A SYSTEMATIC METHOD OF EVALUATING THE BREEDING IMPORTANCE OF TRAITS IN EGG-TYPE CHICKENS

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SUMMARY

A systematic procedure was presented to evaluate the breeding objective in an integrated three-way cross breeding system of egg-type chickens. Profit functions were developed under the production and economic condition of China and marginal returns of each traits calculated. Relative economic weights of traits in three pure lines were obtained under the basis of marginal return.

INTRODUCTION

In breeding of egg-type chickens, there are many traits affecting the production efficiency and thus needing genetic improvement. Index selection is generally used to meet this demand. To ensure satisfactory genetic improvement, traits included in the index must be carefully chosen and the relative economic weights reliably estimated. Therefore, it is very important to evaluate the breeding importance of all available traits.

Harris (1970) proposed that the bio-economic objective can be expressed by a function including the difference between total income and total cost and should include all the traits of economic importance and their related economic constants. Harris *et al.*(1984) further developed the idea to a systematic approach to designing comprehensive breeding programme. Akbar *et al.*(1986) applied this procedure to develop the relative economic weights in commercial broilers.

When selection is operated in pure lines, the genetic effects would not be limited to pure lines. The main effects of selection are to improve the performance of commercial stock through appropriate breeding system and finally to increase the production efficiency of the whole breeding system. In evaluating the breeding importance of traits, we could see its effects on the total profit. The marginal return, which in this paper was defined as the change in profit of the breeding system when a unit genetic change on a trait has taken place, was used as criterion to evaluate genetically and economically the breeding objective of egg-type chickens.

MATERIAL AND METHODS

<u>System Description</u>

A three-way cross egg-type chicken breeding system, which is generally adopted in commercial breeding, was considered in the paper. The system consists of 8 genetic groups(Fig.1). Group 1, 2, 3 denotes three pure lines in which selection is operated, Group 4 maternal great-grandparents male, Group 5 maternal great-grandparents female, Group 6 parents male, Group 7 parents female, and Group 8 commercial stock of layers.

The inputs of the system are costs of feed, labour and facilities, etc., and the outputs are incomes of table eggs, culled hens, and the extra pullets. The internal material flow within the system is the chicks needed by next generation. The evaluation was made under the basis of one hen in Line 3. The number of hen in Line 1 and 2 was also defined as 1 to make the size of breeding stock almost the same. The numbers of other groups were calculated according to the respective number and reproduction ability of their parent groups and the viability of themselves.

Eight traits were considered: annual egg number per hen housed(EN), egg weight (EW, in g), body weight(BW, in kg), viability in rearing period(VR), viability in laying period(VL), fertility(FY), hatchability (HA) and feed consumption in laying period(FC, in kg).

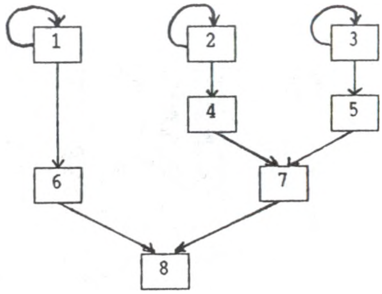

Fig.1 General structure of the system.

Performances and Basic Parameters

Performances of the pure lines(Table 1), and the economic and genetic parameters originate from a chickens breeding farm in China and are close to the real situation in 1989.

Simulation Procedure

Prediction of Trait Values. Since the genetic backgrounds of the GP, PS and CS are determined by the pure lines, and the genetic levels of male and female in the same group are assumed to be identical, the value of each trait in Group 4, 5, 6 is then the same as that in Group 2, 3 and 1, respectively. Group 7 is a cross of Group 4 and 5, therefore the value of each trait is the mean of the respective trait in Group 4 and 5, plus a certain amount of heterosis. Accordingly, the trait values of Group 8 were taken as the mean of Group 6 and 7, plus heterosis.

Establishment of Profit Functions. Profit function, including income function and cost function, was developed for each genetic group according to the production and market conditions of China. Most traits affecting incomes and costs were included in the functions. Due to limit of space, the functions are not listed.

Calculation of Discounted Profit. Upon the establishment of profit functions, the direct incomes and costs could readily be calculated using the trait values and the economic parameters. However, different genetic groups were at different time stage, and their incomes and costs would not occur at the same time. All incomes and costs were then discounted. The start point of discounting was set at the pure line stage, and the generation interval was assumed 1.5 years. Then for Group 2 and 3, the discounting term was 0, for Group 1, 4 and 5 was 1.5 years, for Group 6 and 7 was 3 years and for Group 8 was 4.5 years.

Adding discounted incomes and costs led to the total discounted income and cost respectively. Finally, the total discounted income minus the total discounted cost would give the discounted profit P_0 in the basic situation.

Calculating Marginal Returns

All traits considered have different genetic background, and there are genetic correlations among them. Those traits of larger genetic variation may lead larger selection responses and result in better production efficiency. In calculating the marginal returns, increment of a trait value was then set to one unit of genetic standard deviation of that trait, and the correlated genetic responses of other traits in the same line were also taken into account.

Set X_{ij} denotes the updated value of the jth trait in line i and X'_{ij} the value of that trait, we have

$$X_{ij}=X'_{ij}+s_{ij} \qquad (1)$$

Table 1. Trait values in each genetic group

Genetic Group	EN	EW	BW	VR	VL	FY	HA	FC
1	238.00	61.00	1.86	.9050	.8850	.9350	.9050	40.00
2	241.00	57.50	1.75	.9200	.8750	.9100	.9200	38.00
3	239.50	58.50	1.75	.9150	.8900	.9050	.9100	38.50
4	241.00	57.50	1.75	.9200	.8750	.9100	.9200	38.00
5	239.50	58.50	1.75	.9150	.8900	.9050	.9100	38.50
6	238.00	61.00	1.86	.9050	.8850	.9350	.9050	40.00
7	252.26	58.58	1.77	.9450	.9002	.9257	.9425	37.10
8	252.49	60.15	1.82	.9417	.9033	.9415	.9404	37.86

Table 2. Cost, income and profit in each genetic group (in RMB Yuan)

Genetic group	Cost	Discounted cost	Income	Discounted income
1	83.3160	75.0648	20.2119	18.2102
2	81.7074	81.7074	19.1365	19.1365
3	82.1214	82.1214	19.3845	19.3845
4	85.0611	76.6370	11.4035	10.2741
5	571.2139	514.6436	193.8446	174.6472
6	6148.1170	4990.6570	851.5646	691.2469
7	39229.4200	31843.9900	14228.2400	11549.5900
8	3111486.0000	2275575.0000	3538523.0000	2587888.0000

Total discounted profit is 287130.30

Table 3. Marginal returns of all traits in each pure line

Line	Trait	Marginal Return	Relative Value	Relative ratio (%)
1	EN	44256.0000	1.0000	11.28
1	EW	95065.7500	2.1481	24.24
1	BW	54487.7500	1.2312	13.89
1	VR	64065.5000	1.4476	16.33
1	VL	24087.5000	.5443	6.14
1	FY	29503.5000	.6667	7.52
1	HA	61308.7500	1.3853	15.63
1	FC	-19466.5000	-.4399	4.96
2	EN	46975.0000	1.0614	17.12
2	EW	44706.5000	1.0102	16.29
2	BW	7925.5000	.1791	2.89
2	VR	59779.2500	1.3508	21.79
2	VL	13103.2500	.2961	4.78
2	FY	28693.5000	.6484	10.46
2	HA	54112.5000	1.2227	19.72
2	FC	-19074.0000	-.4310	6.95
3	EN	76359.2500	1.7254	25.07
3	EW	38980.2500	.8808	12.80
3	BW	-2873.0000	-.0649	.94
3	VR	70214.0000	1.5865	23.05
3	VL	2293.5000	.0518	.75
3	FY	17919.2500	.4049	5.88
3	HA	71006.0000	1.6044	23.31
3	FC	-24991.5000	-.5647	8.20

where s_{ij} is genetic standard deviation of trait ij. To calculate the correlated changes of other traits in the same line, following equation could be deduced using the formula of correlated selection response of Falconer (1981),

$$X_{ik}=X'_{ik}+r(A)_{ijk}*s_{ik} \qquad (k=1\text{-}8,\ k\neq j) \qquad (2)$$

where $r(A)_{ijk}$ is genetic correlation between trait j and k in line i.

To calculate the marginal return of trait ij, use equation (1) to change the value of trait ij, then use equation (2) to update the other seven traits of the same line. With all the updated trait values, the above procedure of calculating income and cost was repeated to get the discounted profit P_{ij}. The difference between P_{ij} and the basic profit P_0 is then the marginal return of trait ij. The process was repeated for every trait in each line to get marginal returns of all traits.

RESULTS AND DISCUSSION

The results are shown in Table 1, 2 and 3. The most important traits in this breeding programme are: Egg production, Viability in rearing period, Hatchability and Egg weight. It could be noted that viability in rearing period and hatchability have significantly great breeding importance in all pure lines, and this indicated these two traits prominently affected the economic return of the system and need to receive more attention in future selection programme.

The relative values of marginal returns in Table 3 can be used as the relative economic weights and are very important for optimization of selection within pure lines. Moav and Hill(1966) found that establishing specialised sire and dam lines, each selected on a specialised index, was the most efficient method of genetic improvement. And this has been demonstrated in commercial breeding practice (Arthur, 1986). Results of the paper indicated a difference of trait breeding importance among lines, therefore, specialised selection index with respective sets of economic values and genetic parameters shoud be constructed for each line. Index selection based on these economic weights could lead to better genetic advances and production efficiency of the whole system.

A general computer programme based on the method to evaluate the breeding objective has been developed. It could be extended to the designing of breeding programmes in crossbreeding systems of egg-type chickens. After necessary modifications, the programme could also be applied to the evaluation of breeding objectives in crossbreeding systems of meat-type chickens and pigs, etc.

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