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# Identification of best performer hilly chickens of Bangladesh in consideration of climate change factors: light and heat

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ABSTRACT

The best performer hilly chickens in consideration of light and heat were assessed under rural conditions. Based on the survey, the chickens and farm household were selected. The chickens were provided supplementations of concentrate feed (50g/chicken/day). The selected chickens were divided into 3 groups (heat stress, light and control) for the study of their egg production potential. Heat was generated in the chicken's shelter by keeping a black shaded light (Lantern) for 2 to 3 h more after sunset. A lighting device (Lantern) was kept in the chicken's shelter for 2 to 3 h more after sunset for increasing the duration of day light. Temperature and humidity index was calculated from the recorded temperature and humidity. The individual chicken's egg production, egg weight and mature live weight were studied for different types of hilly and non-descriptive desi chickens. It was observed that hilly chickens produced more eggs than desi. The hen house egg production percentage (19.95%) and yearly egg production (90 no/year/chicken) of desi white was significantly higher than spotted hilly (17.29% and 83.4 no egg, respectively) but reddish brown hilly type produced more number (100.80 no/year/chicken) of eggs than all types. The egg weight varied from 41.27 g to 43.85 g. Mature live weight were significantly different between hilly and desi (1438.70 g vs 1309.27 g). Among the 3 treatments, the lighting group hilly chickens produced 7.71 and 5.60 more eggs than control and heat stress group, respectively. One hour lighting length increased egg production by 4 to 5.8%.

**Key words**: Artificial light, Chicken types, Heat index, Traits

Heat stress is one of the most important environmental factors for poultry production. The effects of heat stress on broilers and laying hens are reduced growth and egg production with decreased poultry meat and egg quality (Lucas *et al.* 2013). Star *et al.* (2008) reported a reduction of 31.6% in feed conversion, 36.4% in egg production, and 3.41% in egg weight in laying hens subjected to heat stress. Similar findings were reported by Deng *et al.* (2012) for heat stress on laying hen. Day light has positive effects on feed intake and formation of eggs which leads to increased live weight and more eggs (Nayak *et al.* 2015). However, in Bangladesh there are still some remote areas where no electricity supply is available.

Among the different types of native chickens, the production potentialities of hilly chicken is relatively higher than other native chickens of Bangladesh (Khan *et al.* 2007). The hilly chickens under farmer's condition may have some different types that have not been properly assessed under various climate changes factors. Therefore, the current study was conducted with the objective to identify the best egg producers' hilly chickens in consideration of climate change factors (light and heat); and to select the best genotypes of hilly chickens for further improvement.

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## MATERIALS AND METHODS

The research work was conducted at the Chittagong Hill Tract (CHT) region of Bangladesh from February to September 2015. A baseline survey was conducted in the 194 households (those farmers who had at least 5 chickens) with a questionnaire. The phenotypic and morphological features of the chickens were recorded according to the criterion described by Khan *et al.* (2004) and Faruque *et al.* (2010). The chickens and farmers were categorized as per the phenotypic and morphological features of the chickens and on the basis of survey results. The chosen hilly chickens were identified and kept in the farmers' households. The selected chickens were maintained by providing some supplementations of concentrate feed (50g/chicken/day) having energy 2700 kcal/kg and 15.5% crude protein. Feed ingredients used were broken corn (38%), broken wheat (26.50%), rice polish (16%), soybean meal (14%), oyster shell (5%) and salt (0.5%). These feed ingredients were selected by allowing the chickens to scavenge the surrounding of the farmers' house where they pickup their

required feed while if there were any deficiencies of energy, protein, calcium and phosphorus that would be filled up from the supplements. The supplementary feeds were supplied to the farmers twice in a month from the commencement of the study and it continued up to the end of study. The farmers provided the feed ingredients twice daily (morning and afternoon) to the experimental chickens only with a temporary bamboo made fenced guard. The selected farmers were provided with necessary training for poultry rearing in two months interval.

The selected chickens were divided into 3 groups (heat stress, light and control) for studing the egg production potential. Fifteen farmers were selected for each treatment group. Heat was generated in the chicken's shelter by providing a black shaded light (Lantern) for 2 to 3 h more after sunset. A lighting device (Lantern) was kept in the chicken's shelter for 2 to 3 h more after sunset in order to increase the duration of day light. A control group was maintained for comparison of the effects of heat stress and light.

Temperature was recorded 3 times in a day by the analogue thermometer reading and average monthly temperature was calculated from the recorded data. The humidity data was collected from the weather broadcast. From the recorded temperature and humidity data, the temperature humidity index (THI) was calculated according to the NWS polynomial regression formula (Schoen 2005).

For all treatment groups, the egg production of the individual chickens of each type and treatment groups was recorded daily from the start of study up to 6 months (180 days). From this recorded data, monthly egg production, hen day egg production percentage and yearly egg production were calculated. More than 40 weeks aged chickens were considered as mature chicken. The mortality of the chickens was recorded routinely. Broodiness, nesting behavior and egg shell colour was observed for all chicken type and treatment groups.

*Statistical analysis:* Least square means were estimated from the collected data for egg production, egg weight, mature live weight and mortality according to treatments and chicken types and was analyzed by SAS (SAS 2008) using the following model.

$$Y_{ijkm} = \mu + T_i + F_k + I_{ik} + e_{ijkmn}$$

where, $Y_{ijkm}$, measurement of particular trait; $\mu$, population mean; $T_i$, effects of $i^{th}$ treatment (i = 1 and 3); $F_k$, effect of climate change factors (light or heat stress); $I_{lk}$, interaction effect of $l^{th}$ treatment and $k^{th}$ climatic factors; and $e_{ijkmn}$, random error associated with each record, distributed as N (0, $\sigma^2$).

The mean value was compared by using the Duncan Multiple Range Test (DMRT) at $P<0.05$ level of significance. Finally, the best category chickens were identified in consideration of heat and light (climate change factors) for further improvement.

## RESULTS AND DISCUSSION

*Selection of farmers and studied chickens*: The chicken types, composition, percentage of layer in each type, number of total chicken and layer per household are presented in Table 1. The Reddish Brown colour chickens' population, percentage, number of chicken and number of layer was higher than other type of chickens (Table 1). As per the plumage colour, shank colour and other body characteristics, it was indicated that the Reddish Brown and Spotted white and Black colour chickens were identified as hilly chicken. Other than these two types and naked neck chicken, all types are considered as non-descriptive desi. Khan *et al.* (2004) and Faruque *et al.* (2010) supported the current study, they described similar plumage colour for hilly chicken.

*Different traits according to types of chickens and treatments:* Monthly average egg production per chicken, mature live weight, egg weight and clutch size of chickens for hilly and non-descriptive desi chickens irrespective to treatment groups are presented in Table 2. It can be seen that for the egg production, hilly chickens (7.67 number/month/chicken) were better than non-descriptive deshi (6.85 number/month/chicken). The hen house egg production percentage and yearly egg production of desi white was significantly higher ($P<0.05$) than spotted hilly (17.29% and 83.4 number egg, respectively) but reddish brown hilly type produced more eggs (100.80 number/year/chicken) eggs (Table 2). The egg weight of various genotypes was ranging from 41.27 to 43.85 g. Significant difference ($P<0.05$) was observed for egg weight between non-descriptive desi grey with other genotype. In addition, significant differences ($P<0.05$) were found for mature live weight between hilly and non-descriptive desi. These findings were similar to Khan *et al.* (2004), who observed

Table 1. Chicken types' composition, percentage of layer in each type, number of total chicken and layer per household

| Parameter | Chicken types | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total hen | Total layer | Total cock | Totals chicks | Percentage of layer | Number of chicken/ household | Number of layer/ household |
| Reddish Brown | 1686 | 402 | 112 | 516 | 23.8 | 5.97 | 1.63 |
| Black | 634 | 172 | 46 | 144 | 27.98 | 3.52 | 1.34 |
| White | 560 | 56 | 118 | 132 | 10 | 3.64 | 1.22 |
| Spotted black and white | 910 | 128 | 96 | 330 | 14.05 | 4.69 | 1.94 |
| Brownish | 352 | 24 | 30 | 90 | 0.07 | 2.44 | 1.09 |
| Naked Neck | 8 | 6 | 14 | 18 | 75 | 1.33 | 1.00 |

Table 2. Egg production, egg weight and live weight of chicken according to plumage color

| Parameter | Breeds | | | | | SEM | P value |
|---|---|---|---|---|---|---|---|
| | Hilly | | Non descriptive Desi (ND) | | | | |
| | Reddish Brown | Spotted Black and White | Whitish | Grey | Black | | |
| Egg production (no/month/chicken) | 8.40$^{a}$ | 6.95$^{ab}$ | 7.30$^{ab}$ | 7.50$^{ab}$ | 5.77$^{b}$ | 0.426 | 0.023 |
| Hen house egg production (%) | 17.18$^{b}$ | 17.29$^{b}$ | 19.95$^{a}$ | 12.89$^{c}$ | 17.65$^{ab}$ | 1.143 | 0.010 |
| Egg production (no/year) | 100.80$^{a}$ | 83.40$^{ab}$ | 87.60$^{ab}$ | 90.00$^{ab}$ | 69.24$^{b}$ | 5.123 | 0.002 |
| Clutch size (no) | 11.99$^{ab}$ | 13.23$^{a}$ | 10.75$^{ab}$ | 5.27$^{c}$ | 9.50$^{b}$ | 1.368 | 0.001 |
| Egg weight (g) | 41.27$^{b}$ | 41.49$^{b}$ | 41.98$^{b}$ | 43.85$^{a}$ | 41.89$^{b}$ | 0.457 | 0.001 |
| Live weight (g) | 1440.60$^{a}$ | 1436.80$^{a}$ | 1277.80$^{b}$ | 1300$^{ab}$ | 1350a$^{b}$ | 33.797 | 0.014 |
| Mortality (%) | 20.00$^{b}$ | 16.75$^{b}$ | 15.80$^{b}$ | 30.50$^{a}$ | 18.20$^{b}$ | 2.658 | 0.025 |
| Egg colour | Brown and light brown | White and light brown | White | White | White | | - |

Means with different superscripts are different at 5% level of significance; SEM, standard error of mean.

Table 3. Egg production, egg weight and live weight of chicken according to treatment

| Parameter | Treatment | | | | | | SEM | P value |
|---|---|---|---|---|---|---|---|---|
| | Control | | Heat stress | | Light | | | |
| | Hilly | ND | Hilly | ND | Hilly | ND | | |
| Egg production (no/month) | 7.87$^{a}$ | 6.40$^{b}$ | 8.02$^{a}$ | 6.58$^{b}$ | 8.49$^{a}$ | 6.75$^{b}$ | 0.359 | 0.049 |
| Egg production (no/year) | 94.44$^{a}$ | 76.80$^{b}$ | 96.24$^{a}$ | 78.96$^{b}$ | 101.85$^{a}$ | 81.00$^{b}$ | 4.309 | 0.022 |
| Egg weight (g) | 41.45$^{b}$ | 41.66$^{b}$ | 39.26$^{c}$ | 41.97$^{ab}$ | 43.09$^{a}$ | 43.01$^{a}$ | 0.569 | 0.001 |
| Live weight (g) | 1425.60$^{b}$ | 1357.14$^{bc}$ | 1405.83$^{b}$ | 1381.25$^{b}$ | 1474.12$^{a}$ | 1312.50$^{c}$ | 22.884 | 0.016 |

Means with different superscripts are different at 5% level of significance; SEM, standard error of mean.

average female hilly chicken possessed 1489.44 g mature live weight and egg weight was 41.15 g. Barua and Howlider (1990) and Bairagi (1992) found that the average egg weight of non-descriptive desi chickens ranged from 30 to 40 g, and the average live weight of desi chicken was 1,000 to 1,200 g. This higher body weight of hilly chickens may be due to genetics.

The mortality of the chickens was about 15 to 30%. The grey colour desi chickens group had highest ($P<0.05$) mortality than other groups. The main causes for mortality were outbreak of diseases viz. New castle, fowl pox, fowl cholera, and predator attack on rearing chicken. The hilly people do not treat their diseased chickens. In addition, New castle disease vaccine are vaccinated to their chickens only once a year by the Department of Livestock Services (DLS) and poultry workers but this is not regular. The predator problems have arisen because their living house is near or within the hills and most of the hills are succumbed with predators like fox, wild cat, mongoose etc. All types of chicken showed broodiness and nesting behaviour and hatched their chicks.

The egg production, egg weight and mature live weight of hilly and non-descriptive desi chickens under three different treatment groups are presented in Table 3. All the 3 traits were better for artificial lighting group than heat stress and control group (Table 3). Heat stress and control group had the similar values for all the three traits. Heat stress reduces body weight, egg production and egg weight (Lucas *et al*. 2013, Deng *et al.* 2012).

The lighting group hilly chickens produced 7.71 and 5.60 more number of eggs than control and heat stress group and non-descriptive desi produced 4.0 and 3.04 more number of eggs than control and heat stress group, respectively. However no significant ($P>0.05$) differences were found between treatments within hilly and non-descriptive desi types. Nayak *et al.* (2015), Jacome *et al.* (2014) and Geo *et al.* (1998) reported that artificial light had positive effects on laying hen for egg production and live weight gain. Egg weight and live weight for artificial lighting group was also higher than other two treatments in both hilly and desi chicken types.

*Effects of lighting on different traits*: The effects of artificial lighting lengths on egg production, egg weight and mature live weight of hilly and non-descriptive desi chickens are presented in Table 4. The egg production, egg weight and mature live weight of both hilly and desi type's chickens increased with the augmentation of lighting duration from 10 to 14 h. There were significant ($P<0.05$)

Table 4. Egg production, egg weight and live weight of chicken according to lighting hour

| Parameter | Lighting hours | | | | | | | | | | | | SEM | P value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14 h | | 13.5 h | | 12.5 h | | 11.5 h | | 11.0 h | | 10.5 h | | | |
| | Hilly | ND | Hilly | ND | Hilly | ND | Hilly | ND | Hilly | ND | Hilly | ND | | |
| Egg production (no/month) | 9.1 | 6.3 | 7.9 | 5.3 | 8.0 | 8.5 | 7.9 | 7.3 | 7.8 | 5.6 | 9.3 | 7.5 | 0.363 | 0.011 |
| Egg production (no/year) | 108.6 | 75.0 | 94.3 | 63.9 | 96.0 | 102.0 | 95.4 | 87.6 | 93.48 | 67.2 | 111.9 | 90.0 | 4.347 | 0.013 |
| Egg weight (g) | 42.9 | 44.1 | 43.23 | 39.8 | 44.1 | 43.9 | 40.7 | 41.2 | 39.9 | 43.2 | 40.4 | 41.5 | 0.481 | 0.001 |
| Live weight (g) | 1390 | 1325 | 1508 | 1350 | 1300 | 1250 | 1378 | 1350 | 1444 | 1450 | 1400 | 1250 | 22.804 | 0.002 |

SEM, standard error of mean.

Table 5. Egg production, egg weight and live weight of chicken according to heat stress

| Parameter | THI | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 78.97 | | 79.43 | | 82.34 | | 83.39 | | 84.62 | | 84.94 | |
| | Hilly | ND | Hilly | ND | Hilly | ND | Hilly | ND | Hilly | ND | Hilly | ND |
| Egg production (no/month) | 8.41 | 4.50 | 9.00 | 6.50 | 12.33 | 7.00 | 9.56 | 7.67 | 10.5 | 8.0 | 9.48 | 5.50 |
| Egg weight (g) | 42.84 | 38.93 | 44.12 | 43.98 | 43.26 | 44.81 | 41.31 | 44.30 | 41.36 | 41.09 | 37.56 | 42.03 |
| Live weight (g) | 1487.50 | 1450 | 1300 | 1250 | 1428 | 1400 | 1449.09 | 1400 | 1363.64 | 1266.67 | 1463.64 | 1500 |

differences found between hilly and non-descriptive desi but within same chicken types, no differences were observed. One hour lighting length increased about 4 to 5.8% egg production and simultaneously other traits (egg weight, live weight) value also increased than control and heat stress group (Table 4). But, the increased day lengths were found to stimulate a reproductive response that helps to shed the eggs regularly. Similar results were reported by Nayak *et al.* (2015) and Jácome *et al.* (2014). Light effects the endocrine system that controls ovarian activity in females, and therefore, their reproductive and behavioural functions and secondary sexual characteristics (Morris 1973). However, in Bangladesh, there are still some remote areas without electricity supply, where cheap source lighting device like lantern can be used as lighting source. In this current study, lantern was used as a lighting source and the results showed it enhanced the production potentials of hilly chickens.

*Effects of heat stress on different traits*: The effects of heat stress i.e. is the temperature and humidity index (THI) on egg production, egg weight and mature live weight of hilly and non-descriptive desi chickens are presented in Table 5. With the increase of THI, the egg production, egg weight and mature live weight decreased (Table 5). Egg production was more affected than other two traits (egg weight and mature live weight). Hilly chickens were more susceptible than non-descriptive desi for heat stress. Up to THI 87, the egg production was similar for all types of chicken after which it sharply declined. This might be due to the effect of less feed intake. The feed intake was reduced with the maximization of THI. In this study, it can be noticed that about 19.68% egg production was decreased with the maximization on 3.83 THI value. The negative effects of heat stress on broilers and laying hens are reduced growth and egg production to decreased poultry meat and egg quality and their safety as reported by Lucas *et al.* (2013). In laying hen, heat stress depresses body weight (Scott and Balnave 1988), egg production (Deng *et al.* 2012) and egg weight (Ebeid *et al.* 2013). Ilker Kilic and Ercan Simsek (2013) reported that when THI values increased from 25–29, heat stress reduced egg production by 25% (Table 4).

Among the hilly chickens, reddish brown type produced more eggs than spotted black and desi white type. All types of chickens produced similar weight eggs but mature live weight differed between types. The lighting group hilly chickens produced 7.71 and 5.60 more number of eggs than control and heat stress group. Hilly chickens were more susceptible than non-descriptive desi for heat stress. Therefore, in consideration of the effects of temperature and humidity index, lighting duration and productivity, the reddish brown hilly type was identified better than all available types of chicken in hilly areas of Bangladesh. The selected types of hilly chicken (reddish brown and spotted black and white) can be incorporated in the structured genetic improvement programme for dual (egg and meat production) purpose. Such research will be helpful for researchers, academics, farmers and policy maker for undertaking research and developmental work on chickens for egg and meat purpose.

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