations covered only 5 generations. Average flock sizes of these 16 populations were roughly from 400 to 1000 pullets originated from 15 - 30 sires mated to 90 - 200 dams every year, which varied depending on the strain.

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Chicks were hatched in March and April and housed in laying cages at about 140 days of age. The traits included on the index were age of the first egg(SM), body weight at 240 days of age(BW), egg weight at 240 days of age(EW), and egg production rate from 181 to 270 days of age(EP).

Immediately after collecting those data, records of performance were sent to the computer center for the analysis and sent back to the respective stations for selection.

Intended selection index: Selection indices were calculated according to the breeding goals assigned to each strain, based on the parameter estimates given in Table 1. The same parameters were used every year, unless they were specified. On the other hand, breeding objectives of each strain were subjected to change, according to the generational means of the traits concerned. Breeding objectives and calculated selection indices of the 16 strains in 1978 are presented in Table 2 as an example.

Selection indices were calculated as follows: Define Q' be a row vector of the breeding objectives

$$Q' = [Q_1 \ Q_2 \ \dots \ Q_m]$$

$$= q[\Delta G_{1.I} \ \Delta G_{2.I} \ \dots \ \Delta G_{m.I}] = q\Delta G_{1.I}$$

Then, the derived index, b , is

$$b = X^{-1}RG[G'RX^{-1}RG]^{-1}Q$$

where X , R , and G are phenotypic variance-covariance matrix, genetic relationship matrix and genetic variance-covariance matrix, respectively.

Realized selection index: Realized selection index was obtained in two ways, one based on the general parameters given in Table 1 and another based on the parameters estimated from that particular strain. The index is

$$\tilde{b} = i^2[\Delta P_{i,j} \ \text{diag}\Delta P_{j,j}]^{-1}\Delta P_{i.I}$$

where \tilde{b} , $\Delta P_{i,j}$, $\text{diag}\Delta P_{j,j}$ and $\Delta P_{i.I}$ are the vector of weights given to the component traits, phenotypic variance-covariance matrix or direct-indirect selection differential matrix, diagonal variance or direct selection differential matrix, and the vector of indirect selection differentials observed in the component traits of the index, respectively.

Correlated genetic gains of the component traits, when selected on the realized index, I , with the selection intensity i , were estimated as:

$$\Delta G_{1.I} = [\Delta G_{1,j} \ \text{diag}\Delta P_{j,j}] \tilde{b}_i / i^2$$

where $\Delta G_{1,j}$ is the genetic variance-covariance matrix.

The accuracy of the realized selection index can be evaluated by:

$$r_b = (I_{(S)} - \bar{I}) / (I_{(Q)} - \bar{I})$$

where $I_{(Q)}$, $I_{(S)}$, and \bar{I} are the average of the index values of the top q individuals selected by truncation, the average index value of actually selected individuals, and the average index value of the whole population, respectively.

TABLE 2. Breeding objectives and selection indices (1978)

Strains	Breeding objectives(Q)				Weighing coefficients(b)			
	EW	BW	SM	EP	EW	BW	SM	EP
0001	*	*	*	4	1	-.96	-.07	4.13
0002	*	*	*	1	1	-.96	-.07	4.13
0003	1	-1	-5	2	1	-2.88	-.17	.49
0004	*	*	*	4	1	-.96	-.07	4.13
0005	*	*	-5	5	1	-.85	-.26	3.54
0006	*	*	-5	5	1	-.85	-.26	3.54
1001	2	-1	*	3	1	-2.47	0	.64
1002	0	0	-10	4	1	-.31	-1.19	.63
1003	0	0	-10	5	1	-.38	-1.06	1.04
1004	1	0	-6	4	1	-.83	-.28	.93
1005	1	-.6	-6	5	1	-2.33	-.07	1.03
1006	*	-.6	*	5	1	-3.94	0	1.89
1007	1	0	-5	5	1	-.97	-.04	1.39
1008	-2	*	*	7	1	0	-.05	1.34
1009	0	-.5	-5	4	1	-3.45	-.22	1.50
1010	0	0	-5	8	1	-1.68	1.20	8.07

Strain #0001-0006 are Governmental, #1001-1010 Prefectural.
 * indicates the restriction of changing only to the desirable direction. For example, in 0001, EW = present level, BW below present level, SM below present level but EP₅₀₀ must be 4% more than the present level.

Another estimate of the accuracy of the realized selection is the correlation coefficient of the values of the intended selection index and those of the realized index, designated as r_R in this paper.

RESULTS AND DISCUSSION

Comparisons of an intended selection index and two realized selection indices calculated from the general parameters (Table 1) and estimated parameters in a particular strain (#0001) are presented in Table 2. Substantial differences of the weights given to the component traits of the index were easily seen. The discrepancy between intended and realized selection could be ascribed at least to some extent to conscious selections by setting culling levels against small egg weight ($x = 55g$) and late sexual maturity ($x = 180$ days). Occasionally, disease resistance against Marek's by referring the mortality in full brother chicks inoculated with a standard dose of the agent was also taken into consideration. The average correlation coefficients between intended and realized selection pooled over strains and generations are given in Table 4. The accuracies of r_R and r_b are nearly the same order, whereas the correlations between two indices based on generational parameters of the strains gave higher estimates. This suggests that the realized culling variates of a particular strain should be obtained by use of the parameters estimated in the strain. Variances and covariances were appreciably changed among strains and generations.

Expected and actual gains in the component characters are presented in Table 5. Discrepancies were more prominent in low heritable trait, egg production rate for 181 - 270 days, being approximately 1/3 of the expected. Actual gains in BW were negative instead of positive estimates. Without maintaining an adequate control population, it is difficult to assess properly the genetic progress caused by selection. Nevertheless, linear regression analysis to fit the trend of the

TABLE 3. Comparisons of intended (I_1) and realized selection indices (I_2, I_3) in a strain (#0001)

Year		Relative weight				Correlation with intended		Expected gain per generation			
		EW	BW	SM	EP	r_R	r_b	Δ EW	Δ BW	Δ SM	Δ EP
1974	I_1	1.00	-.05	0	1.28			0	-32	-1.40	2.46
	I_2	1.00	-.11	-.90	.71	.07	.59	-.26	-47	-2.00	1.29
	I_3	1.00	-.10	-.47	1.45	.91	.69	-.29	-37	-1.60	1.62
1975	I_1	1.00	-.05	0	1.28			0	-32	-1.40	2.46
	I_2	1.00	-.03	-.51	.34	.60	.57	.47	-7	-2.60	1.73
	I_3	1.00	-.03	-.33	.69	.83	.67	.37	-1	-2.00	2.29
.
1979	I_1	1.00	-.01	0	1.28			.37	0	-1.40	2.83
	I_2	1.00	.00	-.41	.20	.48	.54	1.03	22	-2.74	1.59
	I_3	1.00	.01	-.30	.40	.70	.66	.89	25	-1.94	2.16
1980	I_1	1.00	-.01	0	1.28			.37	0	-1.40	2.83
	I_2	1.00	.01	-.31	.24	.63	.63	1.15	33	-2.26	1.69
	I_3	1.00	.01	-.20	.49	.84	.74	1.05	34	-1.60	2.38

TABLE 4. Average correlations between intended and realized indices pooled over strains and generations

Correlation based on generational parameters (r_R)	0.913 (0.649 ~ 0.976)
Correlation based on initial parameters (r_b)	0.799 (0.568 ~ 0.938)
Biserial correlations based on generational parameters (r_b)	0.926 (0.857 ~ 0.970)
Biserial correlations based on initial parameters (r_b)	0.799 (0.689 ~ 0.905)

TABLE 5. Actual and expected gains per generation averaged over strains and years

Trait	Governmental farm		Prefectural farms	
	Expected	Actual	Expected	Actual
EW	.40	.35	.39	.07
BW	9.19	-15.08	9.93	-8.76
SM	-2.62	-.14	-2.01	-1.21
EP	3.46	1.01	3.40	1.28

population means is still valid to eliminate environmental changes. Breeding objectives in the Governmental flocks were nearly accomplished while they are still far away in the Prefectural strains which came in later into our breeding operation.

Positive genetic gains in both EW and EP, accompanying by negative responses in SM and BW were obtained by the index selection, although $r_G(EW,EP) = -.10$, $r_G(SM,EP) = -.50$ and $r_G(EW,BW) = .40$.

SUMMARY

Poultry breeding based on selection index methods has been practiced in 16 layer strains. Those selection indices were constructed to attain a respective breeding goal assigned to each strain at a minimum length of generations. The traits included in the index were SM = age of the first egg, BW = body weight at 240 days of age, EW = egg weight at 240 days of age, and EP = egg production rate for 181-270 days of age. Although fairly large fluctuations of yearly performance and discrepancies between expected and realized gains in each strain were observed, the breeding goals assigned to these strains were satisfactorily achieved in general. Positive gains in EP and EW were attained with negative correlated gains in BW and SM. The correlations between intended and realized selection indices were the order of 0.6 - 0.9.

R E S U M E N

La mejora avícola basada sobre el método del índice de selección ha sido practida en 16 líneas de ponedoras. Estos índices de selección se construyen para lograr cada uno de ellos un objetivo de mejora asignado a cada línea en una longitud mínima de generaciones. Los caracteres incluidos en el índice fueron SM = edad al primer huevo, BW = peso vivo a los 240 días de edad, EW = peso del huevo a los 240 días de edad, y EP = producción de huevos desde los 181 a los 270 días de edad. Aunque se observaron grandes fluctuaciones de los rendimientos anuales y discrepancias entre las ganancias esperadas y reaocizadas en cada línea, los objetivos de mejora asignados a estas líneas fueron satisfactoriamente logrados en general. Ganancias positivas en EP y EW se obtuvieron con ganancias negativamente correlacionadas en BW y SM. La correlación entre los índices de selección esperados y realizados fué del orden de 0,6 a 0,9.

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