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Effect of Breeding Strategies to Increase Productivity of Indigenous Chicken *in-situ* in Bangladesh

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ABSTRACT. *Performance of three generation (G_0,G_1 and G_2)of indigenous chicken was evaluated to assess the effect of breeding strategies on the productivity. Data on age at sexual maturity (ASM), body weight at sexual maturity (BWM), body weight at one year of age (BWY), eggs per clutch (EGC), clutches per year (CLY), hatchability on set eggs basis (HAT) and survivability of baby chicks up to sexual maturity (SUR) were collected from a total of 1392 birds reared in four rural villages under traditional scavenging system during December 2010 to June 2013. The birds belong to three generations (G_0, G_1 and G_2) and are from three breeding strategies (BS_1 use of only pure and superior indigenous mature cocks, BS_2 use of pure and superior indigenous mature cocks and mature hens and BS_3 use of existing or random indigenous cocks and hens). In G_2, the lowest ASM of male birds (156.56±3.39 days) was observed and the highest in BS_2, whereas in BS_3 high BWM and BWY of male (1200.00±19.99; 1779.63±27.20 gm) and female (994.48±10.86; 1350.38±14.46 gm) birds were observed in BS_2. However, in G_2 the highest EGC (14.97±0.20), CLY (4.53±0.05) and HAT (89.79±0.96%) were observed in BS_1 but the highest SUR (51.15±2.36%) was documented in BS_3. Present study revealed that use of superior Indigenous mature cocks alone and exercising cock rotation program can help to increase egg production, hatchability and decrease ASM of female birds of progressive generations in rural low input system. On the other hand, use of both superior Indigenous mature cocks and hens at a time at farmers end and exercising cock rotation program can help to improve body weight in rural low input system.*

Keywords: *Bangladesh, breeding strategies, indigenous chicken, productivity in- situ*

INTRODUCTION

The contribution of the livestock and poultry sub sector in GDP at constant price is 2.5 percent in the financial year 2011-12 in Bangladesh. Though the share of the Livestock and poultry sub sector in GDP is small, but it has enormous contribution to meet the daily animal protein requirements for human consumption (MoFL, 2013). Islam *et al.* (2012) found the average number of chickens per household was 9.5, and the national share of commercial and family poultry in terms of egg production is probably almost equal and that of meat production is 60:40 (Bhuiyan, 2011). However, indigenous and local breeds share 90% of the total poultry population in developing countries (Besbes, 2009). According to the estimate of

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the Department of Livestock Services, the population of Livestock and Poultry were 53.21 million and 296.26 million, respectively but among poultry the number of chickens and ducks were 249.01 million and 47.25 million, respectively in 2012-13 (MoFL, 2013). On the other hand, according to MoFL (2013) per capita availability of milk, meat (beef, mutton and chicken) and eggs in Bangladesh were 91.03 ml/head/day, 65.03 gm/head/day and 50.00 nos/head/year respectively where FAO recommended per capita requirement for the same commodities were 250 ml/head/day, 120 gm/head/day and 104.00 nos/head/year, respectively. This huge gap between demand and supply of animal protein as eggs and meat could be minimized by poultry keeping (Das *et al*., 2008).

FAO (2010) observed that among several ways like buying a cock to mate with the existing hens, record-based selection of the hens or buying high-yielding cross-bred chicks for meat or egg production, cock-improvement programme is the most common to influence the smallholder farmers for better production. Higher egg production, body weight gain and low mortality were observed in crossbred of RIR x Fayoumi (Sonali) among four different breed/breed combination under a semi scavenging production system but good management, availability of scavenging feed and rate of feed supplementation were the prerequisite of better performances (Zaman, 2003) though, high-yielding hens often show high levels of cannibalism and feather pecking in free ranging production systems (Sorensen, 2001). However, indigenous chicken perform better with respect to survivability, fertility and hatchability though, they have poor productivity under traditional or extensive production system. The low productivity does not encourage farmers to increase the present level of poultry operation (Huque and Haque 1990; Barua *et al.,* 1998; Islam, 2006). In contrast, improved exotic chickens produce high number of eggs and amount of meat while they are not adapted to the adverse environmental conditions, such as high temperature, disease and shortage of feed (Ali *et al.,* 2000; Islam and Nishibori, 2009). The FAO (2010) suggested that the low input/output smallholder system would continue to exist in many parts of the developing world, sustainable progress in productivity of 2 - 4 percent per year will be possible using local chickens.

The demand of indigenous chicken is sky rising and exotic hybrid are not performing up to expected standards in rural village conditions creating a big gap between demand and supply. Breeding efforts to improve Bangladesh chicken genetic resources have been undertaken mainly through an upgrading and/or crossbreeding programme under intensive and semi-intensive production systems but with the indigenous Deshi chicken improvement and conservation programme at the smallholder village levels (*in-situ*) is yet to be tested (Bhuiyan *et al.* 2005). However, high demand of indigenous (Deshi) cockerels for the tenderness and special taste of their meat was observed (Ahmed and Ali, 2007). Barua and Howlider (1990) found non-descript Deshi chicken more acceptable to rural people as an important source of meat and egg because of low nutritional demand and high resistance to diseases and heat stress shown by Deshi chicken. Moreover, Chowdhury (2012) observed that indigenous chicken were popular among rural, peri-urban and urban people and were usually sold at double the price or even more of the commercial strains of broilers. Nevertheless, under traditional husbandry system indigenous chicken found better matched to the economy of poor livestock keepers in Bangladesh (Bhuiyan, 2011). Hence, local chicken production was an established component of the rural economy and necessity for its development is obvious (Kperegbeyi *et al.,* 2009). The objective of this study was to assess the effect of three breeding strategies on the changes in productivity of indigenous chicken of progressive generations in the low input production system in Bangladesh.

METHODOLOGY

Location of study

Data were collected from four villages namely, Rangtia (25°22′ N & 90°09′ E), Shalchura (25°21′ N & 90°08′ E), Dudhnoi (25°18′ N & 90°09′ E) and Bangaon (25°16′ N & 90°09′ E) of Jhenaigati upazila under Sherpur district in Bangladesh. Global Positioning System (etrex, VENTURE HC, GARMIN) was used to mark the locations of villages.

Feeding, vaccination and de-worming of chicken

Birds were raised under traditional scavenging system with feed supplementation (40 to 50 gm/hen or cock). Feed ingredients such as rice *kura*, rice polish, rice bran, broken rice, wheat, kitchen waste, boiled rice with or without water and table salt separately or in a mixer were includes in this diet. Regular vaccinations against Newcastle and Fowl pox diseases were done as per manufacturer's instruction and de-worming was also done in a regular interval of 4 months period.

Alternate breeding strategies

Breeding strategy one (BS_1)

Superior mature cocks were collected from the indigenous chicken gene pool of Bangladesh Livestock Research Institute (BLRI). BLRI cocks possessed a standard body weight of 1500 to 1900 gm, at age 210 days to 224 days, also they were free from disease deformations, regularly vaccinated and de-wormed, alert and responsive. BLRI birds were comparatively better performing than the locally found indigenous cocks. Forty households (HHs) were included in this study and a total of 481 birds of generation zero (G_0), one (G_1) and two (G_2) were individually evaluated. Only pure and superior indigenous mature cocks were distributed among HHs and successive generations of chicks were produced. The superior cocks distributed to each village were rotated in G_1 and G_2 among the households to avoid the full sib and half sib mating.

Breeding strategy two (BS_2)

Pure and superior indigenous mature cocks and mature hens were distributed and successive generations of chicks were produced. Forty HHs were taken under this study and a total of 488 birds of G_0, G_1 and G_2 were individually evaluated. Criteria which were used to select superior indigenous mature hens were: appearance, alert and responsive, disease conditions pelvis width (above 20 mm), age (not over 210 days) and body weight (not less than 800 gm). The criteria of superior cocks were same as described under BS_1. Cocks were rotated in G_1 and G_2 among the households to avoid the full sib and half sib mating.

Breeding strategy three (BS_3)

Existing or traditional system of breeding of indigenous chicken (mature cocks and mature hens roam together under scavenging system) available at farmers' houses were used and successive generations of progeny were produced. Forty HHs were considered in this study and a total of 423 birds of G_0, G_1 and G_2 were individually evaluated.

Traits recorded

ASM: The age on which a male bird took part in mating was considered as the ASM of male bird while the age on which a female bird laid her first egg was calculated as the ASM of female bird.

BWM and BWY: Live BWM and BWY were taken using a 5 kg weighing balance (CAMRY, CHINA.).

EGC: Number of eggs laid by a hen at a single start until becomes broody with or without gap for one or two days was calculated as eggs per clutch.

CLY: Mean clutch intervals from three consecutive clutches of egg production were used to calculate the number of CLY. Clutch interval between two clutches is a period of days from start of lay for one clutch to the start of lay for the immediate next clutch.

The formula used in calculating CLY is given in Equation 1.

$$\text{CLY} = \frac{\text{365 days}}{\text{Mean clutch interval in days}} \quad \text{........................ Eg 1}$$

HAT and SUR: HAT and SUR were calculated using Equations 2 and 3.

$$\text{HAT} = \frac{\text{Number of day old chicks hatched out}}{\text{Number of eggs set}} \times 100 \quad \text{................. Eg 2}$$

$$\text{SUR} = \frac{\text{Number of birds survived up to ASM}}{\text{Number of day old chicks hatched out}} \times 100 \quad \text{................. Eg 3}$$

Data collection and analysis

Birds were individually identified using leg and wing bands. Data were collected with the help of an in-depth data collection format developed by GEF Asia project by door to door visit. Farmers were given orientation on the use of data collection sheet for egg laying and hatching information, and periodical visits were made to verify the collected information. Body weight and other information were collected by direct visit to farmer's house. SAS (2006) software was used to calculate descriptive statistics and Duncan Multiple Range Test (DMRT) results on ASM, BWM, BWY, EGC, CLY, HAT and SUR. The least squares means were obtained in SAS GLM using the following generalized linear model:

$$Y_{ijk} = \mu + B_i + G_j + e_{ijk}$$

Where, Y_{ijk} = Dependent variables (ASM, BWM, BWY, EGC, CLY, HAT and SUR)

μ = Overall population mean for any of the said traits;

B_i = Effect of i^{th} breeding strategy (where i = 1, 2 and 3),

G_j = Effect of j^{th} generation (where j = 0, 1 and 2)

e_{ijk} = Random residual error associated with Y_{ijk} observation.

RESULTS AND DISCUSSION

Under BS_1 and $BS_{2,}$ ASM of female birds decreased from G_1 to G_2 but in $BS_{3,}$ ASM increased from G_1 to G_2 (Table 1). Moreover, in $G_{2,}$ ASM were lower in BS_1 (168.50±1.12) than BS_2 (169.63±1.05). This result indicated that BS_1 could have contributed more to early maturity of female birds of progressive generations under traditional scavenging production system at rural villages than BS_2 and $BS_{3.}$

Table 1. Age at sexual maturity (ASM) of Indigenous chicken in different generations under different breeding strategies (number of observations are given in the parenthesis)

Sex		G_0	G_1	G_2	LS
Male	BS_1	164.32±1.17 (38)	160.00±2.22 (32)	159.60±2.81 (25)	NS
	BS_2	163.76^b±1.14 (38)	160.82^a±1.93 (33)	160.63^a±2.51 (27)	*
	BS_3	168.57^c±1.85 (37)	156.44^a±2.95 (27)	156.56^b±3.39 (18)	**
	LS	NS	NS	NS	
Female	BS_1	188.19^c±0.59 (156)	169.69^b±1.15 (127)	168.50^a±1.12 (103)	***
	BS_2	187.56^c±0.59 (156)	170.53^b±0.99 (129)	169.63^a±1.05(105)	***
	BS_3	188.64^c±0.66 (154)	169.13^a±1.21 (113)	169.53^b±1.56 (74)	***
	LS	NS	NS	NS	

Note: LS=Level of significance, NS= Not Significant (P>0.05), *significance at 1.1 to 5%, **significance at 0.1 to 1% and ***significance at lower than 0.1%, [abc]Means with the different superscripts differed significantly within the row (P<0.05).

Breeding strategy did not effect on ASM of male and female birds significantly in $G_{0,}$ G_1 and G_2 (Table 1). The observation of ASM (156.44±2.95 to 188.19±0.59 days) at present study were very close to Kalita *et al*. (2009) (160.63±4.61 to 177.27±4.88 days) but lower than Bhuiyan *et al*. (2005) (175 to 234 days) and Benabdeljelil *et al*. (2001) (29 weeks / 203 days) in semi scavenging condition. In $BS_{2,}$ ASM of male birds between G_1 and G_2 did not differ significantly. Though, ASM of male birds was the lowest in BS_3 in $G_{2,}$ it was even lower in G_1. Therefore, it is remaining unclear whether BS_3 has shortened the ASM of male in progressive generations or not. The findings of the present study indicated that breeding strategy did not contribute significantly to ASM of male birds in progressive generations.

Breeding strategy (BS) affect significantly on BWM of female birds (Table 2) in G_0 and G_2 but not on those in $G_{1.}$ However, BWM of female birds were higher in BS_2 than those reported by Kalita *et al*. (2009) (body weight of indigenous chickens 740.00±11.67 gm to 862.25±17.31 gm at the age of 5 months) but lower than those reported by Daikwo *et al.* (2011) (1.05±0.02 kg). The BWM of female birds were higher in BS_2 than BS_1 and BS_3 in both G_1 and G_2 Hence, the present observation indicated that BS_2 could contribute more to increase BWM of female birds of progressive generations at in-situ under traditional scavenging production system at rural villages than BS_1 and $BS_{3.}$

Table 2. Body weight at sexual maturity (BWM) of Indigenous chicken in different generations under different breeding strategies (number of observations are given in the parenthesis)

Sex		G_0	G_1	G_2	LS
Male	BS_1	1427.63^{ax}±9.90 (38)	1009.06^{cy}±24.11 (32)	1089.06^{by}±23.29(25)	***
	BS_2	1413.16^{y}±7.68 (38)	1159.39^{x}±29.07 (33)	1200.00^{x}±19.99 (27)	NS
	BS_3	788.11^{z}±13.07 (37)	765.56^{z}±15.31 (27)	767.22^{z}±21.54 (18)	NS
	LS	***	***	***	
Female	BS_1	839.62^{y}±11.04 (156)	883.86±8.70 (127)	918.83^{y}±9.22 (103)	NS
	BS_2	909.42^{x}±9.39 (156)	942.71±9.46 (129)	994.48^{x}±10.86 (105)	NS
	BS_3	807.79^{z}±9.33 (154)	805.40±12.33 (113)	818.78^{z}±16.57 (74)	NS
	LS	***	NS	***	

Note: LS=Level of significance. NS= Not Significant and ***significance at lower than 0.1%, ^{xyz}Means with the different superscripts differed significantly within the column (P<0.05). ^{abc}Means with the different superscripts differed significantly within the row (P<0.05).

Breeding strategy (BS) affected significantly on BWM of male birds in G_0, G_1 and G_2 (Table 2). BWM of male birds in BS_1 (1427.63±9.90 gm) and BS_2 (1413.16±7.68 gm) were higher than BS_3 in G_0 and also the value reported by Daikwo *et al.* (2011) (1.32±0.02 kg).The BWM were higher in BS_2 in G_1 than BS_1 and BS_3 and similarly the BWM were higher in BS_2 (1200.00±19.99 gm) in G_2 than BS_1 and BS_3. The results indicated that BS_2 could have contributed more to increase BWM of male birds in progressive generations under traditional scavenging production system at rural villages than those contributed by BS_1 and $BS_{3.}$

Breeding strategy affected significantly of BWY of female birds in G_0, G_1 and G_2 (Table 3). In G_1 BWY of female birds were higher in BS_2 than BS_1 and BS_3. Similarly, in G_2 BWY were higher in BS_2 (1350.38±14.46 gm) than BS_1 and BS_3. It might be indicative that BS_2 could contribute more to increase BWY of female birds of progressive generations under traditional scavenging production system at rural villages than those contribute by BS_1 and $BS_{3.}$

Table 3. Body weight at one year of age (BWY) of male and female birds in different generations under different breeding strategies (number of observations are given in the parenthesis)

Sex		G_0	G_1	G_2	LS
Male	BS_1	2061.32^{ay}±23.90(38)	1618.44^{cy}±31.35 (32)	1706.00^{by}±26.67 (25)	***
	BS_2	2161.58^{ax}±21.59 (38)	1691.21^{cx}±26.33 (33)	1779.63^{bx}±27.20 (27)	***
	BS_3	1020.81^{z}±17.42 (37)	1075.56^{z}±21.88 (27)	1099.44^{z}±35.06 (18)	NS
	LS	***	***	***	
Female	BS_1	1073.91^{cy}±13.67 (156)	1189.13^{by}±10.92 (127)	1239.03^{ay}±12.33 (103)	*
	BS_2	1245.96^{x}±12.56 (156)	1308.68^{x}±14.70 (129)	1350.38^{x}±14.46 (105)	NS
	BS_3	1002.79^{z}±9.76 (154)	1040.53^{z}±11.51 (113)	1049.05^{c}±16.45 (74)	NS
	LS	***	***	***	

Note: LS=Level of significance, NS= Not Significant, *significance at 1.1 to 5% and ***significance at lower than 0.1%. ^{xyz}Means with the different superscripts differed significantly within the column (P<0.05). ^{abc}Means with the different superscripts differed significantly within the row (P<0.05).

Breeding strategy (BS) affected significantly on BWY of male birds in G_0, G_1 and G (Table 3). BWY of male birds increased from G_1 to G_2 in both BS_1 and BS_2 while there were no significant changes observed in BS_3. BWY in G_0, in BS_1 and BS_2 were close to the live weight of cocks as reported by Portas *et al.* (2010). However, BWY of male birds were the highest in BS_2 in G_1, and similarly BWY were the highest in BS_2 (1779.63±27.20 gm) in G_2. This result indicates that BS_2 could contribute more to BWY of male birds of progressive generations under traditional scavenging production system at rural villages than BS_1 and BS_3.

Breeding strategy (BS) affected significantly on EGC (Table 4) only in G_1 and G_2.. EGC in BS_3 (12.02±0.11 to12.25±0.17) were similar to the observation made by Portas *et al.* (2010) (10-12 eggs/clutches) and Benabdeljelil *et al.* (2001) (13.5 eggs/ clutch) However, EGC in BS_1 and BS_2 in G_1 and G_2 were in line with the observations made by Islam *et al.* (2012) (15.7±1.24 eggs/clutch) and Shahjahan *et al.* (2011) (15.45 eggs/clutch). EGC were higher in BS_1 than BS_2 and BS_3 both in G_1 and G_2. This observation clearly indicates that BS_1 contribute heavily to increase EGC of progressive generations under traditional scavenging production system at rural villages than BS_2 and BS_3.

Table 4. Eggs per clutch (EGC) and clutches per year (CLY) of Indigenous chicken in different generations under different breeding strategies (number of observations are given in the parenthesis)

Trait		G_0	G_1	G_2	LS
EGC	BS_1	11.96^{c}±0.10 (156)	14.39^{bx}±0.17 (127)	14.97^{ax}±0.20 (103)	***
	BS_2	12.17^{c}±0.10 (156)	14.26^{by}±0.16 (129)	14.86^{ay}±0.22 (105)	***
	BS_3	12.02±0.11 (154)	12.09^{z}±0.13 (113)	12.25^{z}±0.17 (74)	NS
	LS	NS	***	***	
CLY	BS_1	4.56^{x}±0.08 (156)	4.52±0.05 (129)	4.53^{x}±0.05(103)	NS
	BS_2	4.38^{y}±0.08 (156)	4.44±0.05 (129)	4.46^{y}±0.05 (105)	NS
	BS_3	4.12^{z}±0.07 (154)	4.17±0.06 (113)	4.14^{z}±0.07 (74)	NS
	LS	**	NS	*	

Note: LS= Level of significance, NS= Not Significant, *significance at 1.1 to 5%, **significance at 0.1 to 1% and ***significance at lower than 0.1%. ^{xyz}Means with the different superscripts differed significantly within the column (P<0.05). ^{abc}Means with the different superscripts differed significantly within the row P<0.05).

Clutches per year differed significantly with BS (Table 4) in G_0 and G_2 but did not change in G_1. However, CLY did not change significantly among generations. The CLY observed in the present study were higher than that was reported by Islam *et al.* (2012) (3.4±0.25 clutches/year) and Shahjahan *et al.* (2011) (3.50 clutches/year). Present study showed that CLY were the highest in BS_1. Moreover, the highest CLY in BS_1 were observed (4.53±0.05) in G_2. The present results suggest that BS_1 could have contributed to increase CLY of progressive generations under traditional scavenging production system at rural villages.

Hatchability (HAT) has got affected significantly by BS (Table 5) within generation among generations. The value of HAT in BS_3 observed in the present study (79.99±1.08 % to 82.01±1.42 %) were similar to Kalita et *al*. (2009) and (70 -81 %) Portas *et al.* (2010). However, the HAT observed in BS_1 and BS_2 were higher than Azharul *et al*. (2005) (on fertile egg basis hatchability; 87 %). However, HAT was higher in BS_1 than BS_2 and BS_3 both in G_1 and G_2. According to the present results, it could be suggested that BS_1 could have contributed more than BS_1 and BS_2 to increase HAT of progressive generations under traditional scavenging production system at rural villages.

Table 5. Hatchability on set egg basis in percent (HAT) and survivability (SUR) of baby chicks up to age of sexual maturity of Indigenous chicken in different generations under different breeding strategies (number of observations are given in the parenthesis)

Trait		G_0	G_1	G_2	LS
HAT	BS_1	87.31^y±0.57 (156)	89.98^x±0.70 (127)	89.79^x±0.96 (103)	NS
	BS_2	87.98^x±0.61 (156)	89.35^y±0.65 (129)	89.01^y±0.71 (105)	NS
	BS_3	79.99^z±1.08 (154)	80.70^z±1.19 (113)	82.01^z±1.42 (74)	NS
	LS	**	**	***	
Trait		G_1	G_2	G_3	LS
SUR	BS_1	49.36±1.37 (156)	48.41±1.23 (127)	48.93±1.14 (103)	NS
	BS_2	46.55±1.36 (156)	48.89±1.52 (129)	49.48±1.54 (105)	NS
	BS_3	49.01±2.11 (154)	48.58±1.73 (113)	51.15±2.36 (74)	NS
	LS	NS	NS	NS	

Note: NS= Not Significant, **significance at 0.1 to 1% and ***significance at lower than 0.1%. . ^{xyz}Means with the different superscripts differed significantly within the column (P<0.05).

Neither the breeding strategies nor the generations affected SUR significantly (Table 5). However, SUR (46.55±1.36 to 51.15±2.36 %) observed in the present study were higher than those observed by Portas *et al.* (2010) (10 % to 13 % up to age of eight weeks) and Choprakarn (2007) (30 % up to one year of age in semi scavenging condition). Results of the present study suggest that BS could not contribute to the survivability of chicks.

CONCLUSIONS

Present study revealed that use of superior Indigenous mature cocks alone and exercising cock rotation program could help to increase eggs per clutch, clutches per year, hatchability and decrease age at sexual maturity of female birds in progressive generations in rural low input system. On the other hand, use of both superior indigenous mature cocks and hens at a time and exercising cock rotation program could help to improve body weight at sexual maturity and body weight at one year of age of Indigenous scavenging chicken of Bangladesh.

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