Scavenging Duck at Haor Basin: Plane of Nutrition and Response to Production

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ABSTRACT

This study was designed to assess the basic nutrition of duck get from scavenge feeding and their response to egg production. Eight commercial duck farms were randomly selected from three Upazilla and data were arranged into complete randomized design. Significant ($p<0.01$) differences were found in flocks size (111 to 1200 duck), feed (40g to 100g /b/d), ME (95.37 to 246.95 KCal/b/d), CP (3.52 to 8.92 g/b/d) intake and FCR (3.26 to 1.88) value. The range of protein-energy ratio was 1:27 to 1:24 that was in below of standard leaded to poor performance in egg production. Only 37.5% flocks performed 55% to 65% egg production while 53.5% farms were in between 33% to 48% production level with standard egg size (60g). 20% farm possessed1000 to 1200 duck and earned BDT 1200 to 3500 per day while 80% farms reared 100 to 300 duck and earned daily BDT 300 to 500. Jinding took significantly more feed (44%), ME (53%) and CP (40%) but produced less egg than Khaki Campbell reflecting high production cost and low return ($p = 0.02$). Flock size should be with 300 ducks to generate family income from egg. Overall, water logged duck Khaki Campbell is better feed converter and egg producer at under underfed condition.

Key words: *Scavenged duck[1], Waterlogged[2], Nutrition[3], Egg production[4]*

INTRODUCTION

The prospect of duck rearing in Sylhet district owing to large areas of water reservoirs possess a plenty of duck feed viz. aquatic weeds, fishes, snails, insects, fallen grains. Energy and protein rich supplementary feeding (rice polish, broken rice, maize; soyabean meal, fish meal) is necessary to rich peak production. Scanty of data on scavenged duck nutrition in Haor duck is the curse. Regarding this issue, the present study is designed to assess the plain of nutrition of scavenging duck and their response to production.

Duck, the natural forager is an integral part of poultry husbandry in rural area of Bangladesh to generate income and meet up human nutrition. It provides cash income and creates employment opportunity for rural people, particularly for small and landless farmers (Huque et al 2004). Duck population of Bangladesh is estimated to be 52.24 million (DLS 2019) of which 95% are of indigenous type (Ahmed 1986, Huque et al 2003) while other available ducks are Khaki Campbell, Indian Runner, Jinding, Pekin and their crosses occupying second place to chicken in table egg production (10%) in the country (Salam and Bulbul 1983). Pekin, Muscovy, Khaki Campbell, Indian Runner and Mule ducks are popularly raised for their meat and eggs. The preliminary studies showed that Jinding and Khaki Campbell are medium sized egg laying duck breed having potentials to survive well and giving very good production (Zhang et al 1989). The climate and environment of Sylhet is suitable for duck habitation and the innumerable water bodies are also favorable for duck production. Bangladesh possesses 16488 square kilo meter haors, canals, pond and low-lying water reservoir that could be efficiently utilized for aquatic poultry production (Huque and Sultana 2002).Unlike chicken they are less susceptible to diseases and offer low cost eggs and meat. Over 85 to 87% ducks are being reared under scavenging condition (Amin, 1999). The feed obtained from scavenging to be around 60–70% of their requirements and need shelter only at night (Rahman et al 2009). Farmers keep ducks flocks throughout the year allowing them to scavenge on the available rice field, water bodies, post harvested paddy fields, migrated areas during April-June, July-September, October-January and February-March (Fouzder et al 1999).

High price and scarcity of feed during dry season are the major constraints in affecting duck production in Bangladesh (Pervin et al 2013). The prospect of duck rearing in Sylhet district owing to large areas of water reservoirs where water stand throughout the year possessing a plenty of aquatic weeds, fishes, snails, insects, fallen grains etc, on which ducks can thrive under scavenging and semi scavenging systems. However, only scavenging cannot fulfill the nutritional requirements of growing and productive ducks round the year. Moreover, scarce of data on nutrient requirements, chemical analysis of aquatic feeds, nutrients intake from natural hunting, nutrient balance and productive performance in relation to feed supplement under scavenging system in Haor. Keeping these views, this study was endeavored to seek the level of nutrition of scavenged duck and their egg production.

MATERIALS AND METHODS

Farm selection and data collection

The study was conducted under three Upazilla : Jaintiapur, Kanaighat and Gowainghat in Sylhet district. Total eight commercial duck farms were randomly selected (Table 1) and data were collected through the pre-tested interview schedule by face-to-face interview procedure using standard questionnaire during the period for three months from September to November 2019 for getting information on duck rearing practices, especially on feeds and feeding systems of ducks as well as marketing of their duck and eggs.

Allow to scavenge of duck flock

Ducks were allowed for 7 to 8 hours (10 am to 5 pm) a day for naturally hunting feed from water bodies and some time from harvested paddy field. Ducks were allowed to stay on duck shed up to 10 am to harvest egg as duck lay at day time by 9 am. At 5 to 6 pm they were supplied pseudo paddy and some wheat grain at different amount (60 - 120g/duck/day) within fermer's ability. The supplied and hunting nutrients presumably shown in Table 1. The remarkable variations of nutrients are presented in this table.

Table 1. Supplied ration (%) of different farmers for scavenging duck at Haor region in Sylhet

	Scavenging duck farms							
	1*	2*	3**	4**	5**	6*	7**	8*
Residue paddy	49.96	49.98	74.97	49.96	33.3	99.97	66.66	49.96
Wheat grain	49.96	49.98	24.99	49.96	66.6	-	33.33	49.96
Snails	0.04	0.04	0.04	0.04	0.05	0.002	0.004	0.04
Small fishes	0.02	0.02	0.02	0.02	0.03	0.008	0.002	0.02
Aquatic insects	0.015	0.015	0.015	0.015	0.02	0.006	0.002	0.015
Soft green grasses	0.005	0.005	0.005	0.005	0.007	0.002	0.0006	0.005
Total	100	100	100	100	100	100	100	100
CP (%)	12.00	11.67	11.38	11.66	11.82	11.01	11.5	11.66
ME (Kcal/kgDM)	2389	2389	2160.86	2355.79	2468	1904	2232	2354.04

1= Abdus Salam Duck Farm, 2= Chan Mia Duck Farm, 3= Shamol Dey Duck Farm, 4= Mosarrof Hossain Duck Farm, 5= Sohel Duck Farm, 6= Hasem Duck, 7= Kuddus Ali Duck Farm, 8=Sahid Mia Duck Farm
**Khakicampbel duck, ** Jinding duck*

Feed sample collection and chemical analysis

The feed samples were collected, dried, grinded and analyzed chemically according to AOAC (2008) method. Metabolizable energy (ME) was measured as Menke and Steingass (1988).

Statistical analysis

Data was analyzed using SAS 2007 version 9.1.3 statistical computer program in Randomized Complete Randomized Design (CRD) to compute Analysis of variance (ANOVA).

Results and discussions

The present study find out the feeding pattern of commercial duck farms and their response to production, for that specific data were collected from the farm owners which was compiled and tabulated.

Table 2. Feed and nutrient intake, flock size and feed utilization scavenged duck

Parameters	Farms								SEM	P value
	DF1*	DF2*	DF3**	DF4**	DF5**	DF6*	DF7**	DF8*		
No. of Birds	300^{c}	1000^{b}	300^{c}	200^{e}	111^{f}	300^{c}	1200^{a}	210^{d}	51.05	0.001
Feed intake/F/d (kg)	13.3^{e}	62.5^{b}	23.4^{d}	13.8^{e}	11.1^{f}	24.9^{c}	111^{a}	13.5^{e}	4.41	0.001
Feed intake/b/d (g)	40.4^{h}	62.5^{g}	78.1^{d}	69.0^{e}	100^{a}	83.0^{c}	92.6^{b}	64.5^{f}	2.36	0.001
MEI(KCal/b/d)	106^{e}	95.4^{f}	169^{c}	161^{cd}	247^{a}	159^{d}	193^{b}	152^{d}	5.95	0.001
CPI(g/b/d)	3.90^{g}	3.52^{h}	6.55^{d}	6.12^{e}	8.92^{a}	6.72^{c}	7.99^{b}	5.58^{f}	0.23	0.001
FCR	2.24^{e}	1.88^{f}	2.80^{c}	2.91^{b}	2.88^{bc}	2.62^{d}	3.26^{a}	2.87^{bc}	0.05	0.001
Protein Energy Ratio	1:27.2	1:27.1	1:25.8	1:26.2	1:27.7	1:23.6	1:24.1	1:27.2	-	-

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** Khaki Campbell, ** Jinding duck, MEI=Metabolizable energy intake, CPI=Crude protein Intake, FCR= Feed Conversion ratio, SEM=Standard error of mean*

The Table 2 represents the flock size, feed and nutrients (CP and ME) intake and feed conversion efficiency of haor scavenged duck in Sylhet. There were significant ($p<0.01$) difference among the flocks in bird number they raised from 111 to 1200. Similarly, feeding management were remarkably ($p<0.01$) different in terms of DM feed, CP and ME intake. Duck of farm 5 took highest feed 100.08 g/b/d followed by farm 7, 7, 3, 8 2 and 1 ranges from 93g to 40g. A big fluctuation was observed among the birds due to farm to farm management. On the other hand, energy (ME KCal/b/d) intake also varied significantly ($p<0.01$) without keeping any similarity with CP (g/b/d) intake. Bird of farm 5 ingested the highest energy 246.95 KCal/b/d followed by farm 7, 3, 4, 6, 8, 1 and 2. The lowest Me intake was in the bird of farm 2 (95.37 KCal/b/d). Significant variation of ME intake was found due to individual management and supplied different feed grains rich in energy. The FCR values were seen highest in bird of farm 7 (3.26) followed by 4, 5, 8, 3, 6, 1 and 2. The best feed converter was farm 2 (1.88) followed by 1, 6, 3, 8, 5, 4 and 7 respectively while their protein energy ratio was 1:27, 1:27, 1:24, 1:26, 1:27, 1:28, 1:26 and 1:24 respectively. Based on grazing season of ducks Kabir et al (2007) categorized the season as lean season (summer) March to June, abundance season (rainy) July to October and moderately abundance season (winter) November to February for coastal duck feeding. They also suggested that rainy season would be the best season for rearing ducks, followed by winter and summer at patuakhali coastal district. But in haor basins, it is suitable to scavenge the ducks at early rainy and winter. They also observed DM intake of ducks supplemented Level-II was 63.17 g, Level-I (56.80 g) and varied significantly ($p<0.01$) with control (38.42 g). Feed conversion efficiency (FCR) found 6.43, 7.01 and 4.86; duck-day egg production 43.93%, 45.53% and 23.45%; egg weight of ducks was. They also observed that recovery of deficit nutrients reduces the first lay time from 141days to 126 days or 128 days. Similarly egg weight increased from 57.08g to 62.46g or 61.15 g. Feed intake and egg weight of present findings match with the findings of Kabir et al (2007) while the feed conversion efficiency differ remarkably. The reason was not clear. Egg weight at first year of Jinding breed is usually around 70 g (Zhang et al 1989) but in present study was found around 60 to 65 g may be owing to mal nutrition and impurity of breed or suppose to be inbreeding. Thongwittaya and Tasaki (1992) stated that Khaki campbell responed better to 2700Kcal energy and 16.5% protein per kg DM feed.

Table 3. Egg production, feed cost and return from scavenging duck rearing in water logged area

Parameters	Farms								SEM	P value
	DF1*	DF2*	DF3**	DF4**	DF5**	DF6*	DF7**	DF8*		
Egg prodn(%)	33.3^{h}	65.0^{a}	46.7^{d}	40^{f}	58.6^{b}	53.3^{c}	45.8^{e}	38.1^{g}	1.35	0.001
Day Egg prodn/flock	100^{e}	650^{a}	140^{d}	80.0^{f}	65.0^{g}	160^{c}	550^{b}	80.0^{f}	31.3	0.001

Feed cost (Tk.b/d)	1.43[f]	1.99[e]	2.53[c]	2.10[d]	2.10[d]	3.33[a]	2.91[b]	2.12[d]	0.07	0.001
Egg weight (g)	59.5[b]	51.2[c]	60.0[b]	59.5[b]	49.5[b]	59.6[b]	62.0[a]	50.1[b]	0.65	0.001
Egg mass weight (kg)	5.95[e]	33.3[b]	8.40[d]	4.76[f]	3.87[g]	9.54[c]	34.1[a]	4.73[f]	1.61	0.001
Income from Egg (Tk/d)	901[e]	5226[a]	1225[d]	720[g]	585[h]	1520[c]	4675[b]	760[f]	235	0.001
Profit Tk/d)	470[c]	3536[a]	465[c]	300[d]	352[d]	521[c]	1183[b]	315[d]	138	0.001

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** Khaki Campbell duck, ** Jinding duck*

The Table 3 illustrates the performance of scavenged duck and the return from egg per month of duck farmers. Although the Table 1 exhibited the feed and nutrients (ME and CP) intake that did not fulfill the requirements of laying bird and eventually the bird showed the poor performance in laying egg. Only 37.5% flock performed 55% to 65% egg production while around 57% farm was below in 50% production. The lowest performer was flock 3 (33%) while others were in between 40 to 48% production level. The highest egg production was seen in flock 2 (65%) followed by flock 5 (58.59%) and 6 (53.33%). At other means of evaluation considering egg mass weight (kg/d) and egg weight (g/egg) of the flocks were also presented in Table 2. Most of the duck laid standard egg size (60g), however, 37.5 % (farm 2, 8 and 5)farm produced 50g weight egg, the mega size was 62g belongs to farm 7 and the lean weight was 40.45g possessed the duck of farm 5. The price (BDT/egg) of egg was within little bit variation ranging 8.75 to 9.5. The flock 1, 3 and 6 possessed same number (300) of duck followed by flock 8 (200 duck), 4(200 duck) and 5 (111 duck). Only 20% farm possessed big number of duck 1000 and 1200 farm 5 and farm 7 respectively. It is clear that most (80%) farmers reared their flock having 100 to 300 numbers of duck and they earned BDT 300 to 500 per day, meanwhile, whenever flock size increased in 1000 number, income jumped steeply (3 to 7 folds) BDT 1200 to 3500 per day. A big fluctuation was found in net profit parameter owing to variation of feed cost and individual management. Indigenous (*desi)* ducks possess 1300 to 1500g in adult. Sixty seven percent of the farmers reported egg production of a scavenging *desi* duck to be 51-70 eggs/year followed by 71-100 eggs/year for 23% and 30-50 eggs/year for 10% farmers. Salam and Bulbul (1983) and Huque and Ukil (1994) reported egg production to range from 60-91 eggs/duck/year which is in close agreement with the current study comprising reports of 90% of the farmers of this study. The annual production of local duck as reported by Fouzder et al *(*1999) was 89 eggs/duck/year in *haor* (large marshy land) areas. However, variation in different reports has probably arisen from variability in scavenging feed resources and the availability of supplementary feed. Fluctuations in feed availability from natural sources often affect production costs and vary from 72% to 87% of the total production costs (Huque and Sultana 2002). Huque et al (2001) stated that average feed supplement (g/day/bird) is reduced from 105 g in the dry period (October to December) to 34 g in the scavenging period (January to September). The average egg production increased from 30% in the dry period to 62% in the scavenging period. Similarly, Khanum et al (2005) reported on scavenge duck egg production from 48% to 69% in Netrokona District that shows the similarities with the findings of this present studies. In this study farmers usually got BDT 644/duck from Khaki Campbell and BDT 252 from Jinding duck considering annual production 200 eggs (Table 3) while Khanum et al (2005) reported BDT 318 to 393 per year per duck that is also resemble with the present study. Moreover, Huque and Sultana (2002) concluded that scavenging duck rearing is considered to have potential both for poverty alleviation and food production, especially for the rural poor women. They suggested that a farmer with 200 layer ducks with or without rice husk hatchery may earn an annual profit of USD 922 to 1945 and in this finding flock size 200 showed the annual return 1369 USD that support the statement of Huque and Sultana (2002). However, if the flock size increased by 300 duck, it uplifted the return almost two folds (2214 USD) annually. So, standard scavenge duck flock size could be considered as 300 to get a hand sum return per annum for family nutrition and expenditure.

Table 4. Performance of scavenging Jinding and Khaki Campbell duck in haor area

Parameters	Duck Breed		SEM	P value
	Khaki Campbell	Jinding		
Flock size	453	453	0.09	0.99
Day Egg production	248	209	13.7	0.83
DMI (g/b/d)	58.1	84.7	9.42	0.07
MEI (KCal/b/d)	128	196	23.9	0.03
CPI (g/b/d)	4.91	7.27	0.83	0.05
Feed cost (Tk/d/b)	1.96	2.51	0.19	0.34
Income (Tk./d)	2,181	1,805	133	0.81
Profit (Tk./d)	1,456	569	314	0.02

MEI=Metabolizable energy intake, CPI=Crude protein Intake, FCR= Feed Conversion ratio, SEM=Standard error of mean

The Table 4 shows DM feed and nutrient intake, egg production performance and return of two scavenger duck breed in haor basin of Sylhet District. Flock size of Jinding and Khaki Campbell duck was in similar (p=0.99) having averagely 452 ducks in each flock. Day egg production varied (p=0.83) between two breeds where the Khaki Campbell showed better performance than the Jinding. Likewise, the Jinding took significantly more feed (44%), ME (53%) and CP (40%) than Khaki Campbell while exposed poor performance that reflected on high production cost and significantly (p=0.02) low return that was almost lower than half of the Khaki Campbell. Overall, at water logged area Khaki Campbell is the unique breed that could be reared with high economic stands. Research from India indicates that under rural conditions the Khaki Campbell duck had better production than the local birds (Rashid et al., 1995). The mortality, however, was higher in Khaki Campbell. The same research also reported that the economic performance of the local ducks could be improved through a cross-breeding program with Khaki Campbells.

Pervin et al (2013); Halder et al (2007); Rahman et al (2005) reported that majority of the farmers (91.5%) involved in rearing indigenous (*desi)* ducks followed by crossbred (7.5-12%).Rearing of small flock of 5-10 ducks was most common in Bangladesh as family duck flock size that is in consistent with an Indian study where Halder et al (2007) found that the majority of flocks comprised of 6-10 ducks. But the finding of Islam et al (2002) who reported that 85.6% of the flocks comprised 20-50 ducks within an overall range of 20 to 200 birds in Assam, 200-360 ducks in Tamil Nadu, India (Gajendran et al 1992) and 1000-2000 ducklings in south Vietnam, (Nind and Tu 1998), Manhanta et al (2001) reported a relatively lower range of flock size 5-100 in Lakhimpur and Dhemaji districts of Assam, India that match with the present findings of flock size 111 to 1200. The review and present results clearly indicate the variability in flock sizes among countries and within country locations depending on location and financial ability of the farmers. Almost all the farmers reared their ducks in free range system with or without supplementation.

Pervin et al (2013) reported on two districts of southern part of Bangladesh Noakhali and Lakshmipur usually reared (91.5% -95% farmers) indigenous (*desi)* ducks and they were also involved in production by following free range scavenging system fed mixed wet feed (rice polish, broken rice and boiled rice) as supplemental feeds either alone or in combination. But in sylhet farmers are rearing Khaki Campbell and Jinding duck; and fed them somewhat wheat grain and residue paddy grain. Most are scavengers raised seasonally in rice fields during the early growth of the crop and immediately post-harvest; and in backyards or gardens of farm households throughout the year. Bui Xuan Men (2018) observed that Duck and fish production has been expanding and contributes to increased income and improved living standards of the farmers, especially for poor farmers in the remote rural areas. Men et al (1995) supplemented the scavenger duck feed with 50g $duck^{-1}day^{-1}$ of a mixture of broken rice (80%) and dried fish (CDF 20%) to improve meat quality and observed daily live weight gains ($p<0.001$) remarkably . Besides, Pervin et al (2013) and Kabir et al (2007) also observed that supplementation with broken rice alone or a mixture of broken rice and crushed-dried fish to scavenging meat ducks at coastal belt significantly improved the daily gain, egg production and carcass quality, and would shorten the time to market. Similar findings were seen in this study that scavenging feeding of duck did not meet up the requirement of duck. Unlike the coastal duck feeding, Sylhet duck farmers extra fed the ducks at evening with only energy rich wheat grain and or pseudo paddy grain without protein supplementation that suppressed the production.

Duck feeding in coastal areas and haor area seemed to be a bit difference. In coastal areas farmers used rice polish, broken rice and boiled rice as supplemental feeds either alone or in combination to fed the duck with a wide range

30g to 110g/duck/day (Rahman 2009). DLS (1998) also reported that farmers usually supply 62g additional feed/duck/day that was supported by Huque et al (2004) that the farmers of Sylhet basin supplied very little amount (34g) extra feed/duck/day in rainy season that consist with the present study and is scanty for their need. Many scientists in home and abroad (Vietnam, Nepal, India) reported that (Pervin et al 2013; Kabir et al 2007; Huque et al 2004; Khanum et al 2005; Huque and Sultana 2002; Men et al 1995; Halder et al 2007; Gajendran et al 1992; Nind and Tu 1998) all the year round scavenging feeds are not available *ad-libitum* as per requirements of duck. Preston (1995); Culley (1978) and Becerra et al (1994) reported on Duckweed (*Lemna minor*) nutrition (26.3% of DM, 38.6% CP of DM) for duck feeding and could be replaced the soyabeam meal by 19 to 27% even though *ad libitum* for muscovy duck that also supports our country research.

Little or no attention is given about the nutritional status of scavenging ducks. Non genetic factors like poor nutrition has much greater effect on production parameters than the genetic influence for the improvement of ducks under scavenging system of rearing (Sazzad et al 1988). On the other hand Haque et al (1991,1994) suggested feed supplementation to achieve optimum production. Eggs and meat produced from scavenging ducks are considered to be organic, nutritious products and are completely free from hormones and antibiotics as well as get nutrients from wide range of feed ingredients such as snails, fish, earthworms and flora such as duckweed and algae. All these feeds are rich sources of protein, minerals and vitamins that help meeting different types of nutrient requirements needed by ducks and increasing their productivity. Nevertheless, the availability of natural feed resources is affected by their habitats, the waterlogged areas that vary according to seasons of the year and regions of the country. And that lean period duck should be fed with energy and protein rich feed.

CONCLUSION

Poor nutrition is the curse of profit of organic business scavenged duck farming. Only pseudo paddy/wheat grain supplementation is not enough to compensate mal nutrition of ducks. Most of the farmers reared Khaki Campbell and Jinding duck. However, Khaki Campbell rearing is more profitable than Jinding at Sylhet district. Profit would be satisfactory if standard flock size (300 birds) could be maintained with nutritional nourishment at minimum cost.

REFERENCES

Ahmed S (1986). Duck production in Bangladesh. In: Duck Production Science and World Practice, (Farrell, D.J. and Stapleton, P. Ed). University of New England, Armidale, Australia. pp.342-350.

Amin M M (1999). Poultry disease in Bangladesh.Present status and control strategies.
Paper presented in the seminar and international poultry show. Organized by the World's Poultry Science Associoation of Bangladesh Branch, Dhaka. 24-26th April, 1999, 81-91.

AOAC (2008). Association of Official Analytical Chemists, (13th edition)Washington, DC.

Becerra M, Ogle B and Preston T R (1994). Effect of replacing whole boiled soybeans with duckweed (Lemna sp) in the diets of growing ducks. Livestock Research for Rural Development. Volume 7, Number 3, 44.8Kb.

Bui Xuan Men (2018). The Role of Scavenging Ducks, Duckweed and Fish in Integrated Farming Systems in Vietnam, Faculty of Agriculture, Cantho University, Vietnam.

Culley D, Jr D and Epps E A (1973). Use of duckweed for waste treatment and animal feed. Journal Water Pollution Control Federation. Vol. 45, No. 2, pp. 337-347.

D L S (1998). Development and Activities- A Brochure, Department of Livestock Services. Ministry of Fisheries and Livestock Information Office, Farm gate, Dhaka, Bangladesh.

DLS (2019). Directorate of Livestock Services, Government of the Peoples' Republic of Bangladesh.

Fouzder S K, Khaleque M A and Alam A B M M (1999). Evaluation of bio-economic performance of duck farming in Haor area. Bangladesh Journal of Training and Development 12 (1 & 2):93- 98.

Gajendran A K, Kothandaran P, Prabhakaran R and Babu M (1992). Duckling production – an economic appraisal. Indian Journal of Animal Science 7(2): 157-162.

Halder G, Ghoshal T K and Samanta G (2007). Socio-economic background of duck owners and status of duck rearing in West Bengal. Indian Research Journal Extension Education 7 (2&3): 56-59.

Huque K S, Sarkar M S K, Huque Q M E and Islam M N (2004). Duck production in the Sylhet basin of Bangladesh–prospects and problems. Bangladesh Journal of Life Science 16(1):115-126.

Huque K S, Sarker M S K, Huque, Q M E and Islam M N (2001). Duck production in the Sylhet basin of Bangladesh-Prospects and problems. Paper presented in the seminar and InternationalPoultry show organized by the World's Poultry Science AssociationBangladesh Branch at IDB Bhaban. 16-17thFebruary, 40–51.

Huque Q M E and Hossain MJ (1991). Production potentiality of ducks of three genotypes under scavenging system of management. Bang. J. Anim. Sci.20 (1, 2): 119-122.

Huque K S and Sultana N (2002). Study on the existing duck production systems in Bangladesh. A report of Bangladesh Livestock Research Institute, Bangladesh.

Huque Q M E and Ukil M A (1994). Existing poultry production and utilization system in the traditional villages in Bangladesh. Bangladesh Journal of Training and Development 7(1): 35-3.

Huque Q M E, Ukil M A, Haque M E and Hossain M J (1994). Nutrient content in scavenging feed of laying ducks in Bangladesh. Bang. J. Sci. Indust. Res. 29 (1): 70-76.

Huque Q M E, Ukil M A, Haque M E and Hossain M J (1993). Supplementary feeding of laying ducks under scavenging condition. Bang. J. Live. Res.1 (1): 57-62.

Islam R, Mahanta J D, Barua N and Zaman G (2002). Duck farming in North-Eastern India (Assam). World`s Poultry Science Journal 58(4):567-572.

Kabir F, Sultana M.S , Mustafa G , Rashid M M O , Khan M S I and Asgar M A (2007). Study on Production System of Existing Ducks at Potuakhali District of Bangladesh and Development of a Self-sustainable Ducks Rearing Model Under Semi-scavenging System at Farmer`s condition. Journal of Biological Sciences,7:327-332.

Khanum J, Chwalibog A and Huque K S (2005). Study on rural duck production systems in selected areas of Bangladesh. Livestock Research for Rural Development 17 (10)

Mahanta J D, Sapcota D, Mili D C and Chakravorty A (2001). A survey on duck farming in Lakhimpur and Dhemaji districts of Assam. Indian Veterinary Journal 78(6): 531-532.

Men B X, B Ogle and Preston T R (1995). Use of restricted broken rice in duckweed based diets for feeding growing Common and Muscovy ducks. (Unpublished data, Vietnam).

Menke K H, Steingass H (1988). Estimation of the energetic feed value obtained from chemical analysis and in vitro gas production using rumen fluid. Animal Research and Development 28 7–55.

Nind L and Tu T D (1998). Traditional systems of duck farming and duck egg incubation in South Vietnam. World`s Poultry Science Journal 54(4):375-384.

Pervin W, Chowdhury S D, Ali M A, Khan J U and Raha S K (2013). Growth performance of indigenous (*desi*) ducklings receiving diets of varying nutrient concentrations. In: Proceedings of 8th Poultry Show and Seminar, World's Poultry Science Association, Bangladesh Branch, pp. 45-50.

Preston T R (1995). Reserch, Extention and training for Sustainable Farming Systems in the Tropics. Livestock Research for Rural Development. Volume 7, Number 2, 84Kb.

Rahman M M, Khan M J, Chowdhury S D and Akbar M A (2009). Duck rearing system in southern coastal districts of Bangladesh. Bangladesh Journal of Animal Science 38(1&2): 132-141.

Rahman M M, Khan M R A, Khan M J, Shahjalal M, Mostafa M G and Bell J (2005). Duck rearing system in the coastal regions of Bangladesh during rainy season. Bangladesh Journal of Animal Science 34(1&2): 137-149.

Rahman M M (2009). Development of feeding strategy for ducks raised by small farmers in coastal areas of Bangladsh. M.S. Thesis, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh.

Rashid N, Barua A and Bulbul S M (1995). A study on the performance of Khaki Campbell, Desi and Khaki Campbell x Desi ducks with and without extra feeding under rural condition of Bangladesh. Asian-Australasian Journal of Animal Sciences 8(4):375-378. Available online at: http://www.ajas.info/journal/view.php?number=18993 (verified 21 Jul 2014)

Salam M A and Bulbul S M (1983). A comparative study of performance of Khaki Campbell and Indian Runner ducks under Bangladesh Agricultural University farm condition. Bangladesh Journal of Animal Science 12(1-2): 39-48.

SAS (2007). Statistical Analysis System Institute Inc., SAS/ STAT. User's guide. Version 6.3rd edition Carry. North Carolina, USA. 943.

Sazzad M H, Mamotazul S M H and Asaduzzaman M U (1988). Growth pattern of Deshi and Khaki Campbell ducks under rural condition. Ind. J. Poultry Sci., 23: 165-166.

Thongwittaya N, Tasaki I (1992). Energy and protein requirements of Khaki Campbell x Thai Native laying ducks. Asian-Australasian Journal of Animal Sciences 5(2): 365-368.

Zhang S, Chen Y and Lai Y (1989). Jinding duck (a layer duck). Waterfowl production. Proceeding of the International Symposium on Waterfowl Production, the Satellite Conference for the XVIII World's Congress, September 11-18, 1988; Beijing, China. 66-71.