

***Ex situ* Improvement of Indigenous Chicken in Bangladesh**

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ABSTRACT. *This work is part of a long-term selection program carried out (i) to assess the performance of three indigenous chicken genotypes under intensive management and (ii) to evaluate the response to selection of three indigenous chicken genotypes. A total of 5945 day-old chicks representing three types of indigenous chicken genotypes namely Naked Neck (NN), Hilly (H) and Non-descript Deshi (ND) were hatched for foundation generation (G₀), first generation (G₁), second generation (G₂) and third generation (G₃) for this study. In every generation, selection was practiced at 40-week of age on the basis of an index comprising the parameters of age at first egg (AFE), body weight (BW), egg production (EP) and egg weight (EW). The average body weights of ND, H and NN were 1074±4.0, 1279.6±5.5 and 1041.0±5.7 g, respectively at the age of 16 weeks. The mean daily weight gain of indigenous chicken at 0-8, 0-12, 0-16 week and 0-maturity were 7.8±0.02, 9.4±0.02, 9.8±0.02 and 8.2±0.03 g, respectively. The lowest hatchability was found in NN genotype (77.5%). The average egg production of ND, H and NN were 83.9±1.1, 76.2±1.4 and 74.0±1.5, respectively. Among the three indigenous chicken types, ND had significantly higher ($p<0.001$) average number of eggs for a given period than H and NN genotypes. In terms of body weight, H genotype was superior. Based on the performance of the four generations, the study revealed that H genotype to be a good base population to be developed as a meat producing strain whereas non-descript Deshi chicken could be improved for.*

Keywords: *Economic traits, ex situ selection, indigenous chicken*

INTRODUCTION

The improvement of productivity of indigenous chicken is a long felt requirement in Bangladesh. Indigenous chickens of Bangladesh are categorized as Non-descriptive Deshi (ND), Naked Neck (NN), Hilly (H), Aseel (AS) and Jungle fowl (Bhuiyan *et al.*, 2005) in respect of the morphological variations as well as production performances. Bangladesh has a rich heritage of indigenous chicken germplasm, which strongly supported decisive measures for conserving indigenous genetic resources. Depending on the phenotype Bhuiyan *et al.* (2009) have predicted that indigenous chickens are genetically diluted in about 60%. Indiscriminate random mating among indigenous types of chicken and unplanned crossing with exotic breeds are the main contributors for genetic erosion leading to loss of original characteristics of indigenous chicken. Hence, a valuable genetic

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characteristics may be lost forever from the indigenous chicken types. Conservation and preservation of resources as an insurance against future needs has become a topic of mounting concern (Crawford, 1984). The genetic potential of indigenous chicken in Bangladesh is poor. Their productivity is low and as a result they are unable to meet the demand for eggs and meat in the country. This is considered as an important constrain to poultry development, which could be overcome through genetic improvement of indigenous stock by appropriate breeding. Since no selection has been done except natural selection, there must be considerable genetic variance for various traits among them which may not be found in the exotic stock and hence, there is a scope for improvement through selective breeding. Therefore, the indigenous chicken must be conserved in adequate quantities for future use and for their improvement; selection and pure breeding is necessary.

Selection for egg and meat production of Genetic improvement of indigenous chickens has been carried out in many places of the world and it is evident that considerable improvement is possible (Bhuiyan *et al.*, 2005), for example, in Bangladesh a number of studies on some productive and reproductive traits of Non-descript Deshi (ND), Hilly (H) and Naked Neck (NN) have been carried out by several researchers (Huque, 1999; Khatun *et al.*, 2005; Bhuiyan *et al.*, 2005; Faruque *et al.*, 2007; Faruque *et al.*, 2011). However, no systematic study has yet been carried out with planned selection and breeding of indigenous chickens under controlled conditions. Therefore, in order to improve the productivity of indigenous chickens the present work was undertaken to fulfil two objectives; to assess the productive and reproductive performances of three indigenous chicken genotypes under intensive management selected over three generations and to predict responses to selection for improving three indigenous chicken genotypes.

METHODOLOGY

Formation of foundation stock

As a part of selection and improvement of indigenous chicken, the Poultry Production Research Division (PPRD) of Bangladesh Livestock Research Institute (BLRI) to date has collected 5 types of indigenous chicken for its conservation and breeding. Selection of those five types has been done using phenotypic characteristics in the past breeding program. Foundation stock was established utilizing those existing stock of BLRI as well as by incorporating variation through screening of males/females/eggs from wide range of indigenous chicken gene pool in Bangladesh.

Feeding and vaccination

Concentrate mixtures that contain 20.1% crude protein and 2908 Kcal ME/kg DM; 18.1% Crude Protein and 2904 Kcal ME/kg DM and 16.3% Crude Protein and 2845 Kcal ME/kg DM were provided twice daily in the morning and evening during brooding, growing and laying periods, respectively. Fresh, cool and clean drinking water was made available for all the times. All chicks were vaccinated as per schedule given by veterinarian.

Egg production traits

Egg production traits were comprised of hen-day egg production, hen-house egg production and egg production rate, and calculated using Equation (i) to (iii), respectively.

$$\text{Hen day egg production (\%)} = \frac{\text{No. of eggs laid}}{\text{No. of hens at lay}} \times 100 \quad \dots (i)$$

$$\text{Hen house egg production (\%)} = \frac{\text{No. of eggs laid}}{\text{No. of hen housed}} \times 100 \quad \dots (ii)$$

$$\text{Egg production rate (\%)} = \frac{\text{No. of eggs laid up to a fixed date or age}}{\text{No. of hen days at lay}} \times 100 \quad \dots (iii)$$

In addition 242 day and 315 day egg production calculated for all the birds.

Fertility

The fertility was obtained as percentage by using formula (iv).

$$\text{Fertility (\%)} = \frac{\text{No. of fertile eggs}}{\text{Number of egg set}} \times 100 \quad \dots (iv)$$

Selection objective

The selection objectives of the study were to improve the egg production and / or growth rate of indigenous chicken belong to ND, H and NN genotypes. Improvement targets were set to increase egg weight by 1 g, to increase egg production rate by 2% per generation, and to improve 8 - weeks body weight of ND, H, and NN chickens (342,375 and 331 g, respectively) to 500 g after three generations of selection and breeding.

Selection criteria

In foundation generation and in 1st and 2nd generation, selection was practiced at 2 (two) stages; breeding value for 8-week body weight and index value at 40-weeks of age, where index comprises of age at first lay (days), body weight (g) at 40 weeks of age, egg production rate (%) at 168-280 days and egg weight (g) at 40 weeks of age.

The Selection Index (I) proposed and developed by Hazel (1943) was computed by the Equation (v).

$$\text{Selection Index (I)} = b_1x_1 + b_2x_2 + \dots + b_nx_n \quad \dots (v)$$

where, x_1, x_2, \dots, x_n represent the phenotypic values for the trait
 b_1, b_2, \dots, b_n denote the relative weights given to each of the trait

Mating design

Selected males and females were mated assertively with a maximum male:female ratio of 1:5 using artificial insemination avoiding mating among close relatives in all the generation.

Statistical analysis

Since sample size varied among three genotypes, data were analyzed based on non-orthogonal factorial experiment and using General Linear Model (GLM) procedure. SPSS 11.5 for Windows (SPSS, 1998) was used for data analysis. For all statistical purposes the theory of Snedecor and Cochran (1989) was followed. Duncan's multiple range test (DMRT) by Kramer (1957) was used for mean comparisons.

Prediction of expected selection response (R)

Expected genetic progress due to selection in a generation for egg production, egg weight, body weight and age at sexual maturity was estimated for G_0 , G_1 and G_2 using Equation (vi) by Falconer (1981).

$$R = 1/2 h^2 \times S_f \quad \dots (iv)$$

where, h^2 = heritability of EP, EW, AFE and BW
 S_f = selection differential for the selected females

The selection response for 8-week body weight was calculated using Equation (vii).

$$R = h^2 \times S \quad \dots (vii)$$

where, h^2 = heritability of 8-week body weight and S = selection differential.

RESULTS AND DISCUSSION

Body weight and weight gain

Male chicks were significantly heavier ($p < 0.001$) in body weights at 8th, 12th and 16th weeks than the females. Many avian species, like chickens, showed marked dimorphism in body weight with males being substantially heavier than females. This could be due to the effect of male growth hormones (Singh *et al.* 1982). Significantly highest ($p < 0.001$) body weights were observed in G_3 generation compared to other generations in all stages. Significant body weight differences among the genotypes were observed at the age of sexual maturity, with the highest body weight observed for H (1499.0±9.5 g) genotype. Khandoker (1993) observed that body weight of indigenous chickens at 8, 12 and 16 weeks of age averaged 186.5, 475.0 and 833.2 g, respectively. Those weights recorded were much lower than the present findings. Faruque *et al.* (2007) reported heavier body weight at sexual maturity in H (1461.2±251.0 g) and the lowest weight in NN (1310.5±136 g), recording more or less similar finding to the present study (Table 1).

The mean daily weight gain of indigenous chickens at 0-8, 0-12, 0-16 week and 0 to maturity were 7.8±0.02, 9.4±0.02, 9.8±0.02 and 8.2±0.03 g, respectively (Table 2). Significantly highest daily gains were observed in G_3 generation compared to other generations in all stages. The mean growth rate varied between sexes and between the times of measurement (Table 2). The mean growth rate in 16th week was higher compared to what was observed in earlier studies (Wilson *et al.* 1987). Faruque *et al.* (2007) observed that daily body weight gain of 5.88, 6.17 and 6.27 g per bird at 8 weeks growth, respectively for ND, H and NN genotype under intensive management, and those results were less than the body weights recorded in the present study. Halima (2007) reported daily body weight gain from 5-8

weeks of age ranged from 8.8 g in Gaassay chicken to 11.50 g in the Mecha chicken which was much higher than the findings in the present study.

Table 1. Variation of body weight (least square mean \pm standard error) in different sexes, genotypes and generation of selection

Factor	Level	8 th week weight (g)	12 th week weight (g)	16 th week weight (g)	Weight at maturity (g)
Sex	Male	507.4 ^a \pm 1.6 (2551)	935.1 ^a \pm 3.7 (1249)	1313.0 ^a \pm 5.2 (854)	-
	Female	425.3 ^b \pm 1.5 (2891)	716.7 ^b \pm 2.5 (2060)	954.9 ^b \pm 3.2 (1875)	-
Genotype	ND	441.6 ^b \pm 1.4 (2910)	776.8 ^b \pm 2.8 (1633)	1074.6 ^b \pm 4.0 (1313)	1212.2 ^b \pm 6.6 (614)
	H	513.0 ^a \pm 2.0 (1363)	920.2 ^a \pm 3.9 (886)	1279.6 ^a \pm 5.5 (728)	1499.0 ^a \pm 9.5 (308)
	NN	441.6 ^b \pm 2.2 (1169)	775.2 ^b \pm 4.2 (790)	1041.0 ^c \pm 5.7 (688)	1180.7 ^c \pm 9.3 (340)
Generation	G ₀	356.6 ^c \pm 2.2 (1447)	768.9 ^c \pm 4.8 (662)	1039.9 ^d \pm 6.0 (660)	1221.5 ^c \pm 8.0 (429)
	G ₁	468.9 ^b \pm 2.2 (1328)	803.1 ^b \pm 4.5 (962)	1121.9 ^c \pm 6.8 (610)	1355.7 ^a \pm 8.8 (421)
	G ₂	490.4 ^b \pm 2.3 (1571)	816.4 ^b \pm 4.3 (795)	1152.9 ^b \pm 6.0 (703)	1309.3 ^b \pm 9.2 (412)
	G ₃	548.4 ^a \pm 2.4 (1096)	922.9 ^a \pm 3.7 (890)	1225.0 ^a \pm 4.9 (756)	-
Overall mean		466.3 \pm 1.1 (5442)	825.9 \pm 2.2 (3309)	1133.9 \pm 3.1 (2729)	1301.5 \pm 5.1 (1262)
R ² of the model		0.974	0.984	0.986	0.985

Least squares means without a common superscript along the column within a factor differed significantly ($p < 0.05$); Figure in the parenthesis indicate the number of observations.

Reproductive traits

Performance of experimental birds is presented in Table 3. Dead in germ percentage did not vary significantly ($p > 0.05$) among genotypes and in different generations of selection. However, dead in shell percentage significantly ($p < 0.05$) varied among genotypes. Fertility was not significantly different ($p > 0.05$) among different genotypes but significantly different ($p < 0.001$) among the generations. Hatchability differed significantly ($p < 0.001$) among the genotypes and generations where NN had the lowest hatchability.

Table 2. Variation of body weight gain (least square mean \pm standard error) in different sexes, genotypes and generation of selection

Factor	Level	0-8 week growth(g/b/ d)	0-12 week growth(g/b/d)	0-16 week growth(g/b/d)	Growth at maturity (g/b/d)
Sex	Male	8.5 ^a \pm 0.03 (2551)	10.7 ^a \pm 0.04 (1249)	11.4 ^a \pm 0.04 (854)	-
	Female	7.0 ^b \pm 0.02 (2891)	8.1 ^b \pm 0.03 (2060)	8.27 ^b \pm 0.02 (1875)	-
Genotype	ND	7.3 ^b \pm 0.02 (2910)	8.9 ^b \pm 0.03 (1633)	9.3 ^b \pm 0.03 (1313)	7.6 ^b \pm 0.04 (614)
	DH	8.6 ^a \pm 0.03 (1363)	10.6 ^a \pm 0.04 (886)	11.1 ^a \pm 0.04 (728)	9.5 ^a \pm 0.06 (308)
	NH	7.3 ^b \pm 0.04 (1169)	8.8 ^b \pm 0.05 (790)	9.0 ^c \pm 0.05 (688)	7.4 ^c \pm 0.06 (340)
Generation	G ₀	5.8 ^c \pm 0.04 (1447)	8.8 ^c \pm 0.05 (662)	9.0 ^d \pm 0.05 (660)	7.7 ^c \pm 0.05 (429)
	G ₁	7.8 ^b \pm 0.04 (1328)	9.2 ^b \pm 0.05 (962)	9.7 ^c \pm 0.06 (610)	8.6 ^a \pm 0.05 (421)
	G ₂	8.2 ^b \pm 0.04 (1571)	9.4 ^b \pm 0.05 (795)	10.0 ^b \pm 0.05 (703)	8.3 ^b \pm 0.06 (412)
	G ₃	9.2 ^a \pm 0.04 (1096)	10.6 ^a \pm 0.04 (890)	10.6 ^a \pm 0.04 (756)	-
Overall mean		7.8 \pm 0.02 (5442)	9.4 \pm 0.02 (3309)	9.8 \pm 0.02 (2729)	8.2 \pm 0.03 (1262)
R ² of the model		0.971	0.983	0.985	0.985

Least squares means without a common superscript along the column within a factor differed significantly ($p < 0.05$); Figure in the parenthesis indicate the number of observations.

The dead in germ and dead in shell percentage of three indigenous chicken types are in agreement with the findings of Khatun *et al.* (2005) who reported 1.6% dead in germ and 12.2% dead in shell. Islam *et al.* (1981) reported that the fertility of upgraded indigenous chicken was 83%, which was lower than that observed in the present study. Khatun *et al.* (2005) reported that the fertility was 94.8%, 88.4% and 88.1%, respectively in ND, H and NN genotypes, and was higher than the present findings. Salah Uddin *et al.* (1995) and Islam *et al.* (1981) have shown that higher fertility of Bangladeshi local chickens when compared with exotic breeds. The lowest hatchability reported in NN genotype (77.5%) could be due to the highest egg shell thickness and stronger breaking strength of NN eggs. Khatun *et al.* (2005) showed that the hatchability ranged from 88.0 to 94.9% in different genotypes with the overall percentage of 86, which was slightly higher than the present findings. The age at first lays ranged from 150.0 to 159.5 days. The age at first lay reported in the present study was comparable to same indigenous chicken genotypes as reported by Faruque *et al.* (2007).

Table 3. Variation of reproductive performance (least square mean \pm standard error) in different sexes, genotypes and generation of selection

Factor	Level	Dead in germ (%)	Dead in shell (%)	Fertility (%)	Hatchability (%)	AFE (days)
Genotype	ND	2.2 ^a \pm 0.4 (575)	8.2 ^b \pm 0.9 (555)	85.7 ^a \pm 1.0 (575)	89.0 ^a \pm 1.0 (555)	155.0 ^b \pm 0.6 (376)
	DH	2.3 ^a \pm 0.5 (302)	10.0 ^b \pm 1.2 (288)	85.2 \pm 1.4 (302)	85.6 ^b \pm 1.4 (288)	159.5 ^a \pm 0.7 (200)
	NN	3.1 ^a \pm 0.5 (300)	19.8 ^a \pm 1.3 (292)	85.4 ^a \pm 1.4 (300)	77.5 ^c \pm 1.4 (292)	152.7 ^b \pm 0.9 (205)
Generation	G ₀	2.3 \pm 0.5 (308)	11.0 \pm 1.2 (300)	82.5 ^b \pm 1.4 (308)	87.5 ^a \pm 1.4 (300)	161.5 ^b \pm 0.5 (391)
	G ₁	3.4 \pm 0.4 (533)	12.5 \pm 1.0 (504)	84.6 ^b \pm 1.1 (533)	84.7 ^a \pm 1.1 (504)	-
	G ₂	2.1 \pm 0.5 (336)	15.8 \pm 1.2 (331)	90.2 ^a \pm 1.3 (336)	78.0 ^b \pm 1.3 (331)	150.0 ^a \pm 0.6 (390)
Overall mean		2.6 \pm 0.3 (1177)	12.9 \pm 0.7 (1135)	85.4 \pm 0.7 (1177)	83.8 \pm 0.7 (1135)	155.7 \pm 0.4 (781)
R ² of the model		0.982	0.953	0.928	0.930	0.995

Least squares means without a common superscript along the column within a factor differed significantly ($p < 0.05$); Figure in the parenthesis indicate the number of observations.

Egg production traits

The effects of genotype, generation of selection and their interactions on egg production traits are presented in Tables 4 and 5. The 242 day and 315 day egg productions and respective egg production rates were influenced by genotype and generation (Table 4). Among three indigenous genotypes, ND produced significantly ($p < 0.001$) highest number of eggs whereas G₂ birds were with significantly ($p < 0.001$) best egg production (Table 4). However, some studies have reported that naked neck (NN) laid a significantly ($p < 0.05$) higher number of eggs compared to frizzle and normal feathered chicken types Yoshimura *et al.* (1997), Moreki and Mosupu (2003). Petersen *et al.* (1991) reported that the village chicken produced an average of 100 eggs per year whereas the egg production of the Ethiopian (Tadelle *et al.* 2003) and Bangladeshi (Huque and Haque, 1990) village chicken were reported to be 75 and 35-45 eggs per year, respectively. Bhuiyan *et al.* (2005) revealed that annual egg production per hen was 50-55 in NN and 45-50 in indigenous chicken under scavenging. Huque (1999) found the annual egg production of selected NN, H and ND was 141, 101 and 121 respectively under intensive rearing which is in agreement with present findings.

Hen-day egg production (HDEP %) and hen-house egg production (HHEP %) of the present study were affected significantly ($p < 0.001$) by genotype, generation and genotype \times generation interaction (Table 5). It was observed that HDEP% and HHEP% were high in G₂ due to selection. Significant effect among different genotypes on HDEP% and HHEP% found in this study confirms the previous report by Miah *et al.* (2002) and Faruque *et al.* (2010) found that breed had significant ($p < 0.05$) effect on hen-day egg production. In this study the highest HDEP% and HHEP% were found in ND (51.4 \pm 0.4 and 49.7 \pm 0.4).

Table 4. Variation of egg production (least square mean ± standard error) in different sexes, genotypes and generation of selection

Factor	Level	242 days EP (no.)	242 days EP rate (%)	315 days EP (no.)	315 days EP rate (%)
Genotype	ND	51.7 ^a ±0.5 (584)	58.7 ^a ±0.5 (584)	83.9 ^a ±1.1 (388)	52.1 ^a ±0.6 (388)
	H	43.2 ^c ±0.7 (291)	49.1 ^c ±0.8 (291)	76.2 ^b ±1.4 (208)	47.3 ^b ±0.8 (208)
	NN	45.4 ^b ±0.9 (293)	51.6 ^b ±1.0 (293)	74.0 ^b ±1.5 (209)	46.0 ^b ±0.9 (209)
Generation	G ₀	43.8 ^c ±0.6 (396)	49.7 ^c ±0.7 (396)	74.9 ^b ±1.0 (399)	46.5 ^b ±0.6 (399)
	G ₁	45.3 ^b ±0.7 (387)	51.4 ^b ±0.7 (385)	-	-
	G ₂	50.9 ^a ±0.9 (385)	57.9 ^a ±1.1 (385)	81.2 ^a ±1.1 (406)	50.4 ^a ±0.7 (406)
Overall mean		46.5±0.4 (1168)	52.9±0.5 (1168)	78.0±0.7 (805)	48.5±0.4 (805)
R ² of the model		0.944	0.944	0.945	0.945

Least squares means without a common superscript along the column within a factor differed significantly (p<0.05); Figure in the parenthesis indicate the number of observations.

Table 5. Variation of hen house (HHEP) and hen day egg production (HDEP) (least square mean ± standard error) in different sexes, genotypes and generation of selection

Factor		HDEP (%)	HHEP (%)
Genotype	ND	51.4 ^a ±0.4 (324)	49.7 ^a ±0.4 (324)
	H	44.0 ^c ±0.4 (324)	41.7 ^b ±0.4 (324)
	NN	48.1 ^b ±0.4 (324)	42.8 ^b ±0.4 (324)
Generation	G ₀	44.6 ^b ±0.3 (486)	41.4 ^b ±0.3 (486)
	G ₁	-	-
	G ₂	51.0 ^a ±0.3 (486)	48.1 ^a ±0.3 (486)
Overall mean		47.8±0.2 (972)	44.7±0.2 (972)
R ² of the model		0.970	0.967

Least squares means without a common superscript along the column within a factor differed significantly (p<0.05); Figure in the parenthesis indicate the number of observations.

Response to selection

Both male and female birds showed a considerable response to selection as observed in 8 weeks body weight (Table 6). As estimated, the expected response to selection of 8 weeks body weight was highest in H (53.98 g vs. 24.70 g) males and females compared to other genotypes.

Table 6. Expected response to selection in 8 weeks body weight (g) of indigenous chicken

Genotype	Sex	Response in G ₁	Response in G ₂	Average response
ND	M	57.91	49.26	52.03
	F	11.28	23.60	20.92
H	M	81.72	28.56	53.98
	F	34.30	12.34	24.70
NN	M	52.90	17.03	37.40
	F	14.89	7.26	12.43

Table 7 shows the expected selection responses for egg production to 280 days in G₀ and G₂ generations of three genotypes of chicken. The observed response in egg number over generations was 0.7% which was less than expected response.

The results indicated that the genetic improvement for egg production will be effective in selection and breeding program. It could be seen that the realized genetic gain in different genotypes was different from prediction. The possible reason for variable responses among genotypes could either be genotype and environment interaction or correlated responses. Another factor that may have contributed to the variability of response from generation to generation may also be due to varying seasons of hatching across generations.

Table 7. Expected response to selection for egg production (%) up to 280 days

Genotype	Response in G ₁	Response in G ₂	Observed response
ND	1.83	2.28	0.722
H	3.10	3.28	
NN	2.46	3.59	

As seen in Table 8, the responses to selection for egg weight at 40 weeks in ND were expected to be negative in G₁ and positive in G₂. The responses to selection for egg weight at 40 weeks in H were expected to be negative in both G₁ and G₂ generation. On the other hand, the responses to selection for egg weight at 40 weeks in NN were expected to be positive in both G₁ and G₂ generation. Nwagu *et al.* (2007) in their study estimated genetic change of average egg weight in female and male Rhode Island chicken to be -0.89 and -0.43 g, respectively per generation which partially agrees with the results of this study (-0.01 to 0.68 g after two generations). The results imply that the genetic improvement for the trait is possible only for NN genotype of chicken.

Table 8. Expected response to selection for egg weight (g) at 40 week

Genotype	Response in G ₁	Response in G ₂
ND	-0.07	0.10
H	-0.05	-0.01
NN	0.01	0.68

*ND=Non-descript Deshi; H=Hilly; NN=Naked Neck; G₀ = Foundation stock; G₂ = Second generation

CONCLUSION

Non-descript Deshi chicken has a potential in improving for egg production purposes whereas Hilly chicken will be suitable for meat purposes. Reproductive performance of Non-descript Deshi chicken is comparatively better than those of other two genotypes. The study of responses to selection in progressive generations revealed that genetic gain by selection of birds on the basis of 8 weeks body weight will be effective for Hilly and Naked Neck genotypes, although there appears a decreasing trend of genetic gain. Response to selection for egg production trait will be effective for Non-descript Deshi and Naked Neck. Selection of birds on the basis of egg weight at 40 weeks will not be effective for Non-descript Deshi and Hilly genotype, although it will be effective only for Naked Neck genotype.

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