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A RESPONSE SURFACE MODEL TO PREDICT THE PROFITABILITY OF RAISING SMALL-SCALE FREE RANGE DOMESTIC PIGEON

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ABSTRACT: The study aimed to investigate the comparative profitability of raising different breeds of small-scale free range domestic pigeon in the Chattogram metropolitan area of Bangladesh. A cross-sectional survey was carried out for a period of three months from July to September 2021 using a structured questionnaire. Results indicated that there were no differences among the performance parameters of the non-descriptive, Gola and Giribaz breeds of pigeon. However, the non-descriptive breeds produced more eggs and thus squabs per year than the Gola and Giribaz. Similarly, the average pause size, feed supply per day and market age were lower in the local breeds compared with Gola and Giribaz. Hatchability percentage of the local breed was higher than the other breeds. Average mortality was moderately higher in the Giribaz. The average flock size was 4.9±0.70 pair. The average annual egg and squab productions were 20.6±1.10 and 10.7±1.00 pairs, respectively. The average daily feed supply was 37.8±1.5 g/bird. The average clutch and pause sizes were 2.0 and 17.3 day, respectively. Average market age, hatchability and mortality were 30.6±0.90 day, 51.4±2.20% and 7.6±1.6%, respectively. Mean feed and housing cost were 1008±24.7 and 443±42.8 Bangladeshi taka (BDT) per pair/year, respectively. Mean market price per pair adult and per squab was BDT 365±18.6 and 130±4.9, respectively. Flock size and pause size had strong positive and negative correlations with annual squab production. There were no significant differences between the net profit of the farms rearing different breeds of pigeon. However, farms raising local breeds had the highest annual net profit (BDT 823/pair) compared with other farms raising Giribaz (BDT 478/pair) and Gola breeds (BDT 319.70/pair). Principal component analysis identified annual egg production and feed cost as the principal eigenvector determining net profit. It was concluded that despite marginal profit, small-scale free range domestic pigeon farming was economically viable for the subsistence of the rural livelihoods.

Keywords: Free range, Giribaz, Gola, Pigeon, Profitability.

INTRODUCTION

The pigeon is a common title for the individuals of the expensive family 'Columbidae' characterized by strong body, long neck, little head and thick overwhelming plumage pattern (El-Haroun et al., 2008) who are related to human being since ancient time. They are the most common type of birds found almost everywhere on the planet (Marques et al., 2007). Pigeons are monogamous, extremely intelligent and complicated creatures of all the avian species (Silver et al., 1985). They coexist with humans as a source of food, hobby, income and research purposes (Levi, 2020). The 'squab', i.e., the young pigeon is a unique source of appetizing, delectable, easily digestible and elegant quality animal protein for human being. They are popular among the people of all faiths. The squab meat is low in cholesterol and high in protein, minerals and vitamins (Kokoszyński et al., 2020) which is thought to have therapeutic properties (Bu et al., 2018). The droppings of pigeon act as a source of bio-fertilizer for home gardening. Moreover, they are used in genetic and hormonal studies (Asaduzzaman et al., 2009). Rearing pigeon as a pet for recreation is becoming popular day by day. Hence, raising pigeon has been one of the popular businesses among the young generations (Maity et al., 2020; Ahamed et al., 2021).

Bangladesh has a long tradition of raising different backyard poultry species (Bhowmik et al., 2014) because of extensive tracts of croplands and housing facilities (Asaduzzaman et al., 2009). More than 60% of the rural households that raise poultry are also found to raise pigeons either commercially or as a hobby (Asaduzzaman et al., 2009). There are several popular breeds of pigeons, i.e., the King, Runt, Red Carneau, French Mondaine and Giant Homers used for squab production while the Fantail, Crowned, Jacobin, Pouter, Swallow, Bokhara trumpeter and Frill back are raised as

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ornamental breed in all over the world including Bangladesh. Flying or homer breeds, i.e., the Racing Homers, Rollers and Tumblers are possibly the most famous breeds used for endurance flying (Kabir, 2014). In Bangladesh, Giribaz is one of the subcontinent's oldest pigeon breeds. The other local breeds of pigeon available are Gola, Siraji, Serting and Mayouri (Islam, 2010).

Pigeon farming requires minimal capital investment, low feed and housing cost and simple husbandry practices. They have rapid reproductive turnover with minimum disease incidence. They can simply eat grains, i.e., mustard, wheat, rice, sorghum, corn, soy bean, peanut, fruits, insects, vegetables and grits (Canova, 2005; ChunQi et al., 2016). They can also rely on mixed crumble or blends of cereals, minerals, grits and water. Although small-scale domestic pigeon provides an alternative source of high-quality animal protein and household income generation, their contribution in family income has not yet been estimated through systematic studies. Therefore, we aimed to elucidate the comparative profitability of raising different breeds of pigeon in the Chattogram Metropolitan area of Bangladesh.

MATERIALS AND METHODS

Study design, area and duration

A cross-sectional survey was carried out for a period of three months from July to September 2021 using a structured questionnaire in the Chattogram Metropolitan area which is one of the epicenters of pigeon farming in Bangladesh.

Farm Selection

Total 10 different pigeon farms were selected where the main selection criteria were minimum one year of farming experience, availability of pigeon house, currently having at least 02 pairs of pigeon reared in backyard system, free family labor and no objection of the family members for keeping the pigeons.

Farmer's interview

Farmers were interviewed in their own premises by one DVM intern of Chattogram Veterinary and Animal Sciences University (CVASU). In order to get detailed information, interviewer interviewed only one farmer a day. It took around two hours to interview a respondent. An observation list was completed during the farm visit. Institutional approval for conducting interviews with the pigeon farmers was obtained from CVASU.

Data collection

Before, the field survey, a structured questionnaire and a survey protocol were developed to achieve targeted objectives of the study. After briefing the objectives of the interview, verbal and written consents of the respondents were taken. At least one week before starting the interview, the interviewer was given printed materials as guidelines for the survey. The questionnaire included data related to farmer's personal information (age, educational level, farming experience), breed, housing, feeding, management, egg and squab production, disease control, marketing and health of pigeon. Data were collected for 100 pigeons.

Statistical analysis

Raw data were compiled into Microsoft excel professional 2019 (Microsoft corporation, USA). Outliers and multi-collinearity in the data set were tested by inter quartile range test and variance inflation factors. Normality of the response variable was checked by Shapiro Wilk test. Profile plots were used to measure the interactions of the covariates. The data were analyzed by generalized linear model (GLM). Heatmap of multiple orthogonal contrasts were produced to check the dimensionality and strengths of the co-variates. Kaiser-Meyer-Olkin measures of sampling adequacy and Bartlett's test of sphericity were applied to test the suitability of the dataset for the principal component analysis. The linear regression and response surface models were fitted using SAS 16.2 (SAS Institute Inc.). When statistical effects were deemed significant ($P<0.05$), the Duncan's New Multiple Range Test (DMRT) was used to compare the means. All statistical tests were performed by using Stata 14.1 SE (Stata Corp LP, College Station, Texas, USA). The following model was used to estimate the effects of the predictors on dependent variables:

$$Y_{ijkln} = \mu_0 + \alpha_{ij} + \beta_{ik} + \gamma_{il} + \ldots\ldots \omega_{in} + \varepsilon_{ijlkn}$$

Where,

Y_{ijkln} = The observed effect of the trait 'i' at the 'j^{th}' level of the predictor 'α', the 'k^{th}' level of the predictor 'β', 'l^{th}' level of the predictor 'γ'.....and the 'n^{th}' level of the predictor 'ω';

μ_0 = The intercept of the regression model;

α_{ij} = The slope of the regression model for the trait 'i' at 'j^{th}' level of the predictor 'α' observed on Y_{ijkln};

β_{ik} = The slope of the regression model for the trait 'i' at 'k^{th}' level of the predictor 'β' observed on Y_{ijkln};

γ_{il} = The slope of the regression model for the trait 'i' at 'l^{th}' level of the predictor 'γ' observed on Y_{ijkln};

ω_{in} = The slope of the regression model for the trait 'i' at 'n^{th}' level of the predictor 'ω' observed on Y_{ijkln};

ε_{ijkln} = The random sampling error of the trait 'i' at the 'j^{th}' level of the predictor 'α', the 'k^{th}' level of the predictor 'β', 'l^{th}' of the predictor 'γ'.....the 'n^{th}' level of the predictor 'ω' which is distributed as $\varepsilon_i \sim NID(0,\sigma^2)$.

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RESULTS

Socio-economy

Age of the pigeon farmers ranged from 27 to 50 year in the study areas. The farmers were classified into two age groups, i.e., the young (25-40 year) and middle aged (41-55 year). It was evident that 90% of the farmers belonged to young group and only 10% of them were middle aged. Accordingly, based on educational qualification the farmers were further divided into three categories where 30% of them were graduate and above while another 30% received only primary education. Unfortunately, remaining 40% of the farmers were illiterate who belonged to middle-class family with annual income ranging from 12000-15000 Bangladeshi Taka (BDT).

Comparative indices

There were no differences (P>0.05) in the performance parameter of the non-descriptive, Gola and Giribaz breeds. However, the non-descriptive breed produced more eggs and thus squabs per year than the Gola and Giribaz although the differences were statistically not-significant (P>0.05). Similarly, the average pause size, feed supply per day and average market age were lower in the local breeds than the Gola and Giribaz (Table 1). Hatchability percentage of the local breed was higher (P>0.05) than the other breeds. Average mortality (%) was higher (P>0.05) in the Giribaz (Table 1).

Table 1 - Comparative performance of the three different breeds of pigeon in the Chattogram metropolitan area (N=100)

Variables \ Breeds	Local	Gola	Giribaz	SEM[1]	P-value
Flock size (pair)	3.00	5.60	5.00	0.67	0.388
Annual egg production (no/pair/y)	22.0	20.6	19.7	1.13	0.814
Annual squab production (no/pair)	12.3	10.6	10.0	1.02	0.779
Average clutch size (d)	2.00	2.00	2.00	0.00	-
Average pause size (d)	16.0	17.2	18.3	0.79	0.644
Feed supply (g/bird/d)	35.5	38.2	38.7	1.50	0.785
Average market age (d)	29.0	30.8	31.3	0.88	0.696
Hatchability (%)	55.7	50.3	50.5	2.24	0.687
Average mortality (%)	8.00	6.00	10.0	1.60	0.609

[1]SEM = Standard error of the means

Overall indices

The mean farming experience of the pigeon farmers was 2.6±0.06 year (CI=1.3-3.9) which ranged from 1-5 years (Table 2). The average flock size was 4.9±0.70 pair (CI=3.4-6.4). The average annual egg and squab productions were 20.6±1.10 (CI=18.0-23.2) and 10.7±1.00 (CI=8.4-13) pair, respectively. The mean quantity of the supplied feed to the pigeon was 37.8±1.5 g/bird/day (CI=34.4-41.2). The average clutch and pause sizes were 2.00 day and 17.3±0.80 day (CI=15.5-19.1), respectively. The average market age, hatchability and mortality were 30.6±0.90 day (CI=28.6-32.6), 51.4±2.20% (CI=46.3-56.5) and 7.6±1.6% (CI=4.0-11.2), respectively. The mean annual feed and housing costs were BDT 1008±24.7 (CI=949-1068) and 443±42.8 (CI=346-540) per pair, respectively, where market prices per pair adult and per squab were BDT 365±18.6 (CI=323-407) and 130±4.9 (CI=119-141), respectively. The heatmap showed the orthogonal correlation between different descriptive parameters (Figure 1). Strong positive correlations were evident among flock size, feed supply, hatchability and annual squab production (Figure 1). On the other hand, pause size had a strong negative correlation with the annual squab production. Despite maximum pause size, net profit was maximum while squab production reached at peak (Figure 2). Overall, annual egg production, flock size, farming experience and squab production contributed maximum net profit (Figures 1-5; Table 2-3).

Table 2 - Least square means of the common variables for the small-scale free range domestic pigeon farming (N=100)

Variables \ Descriptive statistics[1]	Min.	Max.	Mean	SEM	95% CI	
					Min.	Max.
Farming experience (y)	1.00	5.00	2.60	0.60	1.30	3.90
Flock size (pair)	2.00	9.00	4.90	0.70	3.40	6.40
Annual egg production (pair)	15.0	28.0	20.6	1.10	18.0	23.2
Annual squab production (pair)	8.00	18.5	10.7	1.00	8.40	13.0
Feed supply (g/bird/d)	32.0	47.0	37.8	1.50	34.4	41.2
Average clutch size (d)	2.00	2.00	2.00	-	-	-
Average pause size (d)	14.0	22.0	17.3	0.80	15.5	19.1
Average market age (d)	28.0	36.0	30.6	0.90	28.6	32.6
Hatchability (%)	42.0	66.1	51.4	2.20	46.3	56.5
Annual feed cost/pair (BDT)	864	1152	1008	24.7	949	1068
Market price per squab (BDT)	110	150	130	4.90	119	141
Market price per pair adult (BDT)	280	450	365	18.6	323	407
Average mortality (%)	2.00	18.0	7.60	1.60	4.00	11.2
Housing cost/pair/y	305	700	443	42.8	346	540

[1]Min= Minimum; Max= Maximum; SEM= Standard error of the means; CI= Confidence interval; [2]BDT = Bangladeshi taka (1 $USD=93.0 BDT)

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Table 3 - Component score of the intra and inter cluster regression co-efficient of the principal component analysis for the small-scale free range domestic pigeon farming (N=100)

Cluster	Members	R^2 with own cluster	R^2 with next closest	1-R^2 ratio
1	Annual egg production (no)	0.91	0.02	0.09
1	No. of pigeons (pair)	0.89	0.03	0.11
1	Farming experience (y)	0.86	0.01	0.15
1	Annual squab production (no)	0.84	0.04	0.17
1	Mortality (%)	0.39	0.08	0.66
2	Price per squab (BDT)	0.77	0.00	0.23
2	Market age (d)	0.77	0.01	0.23
2	Cost of feed (BDT)	0.74	0.13	0.29
2	Feed supply (g/bird/d)	0.56	0.08	0.48
2	Cost of housing (BDT)	0.32	0.07	0.73
3	Pause size (d)	0.83	0.08	0.19
3	Price per adult pair (BDT)	0.63	0.12	0.43
3	Hatchability (%)	0.59	0.25	0.54

[2]BDT = Bangladeshi taka (1 $USD = 93.0 BDT)

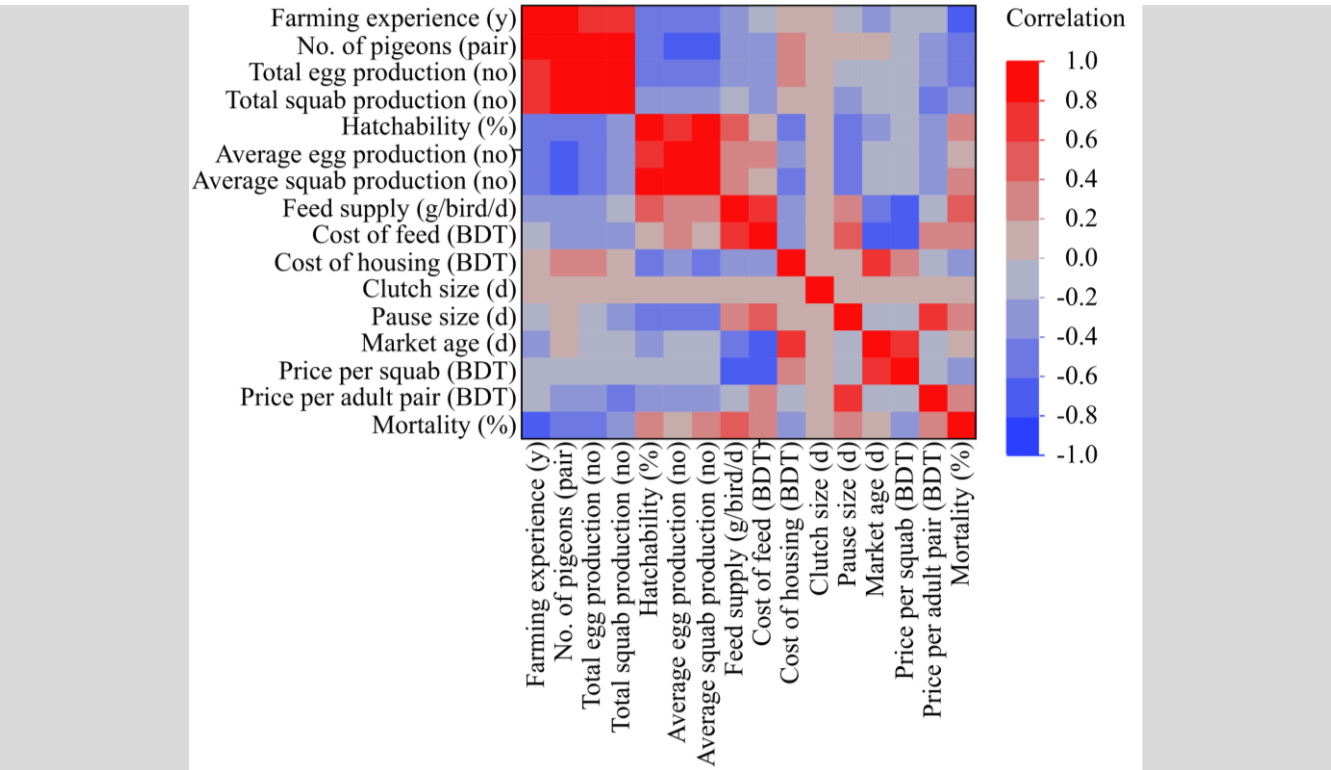

Figure 1 - Heatmap showing orthogonal contrasts of the production indices for the small-scale free range domestic pigeon farming in the Chattogram metropolitan area, Bangladesh (N=100)

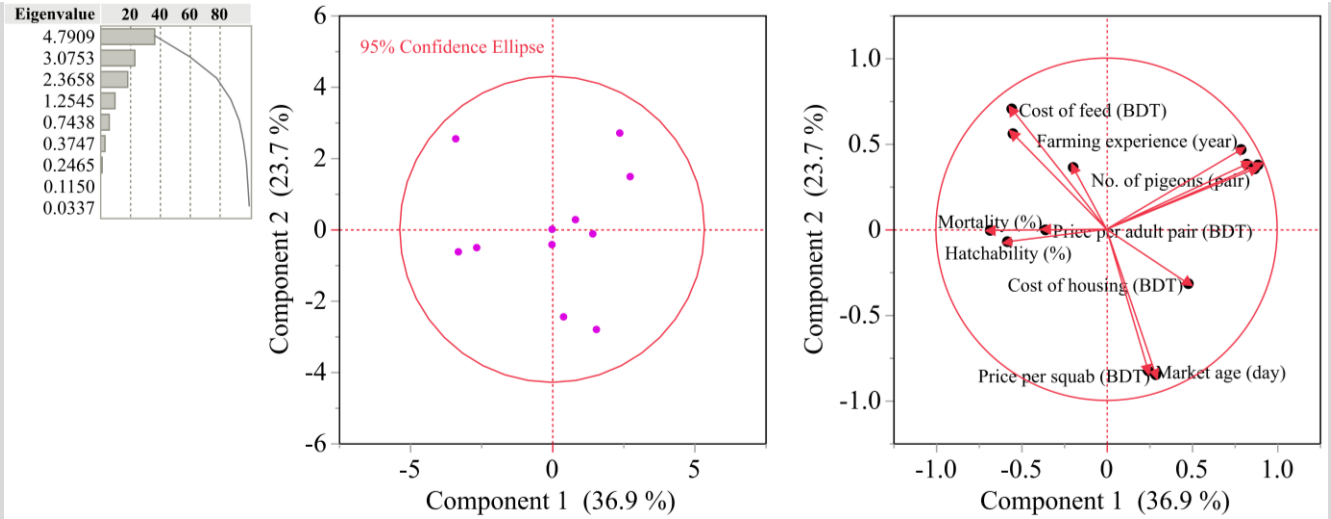

Figure 2 - Principal component analysis showing influence of the predictors on principal component 1 (36.9%; 'y' axis) and component 2 component 1 (23.7%; 'x' axis) for the small-scale free range domestic pigeon farming

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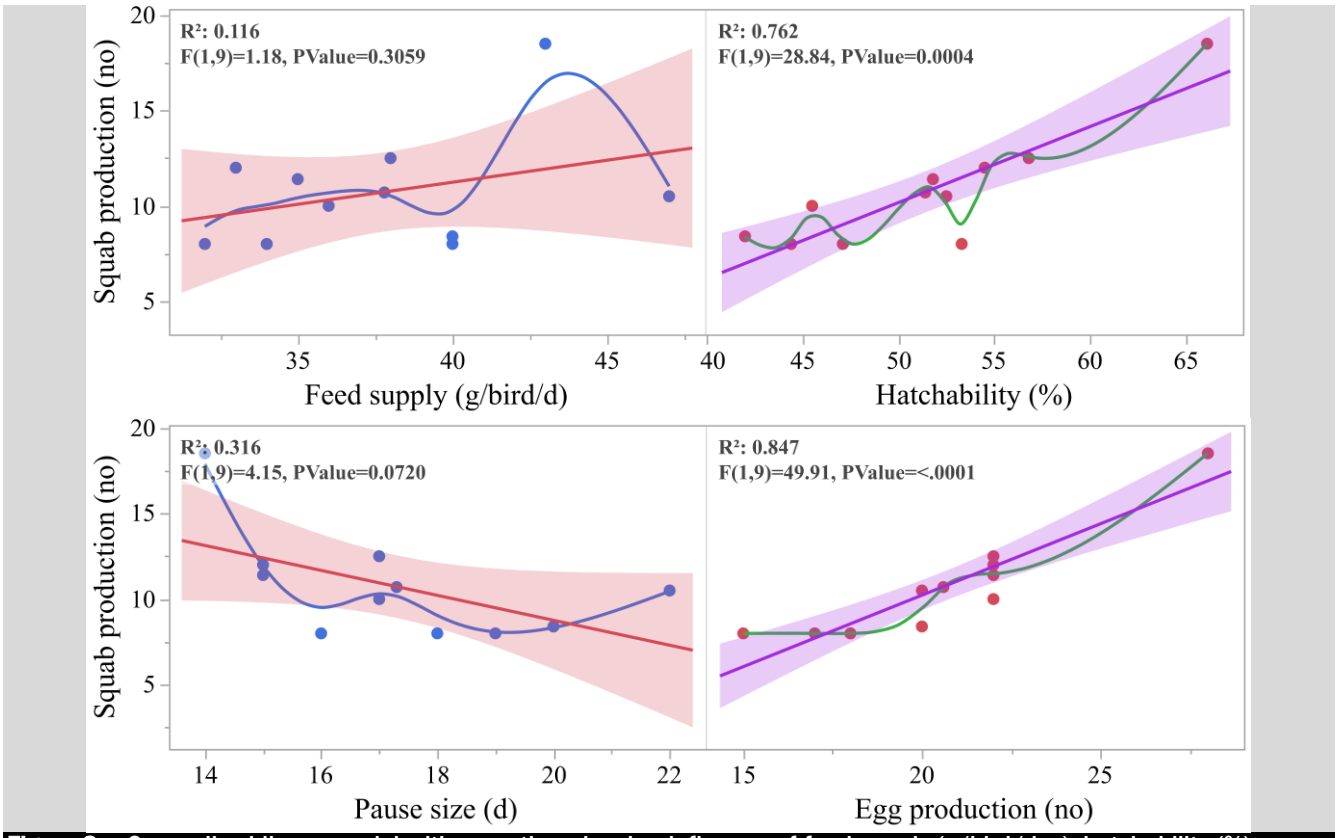

Figure 3 – Generalized linear model with smoother showing influence of feed supply (g/bird/day), hatchability (%), pause size (day) and egg production (no) on annual squab production (pair/couple) for the small-scale free range domestic pigeon farming in the Chattogram metropolitan area, Bangladesh (N=100).

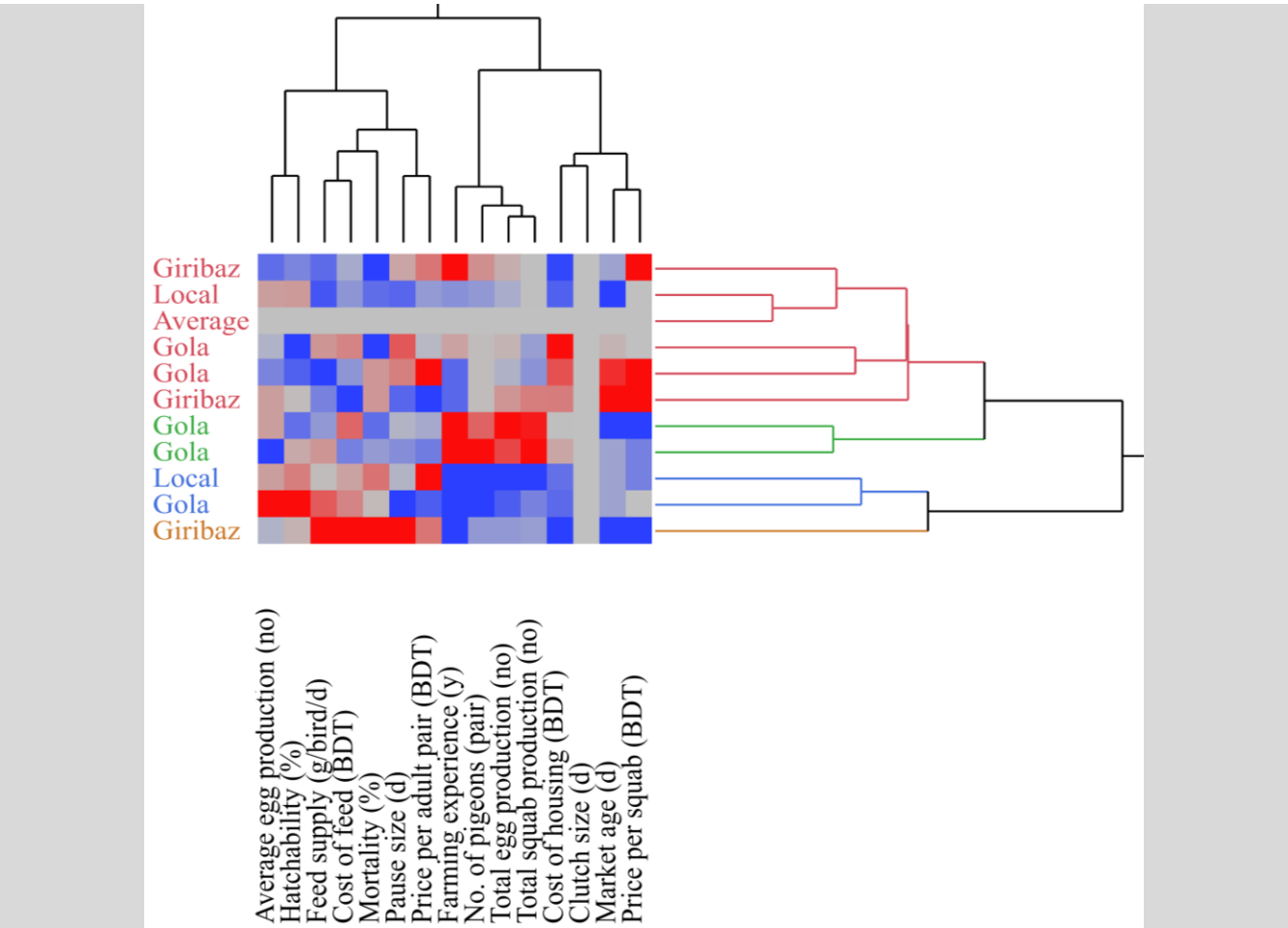

Figure 4 - Hierarchical cluster analysis showing group similar cluster of the performance indices for the small-scale free range domestic pigeon farming (N=100).

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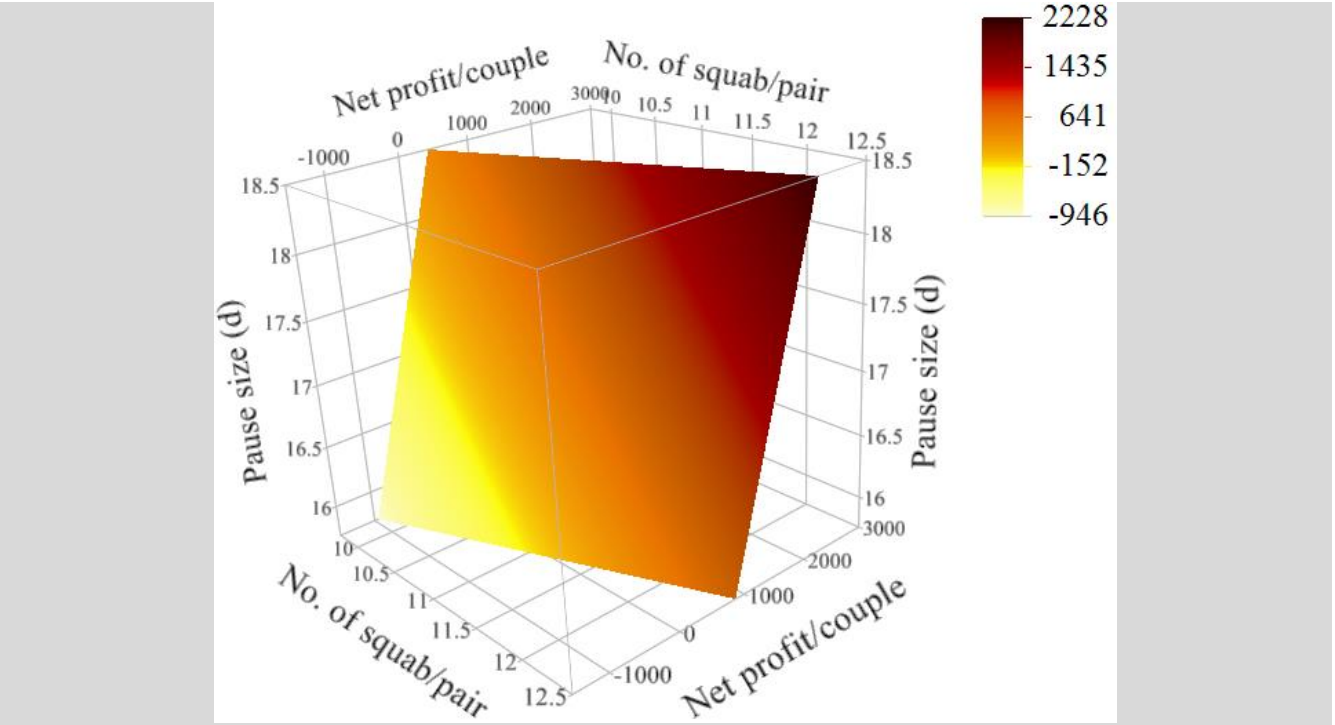

Figure 5 - A response surface model to predict the influence of average pause size (day) and annual squab production (no) on net profit (BDT; 1 USD=93.5 BDT) for the small-scale free range domestic pigeon farming (N=100)

Cost-benefit analysis

The net profit of rearing different breeds of pigeon significantly (P<0.01) differed. The farms raising local breed of pigeon obtained the highest annual net profit (BDT 823/pair) compared with other farms rearing Giribaz (BDT 478/pair) and Gola breeds (BDT 319.70/pair) of pigeon (Table 4). Although, hierarchical clustering clearly stood out Gola, principal component analysis identified annual egg production and feed cost as the principal eigenvector determining net profit.

Table 4 - Cost-benefit analysis of the different breeds of pigeon for the small-scale free range domestic pigeon farming (N=100)

Variables \ Breeds	Local	Gola	Giribaz	SEM[1]	P-value
Feed cost/pair/year (BDT[2])	996.0	1018	1000	1.10	0.948
Housing cost/pair/year (BDT)	348.5	515.2	385.7	42.8	0.250
Market price per breeding pair (BDT)	395.0	356.0	360.0	18.6	0.767
Other costs/pair/year (BDT)	500.0	500.0	500.0	-	-
Total costs (BDT)	2240	2389	2246	51.6	0.675
Market price/pair squab (BDT)	250.0	256.0	273.3	4.94	0.712
Total income from squab sale (BDT)	3063	2709	2724	65.3	0.374
Net profit/adult couple (BDT)	823.0[a]	319.7[c]	478.6[b]	46.3	0.001

[1]SEM = Standard error of the mean; [2]BDT = Bangladeshi taka (1 $USD = 93.0 BDT)

DISCUSSION

Socio-economy

In the present study, most of the pigeon farmers were literate, young to midddle aged who socially belonged to middle class. Age of the pigeon farmers observed in our study although corresponds with Rahman (2002) but contradicts with the findings of Asaduzzaman et al. (2009). Accordingly, the majority of the pigeon farmers were literate in our study which further opposes a previous study (Asaduzzaman et al., 2009) where 53.3% of the pigeon farmers were illiterate. The differences could possibly be explained for the location of study area. Our study was conducted in the Chattogram Metropolitan whereas the above study was held in the Gouripur upazilla of Mymensingh district. Chattogram being the divisional district has far more literacy level and per capita income of the pigeon farmer compared with mymensingh district.

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Comparative indices

In our study, local non-descriptive breeds of pigeon produced more eggs and squabs per year than the Gola and Giribaz although the results were not statistically significant. On the other hand, average pause size, feed supply per day and average market age were pretty lower in the local breeds than the Gola and Giribaz which ultimately helped in increasing productivity of the local breeds (Kabir, 2013). Interestingly, hatchability percentage of the local breed was higher than the other breeds and average mortality was slightly higher in Giribaz. The differences could have possibly been arisen in our study since pigeons were reared in scavenging system whereas in other studies the pigeons were reared in confinement (Abdel et al., 2019).

Overall indices

In our study, most of the backyard pigeon farmers had an average flock size of 4.9 pairs. The average annual egg and squab productions were 20.6 and 10.7 pairs, respectively. Squab production peaked at 18.5 pairs per year. According to Levi (2020), a successful commercial pigeon couple may produce 18 to 20 squabs per year although Abd el azeem et al. (2016) reported 11.4 squabs/pair/year. This discrepancy in squab production could be attributable to the genotype and geographical variables as well as the absence of one or both parents. In our study, the mean quantity of the supplied feed to the pigeon was 37.8 g/bird/day. ChunQi et al. (2016) reported that feed intake per pigeon per day was 47.4 g which was slightly higher than the present study. The differences could have possibly been because the pigeons were reared in scavenging system and farmers provided only supplementary feeding. Whereas, in other studies the pigeons were reared in confinement. The usual market age, hatchability and mortality were 30.6 day, 51.4% and 7.6%, respectively which is aligned with the report of Levi (2020) where marketing age was reported to be 25 to 35 day with an average of 30 day. The mean feed and housing cost were BDT 1008 and 443/pairs/year, respectively where market price per pair adult and per squab were BDT 36 and 130, respectively. In a previous study, maximum construction cost of pigeon house was Tk.150, minimum cost was Tk. 70 and the average cost was Tk. 113 (Asaduzzaman et al., 2009). These variations of construction materials may be due to day by day increasing market price.

Cost-benefit analysis

We estimated that farms rearing local pigeons obtained highest profit (BDT 823/pair) than the farms raising Giribaz (BDT 478/pair) and Gola (BDT 319.70/pair). The reasoning could be the lower feed and housing cost/pair/year and better squab producing capacity of the local breed than the other commercial breeds. This study further demonstrated that the free range domestic pigeon raising can be a good source of domestic income for small scale sustainable farmers. The productivity and profitability of pigeon can be increased if the vaccinations, medications and balanced feed formulations can be ensured at farm level.

CONCLUSION

The non-descriptive local breeds of pigeon produce more eggs and thus squabs per year exhibiting higher hatchability, better survivability, lower pause size, average daily feed intake, market age and mortality than the Gola and Giribaz breeds under traditional low-cost management systems. The local breeds of pigeons are economically more viable than the Gola and Giribaz breeds, hence, more preferable for subsistence rural livelihood. The small-scale free range domestic pigeon farming plays a potential role for the consistent income generation of the unemployed young people in Bangladesh.

DECLARATIONS

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Authors' contribution

Dr. Partha Samanta - Questionnaire preparation, baseline survey, data collection and preparation of initial draft. Dr. Nasima Akter-Conceptualization, project administration, questionnaire preparation and initial draft. Dr. Saiful Islam - Conceptualization and questionnaire preparation. Dr. Emran Hossain - Data curation, GLM, principal component analysis, hierarchical clustering, response surface modelling, result interpretation and finalization of the draft. All authors read and approved the final draft.

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Conflict of interests

None.

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REFERENCES

Abd el Azeem A, Amir A, Shama T and Abas W (2016). Early weaning of pigeon squabs. Egyptian Poultry Science Journal, 36: 205–232. https://epsj.journals.ekb.eg/article_33249_414292439937dfc324a59cfafeb41d06.pdf

Abdel AF, Roushdy ESM, Tukur HA, Saadeldin IM and Kishawy ATY (2019). Comparing the effect of dietary management and rearing systems on pigeon squab welfare and performance after the loss of one or both parents. Animals, 9: 165. DOI: https://doi.org/10.3390/ani9040165

Ahamed AS, Nusrathali N, Mufeeth M, Ranaweera K, Majeed UA (2021). Breeds Distribution and Management Practices of Pigeon Farming in Sri Lanka. Journal of the Bangladesh Agricultural University, 19(4):477-485. DOI: https://doi.org/10.5455/JBAU.97504

Asaduzzaman M, Mahiuddin M, Howlider M, Hossain M and Yeasmin T (2009). Pigeon farming in Gouripur upazilla of Mymensingh district. Bangladesh Journal of Animal Science, 38: 142–150. https://www.banglajol.info/index.php/BJAS/article/view/9923

Bhowmik N, Mia M and Rahman MA (2014). Morphometric, productive and reproductive performance of Jalali pigeon. International Journal of Development Research, 4: 908–911. http://www.asp.zut.edu.pl/ 2016/15_1/asp-2016-15-1-04.pdf

Bu Z, Chang L, Tang Q, Song C, Zhang R, Fu S, Mu C (2018). Comparative study of meat quality, conventional nutrition composition and muscle fibre characteristics of White King pigeons between different age and gender. Journal of Food Safety and Quality, 9(1):13-18. https://www.cabdirect.org/cabdirect/abstract/20183046223

Canova J (2005). Monuments to the birds: Dovecotes and pigeon eating in the land of fields. Gastronomica: The Journal of Food and Culture, 5: 50–59. DOI: https://doi.org/10.1525/gfc.2005.5.2.50

Chunqi GAO, Xiaohui W, Xiaochao HU, Huichao YAN and Xiuqi W (2016). Effects of dietary crude protein levels on growth performance carcass characteristics meat quality of squabs and laying performance of breeding pigeons. Journal of South China Agricultural University, 37: 1–6. https://www.cabdirect.org/cabdirect/abstract/20163333898

El-Haroun AHJ, Hassanein MNF and Sabra ZAM (2008). Studies on native pigeons under Egyptian village Nile delta conditions. Egyptians Poultry Science Journal, 28: 883–900. http://www.ijramr.com/sites/default/files/issues-pdf/2533.pdf

Islam MR (2010). Pigeon farming and meat yield of some genetic groups in Mymensingh district. MSc Thesis, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. Google Scholar

Kabir MA (2013). Productivity, Management and cost-benefit analyses of pigeons in pet shop of Bangladesh. Case Studies Journal, 2:18–19. DOI: https://ssrn.com/abstract=2868293

Kabir MA (2014). Grading system of ten common fancy pigeons of Bangladesh. Integrated Journal of British, 13: 19–26. https://www.academia.edu/download/56646433/grading_system.pdf

Kokoszyński D, Stęczny K, Żochowska-Kujawska J, Sobczak M, Kotowicz M, Saleh M, et al. (2020). Carcass characteristics, physicochemical properties, and texture and microstructure of the meat and internal organs of carrier and king pigeons. Animals, 10(8):1315. DOI: https://doi.org/ 10.3390/ani10081315

Levi WM (2020). Making Pigeons Pay-A manual of practical information on the management, selection, breeding, feeding, and marketing of pigeons. Pierce Press, Arlington, MA02476. https://www.amazon.com/Making-Pigeons-Pay-Information-Management/dp/B00POFEIPY

Maity B, Das TK, Ganguly B, Pradhan K (2020). Pigeon rearing-an investment analysis for secondary income generation to farm women, landless, marginal and small farmers. Asian Journal of Agricultural Extension, Economics & Sociology, 38(6):1-6. DOI: https://doi.org/10.9734/ajaees/2020/v38i630354

Marques SMT, De Quadros RM, Da Silva CJ and Baldo M (2007). Parasites of pigeons (Columba livia) in urban areas of lages, Southern Brazil. Parasitologia Latinoamericana, 62: 183–187. DOI: http://dx.doi.org/10.4067/S0717-77122007000200014

Murdoch J (2005). The Food of China. The Gardners Book, Eastbourne, United Kingdom. https://www.abebooks.co.uk/book-search/title/food-of-china/author/murdoch/

Rahman MW (2002). Consumption of poultry and poultry products by the rural families in selected villages of sadar upazila under Mymensingh. MS thesis, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. Google Scholar

Silver R, Andrews H and Ball GF (1985). Parental Care in an Ecological Perspective: A quantitative analysis of avian subfamilies. Integrative and Comparative Biology, 25: 823–840. DOI: https://doi.org/10.1093/icb/25.3.823

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