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Abbreviations	Elaborations
FMD	Foot and Mouth Disease
HS	Haemorrhagic Septicaemia
BQ	Black Quarter
mg/kg	milligram per kilogram
Av.	Average
ft.	feet

Abstract

Gayal (*Bos frontalis*) is a semi-domesticated and endangered bovine species in Bangladesh. The present study was assigned to determine the physical features, behavioural characteristics and husbandry status of gayal in a selected area of Chattogram, Bangladesh. The study was conducted in a Gayal farm at Rangunia upazilla in Chattogram district, Bangladesh from 15th February, 2021 to 31st March, 2021 for duration of about 1.5 month. It appeared from the study that Gayals were reared under semi-intensive management system in the farm. They browsed forest herbs, shrubs and grasses freely in the hilly environment and came back to the farm after a period for salt. Total number of gayal was counted 95 in that farm. The coat colour of the adult gayal was variable. White stocking was very prominent in adult gayal. All gayal calves possessed reddish brown in colour. The weight of adult gayals was more than 400kg. Reproductive efficiency was high and calving interval was recorded average 402 days from the record book. Both roughage and concentrate were supplied for the animals. Vaccination and deworming were done in the farm following vaccination and deworming schedule. Gayals exhibited high disease resistance. As the gayals' milk production was not sufficient, these animals were reared only for meat purpose. The present study revealed that physical features, behavior character and farming of gayal under semi-intensive rearing system were different from other bovines.

Keywords: Gayal, Crossbred, Semi-intensive, Disease resistance, Bangladesh.

Chapter I

Introduction

Gayal is a feral graminivorous animal under the family, bovidae. It's known as **'Cattle of mountain'**. Gayal is a semi-wild animal and thought to be originated from cross between gaur and domestic cattle (Simoons and Simoons 1968, Tanaka *et al.* 2011). However, the origin and domestication of gayal is not clearly known. In India, this large semi-domesticated animal is popularly known as 'Mithun'. Gayals have been thought to be originated more than 8000 years ago. European studies documented for the first time that the existence of this animal is during the 19thcentury.Three different hypotheses have been proposed on the origin of Gayal: 1) Gayal is domesticated form of wild Gaur, 2) Gayal is a hybrid of bull Gaur with a Zebu cow or either a *Bos indicus* or *Bos taurus* cow, and 3) Gayal is a descendant of a wild Indian bovine, now extinct. Scientific name of gayal is *Bos frontalis*. (Fig. 1.1)

Fig. 1.1 Gayal (*Bos frontalis*)

In 1964, Pakistan Govt. declared gayal as domestic animal. However, it's not fully domesticated yet. It is described as semi-wild or semi-domestic animal (Sc herf 2000). The gayal is found in the hilly areas of Bhutan, eastern India, eastern Bangladesh, northern Myanmar, and north-western Yunnan, China with altitude up to 3000 m (Simoons and Simoons 1968, Faruque *et al.* 1985; Mason 1988; Payne and Hodges1997; *Li et al. 2008*; Mondol *et al.* 2014). In the moist forests of hills, gayal is a free-ranging animal which has no planned breeding.

Gayal is a valuable sacrificial animal and regarded as a symbol of social status of tribal people in Bangladesh and India (Simoons and Simoons 1968, Furer-Haimend orf 1980; Brauns and Loffler 1986). In Bhutan, Thrabum (native cattle) is traditionally used for hybridization with gayal (mithun) and the produced hybrid is preferred for dairy and draught purposes (Hickman and Tenzin 1982; Winter *et al.* 1986). Gayal is an extremely efficient grazer on steep hilly slopes compared to any other animals. Gayal is primarily reared as meat animal and highly preferred among the tribal people of north-eastern region of India. Like buffalo, gayal milk

contains high protein and fat. It is evident that (gayal x cattle) hybrid is used as milk animal in some pockets of north-eastern India and Bhutan. Therefore, this species may also be explored as a supplementary component of milk production system in the region. In Bangladesh, it is found that the home-tract of gayal is Bandarban Hill district. And the one and only gayal farm was established in the village, Sukhbilas at Padua under Rangunia Upazilla in Chattogram district. This farm was established in 2007 by a local resident of Rangunia Upazilla, Ershad Mahmud (The younger brother of MP Hasan Mahmud, Bangladesh Awami-League) with three gayals which were collected from a tribal family of Rangamati hill tracts of Bangladesh.

Though Gayal had been brought under domestication, limited reports were available on physical features, behavioural characteristics and husbandry practices of gayal in Bangladesh. Therefore, the present study was carried out with a view to determining the physical features, behavioural characteristics and husbandry status of gayal.

With this end in view, the study was undertaken with the following objectives:

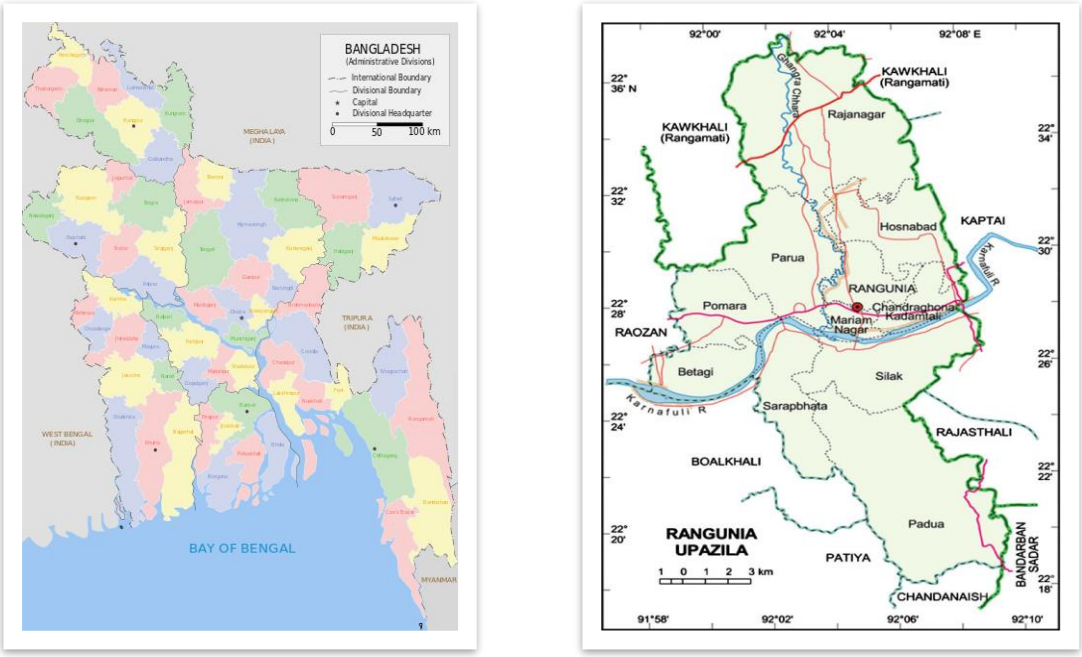
1. To observe the physical features, and behavioural characteristics of gayals.
2. To know the husbandry status of gayal under semi-intensive rearing system.

Chapter II

Methods and materials

2.1 Study area

The study was performed at gayal farm, which was situated at Sukhbilas village under Rangunia Upazilla in Chattogram district, Bangladesh. Rangunia Upazilla is surrounded by Chandanaish Upazilla on the south; Patiya Upazilla, Boalkhali Upazilla, Raozan Upazilla & Kawkhali Upazilla of Rangamati district on the west; Kawkhali Upazilla of Rangamati district on the north and Kaptai Upazilla & Rajasthali Upazilla of Rangamati district and Bandarban Sadar Upazilla on the east (Fig. 2.1).



(a) (b)

Fig. 2.1 Geographical location of data collection site. (a) Map of Bangladesh, (b) Map of Rangunia Upazilla.

2.2 Study period

The study was conducted from 15th February, 2021 to 31st March, 2021 for duration of about 1.5 months.

2.3 Data collection

Physical features, behavioral characteristics were observed through close inspection and data were collected by asking questions to the farm officials. Body weights were measured using weight measuring balance and were assumed in some cases. Management data such as housing, feeding, deworming, vaccination and overall husbandry status were taken from observation and information was found from the asked questionnaire.

2.4 Statistical Analysis

The obtained data were stored in Excel-2007 and descriptive statistics was done to estimate different variables.

Chapter III

Results

3.1 Animals of the farm:

The present study found a number of 95 gayals and their crossbreds (Gayal x Cattle) in the farm situated at Rangunia Upazilla in Chattogram. (Fig. 3.1)

(a)

(c)

(b)

Fig. 3.1 Animals in gayal farm: (a) Gayal, (b) Brahman cattle, (c) Crossbred

3.2 Physical Features of Gayal:

Gayal exhibited different physical features from other bovines that were reported in the study (Table 3.1).

Table 3.1 Physical features of gayals observed in gayal farm.

Parameter	Characteristics	
Size	The bull gayals was found larger than cow and had larger dewlap than cow.	
Colour	Adults	• Whole black; • Body- black, lower limb and tip of the tail- white; • Body- white, along with black markings or not.
	Calves	Golden to reddish brown
Head	Shorter and broader, with a perfectly flat forehead and a straight line between the bases of the horns.	
Horns	-uniform blackish tint from base to tip -thick and massive -extended almost directly outwards from the sides of the head.	
Udder	Poorly developed and covered with hair.	
Limbs	Shorter and stood much lower at the withers.	
Life span	15 to16 Years	

3.3 Behaviour of Gayal:

Gayals were observed to show behaviours other than cattle (Table 3.3). As these animals were brought under domestication from wild, it possessed both domestic and wild behaviour.

Table 3.2 Behaviours of gayals observed in gayal farm.

Parameter	Behavioural attributes
Nature	Gayals seemed as social animals and lived in herds.
Curiosity	They showed watchful behaviour in new environment.
Leadership	While roaming, a female adult gayal was seen to lead the group.
Aggressiveness	The female gayals of the farm showed aggressive behaviour specially while with calves.
	Male gayals of the farm were comparatively less aggressive.
Diurnal	They were active during the day. Most of the gayals were found to take rest in the midday.
Water-loving	Gayals loved to swim in water and wet in the rain.
	They could less tolerate hot weather and didn't like to feed under the hot sun.
Miscellaneous	Gayals liked to take rest in shady place.
	Some gayals showed reluctant to browse with cattle in new environment but after some days, they became habituated.

Number of gayals according to their colour variations (Fig. 3.2, Fig. 3.3) were counted in that farm (Table 3.3).

Table 3.3 Number of gayals according to variations of colour in gayal farm.

Colour variations in Gayal		**No. of animal**	**Percentage (%)**
Adult	Whole black- which gets bigger and heavier than others,	15	15.8
	Body- black, lower limb and tip of the tail- white,	40	42.1
	Body- white, along with black markings or not,	30	31.6
Calf	Reddish brown	10	10.5
Total		95	100

Fig. 3.2 Variations of colour in adult gayal

Fig. 3.3 Gayal calf

Number of gayals of different types were counted in that farm (Table 3.4).

Table 3.4 Types of Gayal

Types	No. of animals	Percentage (%)
Milch cow (Non pregnant)	5	5.3
Milch cow (Pregnant)	10	10.5
Dry cow	5	5.3
Dry cow (Pregnant)	9	9.5
Heifer (Non pregnant)	5	5.3
Heifer (Pregnant)	6	6.3
Growing heifer	3	3.2
Bull	44	46.3
Bull calf	6	6.3
Heifer calf	2	2.1
Total	95	100

Body weights in different age groups of gayals were determined from that farm (Table 3.5).

Table 3.5 Body weight in different age groups of gayal

Age group	Body weight (Av.) in kg	
	Male	Female
6 Months	84	80
6 Months- 1Year	100	95
1-2 Year	250	190
2-4 Year	400	300
>4 Year	>500	>400

3.4 Rearing System:

Gayals were mostly of crossbred along with some wild pure breeds and all animals reared in semi-intensive system in that farm. Wild gayals were carefully trained up in the farm so that it could be reared as a domestic animal like cattle, buffalo etc.

3.5 Housing Management:

Gayals were housed in sheds made of tin roof, concrete floor, having well ventilation facilities. They were kept along with their crossbreds and cattle (Table 3.6, Table 3.7) (Fig 3.4).

Table 3.6 Housing management in gayal farm

Parameters	Housing
Housing system	Face in housing system 1. Single row 2. Double row
No. of sheds	14
Integrated farming	Gayals were kept along with cattle (Local, Nepali, Brahman) and their crossbreds
Shed	Roof: Tin Floor: Concrete Pillar: Concrete, Wood
Isolation shed	For diseased animals
Quarantine shed	For newly brought animals
Maternity shed	For pregnant animals
Calving Shed	For calving

Fig. 3.4 Gayal shed

Table 3.7 Space allocation in the gayal farm

Space allocation	Area (ft.)
Manger	3
Standing platform	6.5
Gutter	1
Common alley	6

3.6 Feeds and feeding management:

Gayals were provided with straw, wheat bran, rice polish, soybean meal, salt, grasses and so on (Table 3.9). These animals were allowed to roam freely in the hilly environment and come back to farm in time. Here's an interesting thing that gayals were found very much fond of salt. So, they returned to farm in the early evening only for getting salt. Thus, they were captured and brought to the shed. Calves usually started to feed naturally grown grasses from 3-4 months of age.

The farm owned separate fodder plant for cultivation of grasses. Green grasses were supplied from their own fodder plant. Napier, Para, German, Pakchong grasses were cultivated in the fodder plant.

Table 3.9 Feeding formula followed in gayal farm

Components	Amount
Fibrous feed	1% of body weight
Grasses	3% of body weight
Concentrate	1-1.5 kg per animal (1-2 years of age)
	2-4 kg per animal (more than 2 years of age)
Salt	Ad libitum
Water	Ad libitum

3.7 Free-ranging System:

Usually, a group of gayals was released for roaming at a time. After returning of this group of gayals, another group was released from another shed. During free ranging, gayals ate wild grasses, shrubs, herbs etc. grown in the hilly environment. The environment where gayals were released was hilly area beside the farm.

3.8 Breeding:

Reproductive potential of the gayals in the farm was found higher than other bovines. Gayals displayed silent heats, so a breeding bull was required to detect heat. Male gayals used to detect estrus through smelling and licking the vulva of female gayal. Those who were not in estrus did not respond to such behaviour. Male gayal seemed furious when it observed the presence of another male beside its targeted female. Mating system in gayals was not well known. During free ranging, mating occurred between female and male gayal. No Artificial insemination was practiced during this study. It was observed that native bull could detect estrus in female gayal too. Gayals usually breed throughout the year. Semi-domesticated gayals were bred with domesticated local cattle which brought about a higher quality breed with good meat and milk production. But a male produced from crossing between gayal and cattle resulted in sterile (Table 3.10).

Table 3.10 Reproductive traits of Gayal

Reproductive traits	Results
Type of oestrous cycle	Polyoestrous
Symptoms of oestrus	• Silent heat mostly. • Jumping – shown most of the time • Secretion of mucus – very less amount • Swelling of vulva – very less
Age of sexual maturity	Female: 2-3 years of age
	Male: 3-4 years of age
Calving interval	Av. 402 days
Gestation length	296 ± 5 days
Birth weight	Female: Av. 20 kg
	Male: Av. 24 kg

3.9 Maternal Behaviour:

During this study, a female gayal calf was born from 3 years of old female gayal (Fig. 3.5). Actually, it was a crossbred of a female gayal and a male RCC bull. So, it was expected that the new born will be a good milk producer than a genuine gayal in future. Calving occurred in the calving shed. No pregnancy complications were recorded in gayals in that farm. After parturition, the new-born calf broke the amniotic sac and began breathing. The mother licked away the rest amniotic sac and tissues of the new-born calf. The calf strived itself to find out the udder of its mother. After parturition, the mother showed very much aggressive behaviour against any other animals or persons seeing closely to them. The mother didn't leave its newborn calf. Grasses and other feeds were provided by the caretakers in the feed trough. After some days, the mother and the calf were kept with other animals. They used to stay together. The calf was allowed to browse and play outside the shed and the mother was found watchful to its calf. The calf was noticed to suck 12-15 times in a day. Thus, a mother took care of its baby up to 1 week of calving. Then, it became normal and went for free- roaming.

Fig. 3.5 Gayal calf with mother

3.10 Health Monitoring System:

Everyday 6 caretakers were involved to look after the animals. Sometimes 8-10 staffs were required. Gayals were regularly checked up and the farm was regularly visited by the veterinarian of Upazilla Livestock Office, Rangunia. The acting Veterinary Surgeon Dr Harun Ar Rashid seemed very much proactive in management, preventing and treating diseases of gayals in the farm. Vaccination and deworming were done following the vaccination and deworming schedule. Vaccination had been done against Foot and Mouth Disease (FMD), Haemorrhagic Septicaemia (HS), Black Quarter (BQ) and Anthrax.

De-worming had been practiced in the farm in a regular basis. All calves were dewormed before getting exposure of grazing and from then it was repeated in every 3 months interval. Ivermectin was used at a dose of 10mg/50kg body weight. Combination of Levamisole and Triclabendazole was also used.

3.11 Cleaning and Sanitation:

Everyday all the sheds were cleaned using clean water. Cleaning work had been started at 7.00 am. All dungs were removed and placed to the biogas plant every morning. Empty sheds were disinfected using bleaching powder and sanitizer on a regular basis. Foot bath and spraying was present in the entrance. The farm was cleaned thrice in a day with plain water.

Chapter IV

Discussion

The present study on gayal in the gayal farm of Rangunia Upazilla where Ershad Mahmud had started domestication of gayal, has a great impact on livestock industry. In the present study, physical features of gayals and their behavioural characteristics were observed. Gayals possessed variations in colour between calf and adults. Both roughage and concentrate were supplied for the animals. From 3-4 months of age, gayal calves started to eat naturally grown grasses. Interestingly gayals were so much fond of salt. A previous study was found supporting these findings. (Faruque *et. al.* 2015)

It appeared from the study that integrated livestock farming was practiced in the farm under semi-intensive rearing system. The farm animals including Gayal and their crossbreds were mainly of meat purpose. It had seemed that gayal was a poor milk producer. Even the produced milk was insufficient for its calf. So, a calf needed other feed supplements from the very beginning of its growth. (Mohan Mondal *et. al.*2014)

The reproductive performance of gayal was very good. From the register book, it was obtained that the gestation period of gayal was 296 days and calving interval was Av. 402 days on an average which was supported by a previous study. (Giasuddin *et. al.* 2002)

From the study, it was found that female gayals showed silent heat. Sometimes less pronounced estrus symptoms were observable. A comparison was made between cattle and gayal regarding the estrus behaviour in a study. (Samad, 1996)

Maternal behaviour in gayal was observed during this study that the mother gayal was so much careful of its newborn and showed aggressive behaviour towards others to protect its baby. Similar observation was reported in a previous study. (M. Giasuddin and M. R. Islam. 2003)

In this study, health status of gayals were regularly monitored and vaccination record was found. Vaccination against FMD, HS, BQ and Anthrax had been practiced in that farm. Though gayals were highly disease resistant, there might be occurred viral diseases. Similar observations were found in previous study. (Huque *et. al.* 2001 & Giasuddin *et.al.* 2006)

In the present study, it was recorded that regular deworming had been practiced in that farm with Triclabendazole, Levamisole and Ivermectin. Because there might be presence of both ectoparasites and endoparasites which was supported by previous study. (Giasuddin *et. al.* 2006).

Chapter V

Conclusion & Recommendation

Conclusion:

From the above discussion it can be concluded that the gayal farm is a very prospective private farm for meat production. In this present study, physical features, behavioural characteristics and husbandry status of gayal under semi-intensive rearing system were exhibited. Though there were similarities of rearing system with cattle, it was not too easy to restrain and bring about those wild animals under domestication. The study may be concluded that the utility of gayal regarding prospect of gayal farming in Bangladesh is gradually getting popularity day by day due to its demand in meat production. It can be assured that the gayal farm will be more profitable for getting standard level production, if bio-security is maintained properly. It is possible to meet the protein demand of Bangladesh and to remove the poverty of people creating employment opportunities in livestock sector through gayal farming. Considering these facts, Govt. should encourage gayal farming and provide financial support to interested farmers so that it becomes an emerging sector to meet the demand for meat in Bangladesh.

Recommendation:

Access of wild birds in farm area should be controlled. Bio-security measures should be taken more strictly. Management policy should be followed more strictly.

Chapter VI

Limitations

Data keeping was not done properly sometimes. Some data were collected indirect way. No fixed protocol was practiced for management. The period of the study was short to analyse the productive performance. Direct Regular follow up of management practices was not possible due to outbreak of disease (FMD) in the farm. Moreover, due to pandemic of the CoViD19 outbreak, data collection was not possible directly at the ending of the study.

Chapter VII

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Acknowledgement

All praises are due to the immeasurable grace and immense kindness of Almighty “GOD”, the supreme authority and supreme ruler of universe, who has empowered me to complete the work successfully.

I would like to express my gratitude to my supervisor, **Professor Dr. A K M Humayun Kober**, Dept. of Dairy and Poultry Science, Chattogram Veterinary and Animal Sciences University. My heartfelt thanks to him for valuable guidance, suggestion, supervision and encouragement during the entire period of this study to complete this production report.

I would like to express my deep sense of gratitude and thanks to **Professor Dr. Md Alamgir Hossain**, Dean, Faculty of Veterinary Medicine, and CVASU.

I express my sincere gratitude and thanks to **Professor Dr. A. K. M. Saifuddin**, Director of External Affairs, for his supervision and kind co-operation during the period of internship.

I am also grateful to **Md. Mustafa Kamal**, Upazilla Livestock Officer (ULO), Rangunia Upazilla, Chattogram and **DR. Harun Ar Rashid,** Veterinary Surgeon (VS), Rangunia Upazilla, Chattogram for his cordial information and guidance at the time of farm visiting.

Thanks to the owner of the farm and other helping hands who helped me in collecting data for this study.

Last but not least, I am profoundly grateful to my family members for their endless sympathies, kind co-operation, sacrifices and prayers.

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My Goal

As a human being, I have a long-cherished dream to serve my nation through my knowledge, creativity and profession. As a veterinarian, I think I have a great opportunity to fulfill my dream by developing my career in the field as a veterinary practitioner. By dealing as a veterinary surgeon, I would be able to expand and spread my knowledge also. I have also a high interest in Medical Research and Public health approach.