

**PRODUCTION AND MANAGEMENT OF SPOTTED DEER AT
NATIONAL ZOO IN BANGLADESH**

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**PRODUCTION AND MANAGEMENT OF SPOTTED DEER AT
NATIONAL ZOO IN BANGLADESH.**

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CERTIFICATE

*This is to certify that the thesis entitled “**PRODUCTION AND MANAGEMENT OF SPOTTED DEER AT NATIONAL ZOO IN BANGLADESH.**” submitted to the Faculty of Animal Science & Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Animal Science**, embodies the result of a piece of bona fide research work carried out by **Md. Rafiqul Islam**, Registration No. **17-08318** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

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*Dedicated
To
My Beloved Parents*

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ACRONYMS AND ABBREVIATIONS

Abbreviation	=	Full meaning
ARKS	=	Animal Record Keeping System
ISIS	=	International Species Inventory System
BNZ	=	Bangladesh National Zoo
VQC	=	Veterinary Quarantine Control
NSW	=	New South Wales
EAPA	=	Employee Assistance Professionals Association.
WHO	=	World Health Organization
DLS	=	Department of Livestock Service
cm ²	=	Square Centimeter
CFU	=	Colony Forming Units
Cm	=	Centimeter
CONTD.	=	Continued
CP	=	Crude Protein
Dr.	=	Doctor
e.g.	=	For Example
ml	=	Milliliter
kg	=	Kilogram
mg	=	Milligram
IUCN	=	International Union for Conservation of Nature.
Kcal	=	Kilo calorie
ME	=	Metabolic Energy
DMI	=	Dry Matter Intake

LIST OF SYMBOLS

Symbols		Full meaning
:	=	Ratio
@	=	At the rate of
+	=	Plus
<	=	Less than
>	=	Greater than
°C	=	Degree Celsius
°F	=	Degree Fahrenheit
%	=	Percentage
&	=	And
/	=	Per

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ABSTRACT

The production and reproduction profile, feeds and feeding and herd management of spotted deer studied in captive condition at Bangladesh National Zoo in this experiment. For these purposes, fifteen (15) deer's from each group i.e. adult male (Stag or buck), adult female (Doe), juvenile and infant were used during January 15th to December 15th 2018 for a period of one year. Available feeds that were supplied to the spotted deer such as maize fodder, Jambu grass and Gourd Spinach (Kolmi grass), cabbages, Cucumber, gourd, Pumpkin, grain, wheat bran and soybean meal. Amount of CP and metabolic energy was 13.63% and 14.38 MJ ME per day respectively. From the study it was observed that average males and females birth weights were 2.97 and 2.73 kg, adult males and females weights 78.08 and 60.97 kg, males and females weaning weights were 19.05 and 18.49 kg respectively. It was also observed that average weaning age was 5.19 months, length of estrous was 17.40 days, age at first fawning was 14.48 months and gestation lengths were 232.69 days respectively. Instead of this it may be "It is concluded that recommended rations needs to be fed with proper management systems to keep balanced nutritive conditions along with productive and reproductive well being of the spotted deer at Bangladesh National Zoo.

CHAPTER-I

INTRODUCTION

Spotted Deer is widely distributed in all habitats of the Sundarbans. The natural distribution of spotted deer (*Axis axis*) is limited in to the Indian sub-continent, although successful introductions occurred elsewhere (Geist, 1999; Seidensticker et al. 1999). The Spotted Deer ranges between 52600 (Khan 1986) and 80000 (Hendrichs, 1975), and 83000 (Dey 2007). The relative abundance of Spotted Deer varies from habitat to habitat, a gradual reduction from west to east (Deodatus and Ahmed, 2002) and deer density increases with the habitat ensuring fresh drinking water (Feeroz, 2001). Apart from the Sundarbans, several islands in the Bay of Bengal also support large population of Spotted Deer. The availability of drinking water, trees for shade, grass for forage, and in presence of the high rugged terrain are four factors that influence the spotted deer concentration in certain areas. Deer have been morpho-physiologically classified as ruminants. Their main fodder in the forest are the leaves and fruits of keora, new leaves of passur, gewa, and various grasses, but they met their calcium requirement by chewing fallen deer antler and eating crab, shrimp etc. In Bangladesh National Zoo (BNZ), the number of spotted deer & barking deer are 241 & 11 respectively. To keep them nutritionally sound everyday a balanced ration is supplied containing green fodders (Maize fodder, Jambu grass, and gourd spinach), vegetables (Cabbage, cucumber, pumpkin) and concentrate feeds (Grain, Soybean meal, wheat bran, vitamin-mineral and common salt). Deer are highly sensitive, agile and powerful. They are hardly an easy experimental animal to work with. Nevertheless, feeding of captive deer is now greatly simplified by the development of a pelleted ration which seemingly provides the essential nutrients for optimum growth and maintenance. In future it could an expedient to supply complete pelleted ration for free roaming deer that are faced with acute browse shortage and severe environmental pressure.

There is about 20% growth rate of world deer industry annually with about five million deer currently being farmed (Hudson, 1999). The estimated national deer

numbers in New Zealand was 2.25 million (24,400 tons of venison) with 90% venison being exported to Europe, mainly to Germany in 2002 (Ministry of Agriculture and Forestry, NZ, 2003). The second largest farmed deer population in the world (500,000, mainly sika deer) is in China. Other countries, such as United Kingdom (UK), Denmark and United States of America (USA), also have a significant number of deer. The highest number of sika deer is being farmed in China, and that of red deer is the highest in the New Zealand. About 4 tons velvet is annually imported from China and Taiwan and about 400 tons venison from New Zealand in Japan (Yokohama et. al., 1991). According to Hoffman's morpho-physiologically criteria, main species of fanned deer in Korea, Wapiti, red deer (*Cervus elaphus*), and spotted (sika) deer, are classified as intermediate farming types (Hoffmann, 1988, Henke et al., 1988). Venison and velvet antlers are the main products produced from deer. Venison is low in calories, fat and cholesterol but high in protein and iron, making it suitable for low fat diets. Venison is rich in poly unsaturated fatty acids (Sookhareea et al., 1995), perhaps because much of the carcass fat is structural. Growth rate and carcass fat content determine the profitability of venison production. The major consumer of venison in the world is Germany with 50-60,000 tons of venison consumed annually. New Zealand is the world's largest producer and exporter of farmed venison. Australia produces 1,000 tons of venison annually, 80% being exported (Shapiro, 1998). Velvet is composed primarily of 34% ash, 12% moisture, and 54% organic substances (contributed to by 10% total nitrogen and 3% fat) (Agri-Research, 1982). According to Wang (1996) deer antler velvet has been used in Chinese medicine for over 2000 years. Although deer antler velvet is mainly used in Chinese medicine to promote wellness and prevent illness, it is believed to have many health benefits. Suggested benefits of deer antler velvet include, possible growth effects, improved immune function, anti-inflammatory and anti-cancer properties, increased athletic performance, decreased recovery time following surgery, memory enhancement, improve cardiovascular function, gonadotropin effects and reductions of cholesterol. Systematic studies have never been conducted on the feeding, reproduction, and management operations of spotted deer in captivity at Zoo in

Bangladesh excluding some surveys. Information on population of this species in-situ and ex-situ are available from some studies conducted by the Sundarban Biodiversity Project (Deodatus and Ahmed, et al., 2002). Spotted deer abundance makes Sundarbans one of the most conspicuous attractions for tourism, takes place significant ecological role in the ecosystem, being the most important link between primary production and tiger densities are positively correlated with the bio-mass of prey species. To ensure tiger's survival we must not only find out more effective ways to protect deer and its habitat, but we should also explore all avenues to protect, maintain and endless cervid populations (Sunquist, 1999). Deer farming is an economically promising industry. To establish deer farming for the production of venison and other by-products, it is essential to understand and develop effective ex-situ management systems of spotted deer in Bangladesh. Conservation of nature and natural resources are now a global concern. Without proper scientific knowledge on conservation management, natural resource utilization is very difficult. Therefore, the present study was undertaken by setting the following objectives.

General Objectives

- To study the management practices

Specific Objectives

- ✓ To find the feeding schedule (feeding schedule and materials, security)
- ✓ To find the habitat situation
- ✓ To find the security situations
- ✓ To find the rearing cost of Spotted Deer (*Axis axis*) Research in Bangladesh National Zoo.
- To examine what practical action could be taken to improve their management.
- To explore the production profile of the spotted deer at Bangladesh National Zoo.
- To know the reproduction profile of the spotted deer at Bangladesh National Zoo.

CHAPTER-II

REVIEW OF LITERATURE

The review of literatures on production and management of deer is presented in this chapter. The parameters includes are: feeds and feeding, production & reproduction profile and herd management.

2.1 Feeds and feeding

Deer seek out the highly palatable feed in preference to feed of medium or low palatability. Their feed utilization is influenced considerably by the season. Highest feed intake occurs during the spring when plants contain highest protein and medium intake occurs during the winter when feed is scarce. During the rut, males ingest little or no feed was reported by Vos, (1982). Deer have been morpho-physiologically classified as ruminants, which readily browse shrubs, forbs and grasses (Hofmann, 1988; Henke *et al.*, 1988; Jeon *et al.*, 1995).

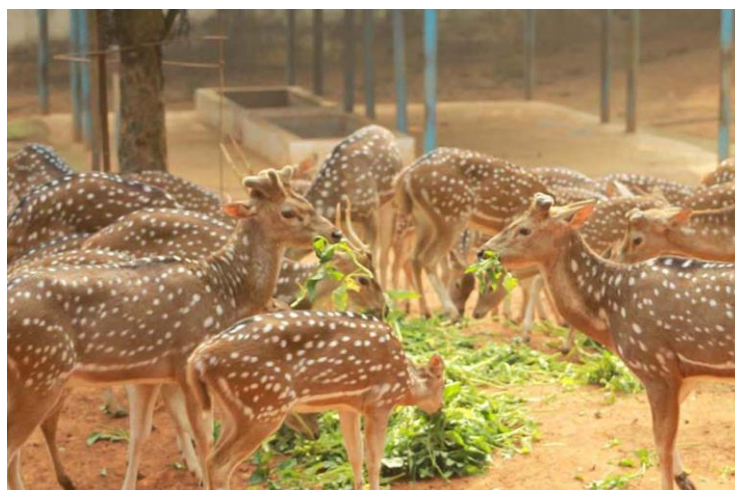
Milne *et al.* (1978) pointed out that deer can eat and digest any kind of feedstuffs used for more traditional domestic ruminants. In digestibility trials deer have been found to digest poor quality roughage diets less completely but high quality concentrate diets more do sheep.

Jeon *et al.* (2000) reported that forest by-products consists of about 80-90% shrubs and browses such as oak tree, lacquer tree, hazel tree, arrowroot, azalea and sedge, were widely available to deer. They also reported that forest by-products are highly economical as a roughage source for deer in competition with imported feed such as oak leaf hay and alfalfa bale. Deer had higher palatability for browses and shrubs than for forages. Natural mixed diets are seldom used on deer farms because they tend to be of variable quality and expensive with the high labour costs to harvest them. In Korea, oak leaf has been used as a roughage source for deer because of high palatability and presence of tannin that can have positive on animal performance was reported by Aerts *et al.* (1999).

Kim *et al.* (1996) reported that imported oak leaf had low nutritive value and nitrogen availability compared with home grown roughage sources such as corn

silage and rye silage. Whole browses, shrubs, and wild grasses from reforestation areas are valuable feed sources for deer was studied by Jeon *et al.* (1998).

Kurkela. (1976) stated that it has been proven possible in Finland to maintain reindeer in a satisfactory condition in enclosures on a diet of green plants even over prolonged periods. They grew and reproduced without any disturbances attributable to this feed. Rein deer consumed grass and cultivated plants. Fodder cabbage and turnips can be used even in slightly frozen state; and has no panel effect on its nutritive value. The use of grain concentrates boosts the overall strength of the diet.



Photograph-1: Feeding of Gourd Spinach at Bangladesh National Zoo



Photograph-2: Feeding of Maize fodder at Bangladesh National Zoo

Moon *et al.* (2000) showed that daily intake is relatively stable at approximately 3% of body weight on a DM basis and they also pointed out the DMI is around 2.0% in winter increasing to 2.3% in summer for adult spotted deer. The tastes of

yesosika deer for hay and silage, which are considered to be generally fed and *Sasa senanensis* which are grazed on by wild yesosika deer throughout the year and notable in terms of effective utilization of resources evaluated by Souma *et al.* (1995). Spotted deer have a good digestive capacity and adaptability for forages Kim *et al.* (1996).

Adam (1994) investigated daily dry matter intakes (DMI/ kg) red deer according to season and physiological status or age.

Table-1: Daily dry matter intakes (DMI/kg) deer according to season & physiological status or age:

Season	Hinds		Stags	Growing calves		
	Status	DMI (Kg/d)	Status	DMI (kg/d)	Age (Months)	DMI (kg/d)
Autumn	Dry/weaned	1.7	Rut/Live weight loss	0.1-3.0	3-5	1.4
Winter	Mid pregnancy	2.0	Maintenance	3.0	6-8	1.3
Spring	Late pregnancy	2.3	Increasing body condition	4.0	9-11	2.00
Summer	Lactation	3.0	Increasing body condition	4.0	12-15	2.2

Source: Azad et al., 2005

Ru and Fortune (2000) stated in their study that In October CP and digestible energy intake by male & female deer was 201.49 g/day (M), 142.7 g/day (F) and 19.49 MJ/day (M), 13.36 MJ/day (F) respectively. The level of supplement tannin during early winter influenced forage intake rate and a decline with the increase of forage. The met-abolishable energy requirement for maintenance for calves (three to 11 months of age is approximately 0.45 MJ/kg (Milne et al., 1987) and for adults is about 0.57 MJ/kg (Fennessy et al., 1981) (Table-1).

Adam (1994); Adam and Fletcher (1994) stated calculated daily ME requirements in their study by red deer for maintenance and requirements for growth, pregnancy

and lactation. Adam (1994) investigated crude protein (CP) concentrations in diets for farmed deer (Table-2).

Table-2: Calculate Daily ME Requirements by deer for maintenance and requirements for growth, pregnancy and lactation.

Item	Body weight (kg)	ME requirement (MJ) for					
		Growth at (g/d)					
		Maintenance	Season	50	100	150	200
Calves (3-16 months)	40	7.2	Autumn	2.8	5.5	8.3	11.0
	50	8.5	Winter	4.4	8.7	13.1	17.4
	60	9.7	Spring/Summer	2.4	4.9	7.3	9.7
		Maintenance	Late pregnancy	Peak Lactation			
Hinds	80	15.2					
	100	18.0	1.7-5.0		17.2		
Stags	150	24.4	-		-		
	250	35.8					

Source: Azad et al., 2005

Table-3: Investigated crude protein concentrations in diets for farmed deer.

Item	Age/Status	Season	CP (% DM)
Calves	3-5 months	Autumn	17.0
	6-8 months	Winter	10.0
	9-15 months	Spring/Summer	12.0-17.0
Hinds	Dry	Autumn/Winter	10.0
	Pregnant	Spring	14.0
	Lactating	Summer	17.0
Stags	Weight loss	Autumn/Winter	10.0
	Weight gain	Spring/Summer	12.0

Source: Azad et al., 2005

Milne et al. (1987) studied that there is no substantial evidence for seasonal changes in the maintenance ME requirement for grazing calves, but some evidence for changes in the efficiency of utilization of ME for growth. Estimated values from United Kingdom studies are approximately 53-57 MJ ME per kg body weight gain in November to December at five to six months of age, 87 MJ in January to February at seven to eight months and 41-56 MJ in March to April at nine to ten months. The additional daily ME requirement above maintenance for pregnancy in the red deer increases from 1.7 to 5.0 MJ in the last three months of gestation Adam et al.(1988) (Table-3).

Verme and Ulirey. (1972) stated that protein is very important for body growth in deer, especially for fawn and yearlings. Inadequate protein intake in a given year will also reduce antler development. In fact, a period of inadequate nutrition (low protein) for buck fawns may adversely influence antler development for several succeeding years. A deer must obtain at least a 6% to 7% crude protein diet to maintain rumen function, but a protein diet in the 13% to 16% range is required for successful growth, antler development and reproduction. For their first year of life, deer benefit from levels of 16-18% dietary protein for elk and red deer and 18.5% for sika deer during antler growth period as reported by Gao et al. (1993).

2.1.1: Water intake

Water requirements for deer vary with type and amount of feed consumed, physiological state, amount of activity and environmental conditions such as varying ambient temperatures. The amount of drinking water consumed is inversely proportional to the percentage of water in feed. Forage plants often contain significant amounts of water (45 to 65% in browse and 70 to 90% in forbs). Water availability can be critical during drought seasons when forbs and other succulent vegetation are scarce (Reid, 1987; Wemmer, 1987). For red deer water intake varied from 0.27 l/kg matter from a grass diet to 3.82 l/kg dry matter on concentrated pellets as investigated by Maloiy et al. (1970).

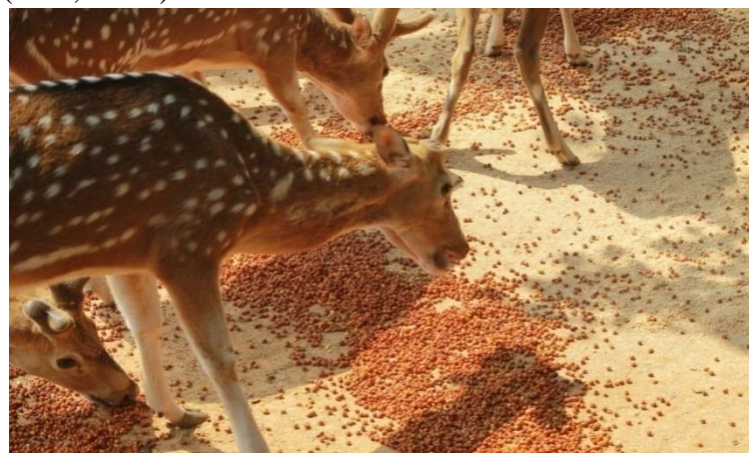
Ullrey et al. (1970) stated that water is consumed in the ratio of 2.9 l/kg of feed. The water intake from ranges of grazing animals is dependent- on ambient

temperature, forage moisture and forage mineral content. Water intake of red deer varies from 0.27 l/kg DMI for a grass diet to 3.82l/kg DM on concentrated pellets as studied by Bonengel, et al. (1969). Fallow deer requires less water per unit of feed intake was studied by Denham et al. (1984).

2.1.2: Supplemental feeding

Karoline and Hoi, (2002) stated in a study that Supplementary feeding which provides constant feed supply throughout winter removes the selective pressure of winter harshness on nutrition-mediated phenotypic traits. In red deer, variations in winter and spring weather conditions encountered by the mothers during pregnancy and during the first year of life are a main determinant for individual life history as well as population dynamics. Stocking rates on deer farms should be relatively high to achieve efficient utilization of expensive fencing. Supplementary feeding will assist efficient utilization of pasture as well as fencing and reduce changes in the botanical composition of pasture as a result of seasonal over grazing was stated by Fennessy, (1982).

The specific objective of supplementary feeding should match the seasonal variation of pasture production with supplements to the seasonal variation of voluntary feed intake by the deer. Supplementary feeding should be carefully planned to correct the energy: protein imbalance of available pasture and to avoid "substitution" feeding (Denham, 1984; Robbins, 1993). Deer show strong preferences for, or rejection, of many supplementary ingredients fed to traditional farm livestock (Koo, 1997).



Photograph-3: Feeding of Grain at Bangladesh National Zoo.



Photograph-4: Feeding of Ration Feed at Bangladesh National Zoo.

2.1.3: Seasonal effect on feed intake

Souma et al. (1998) observed that in yeso sika deer, seasonal changes are occurred in hay intake. These seasonal changes in feed intake may be partly due to seasonal differences in the types of plants that can be grazed on by wild deer. Deer such as red deer are known to show seasonal differences in behavior. In autumn as their reproduction season, male deer show active reproductive in the harems, and a resulting marked decrease in the grazing time reduces feed intake. In female deer, their grazing behavior is prevented by male deer that form harems and surrounding male deer, which also reduces the grazing time compared with the other seasons, was evidenced by Souma et al. (1994).

Masuko et al. (1999) stated in their study that in yeso sika deer, the intake of *Sasa senanensis* differed among autumn, winter, and spring. Seasonal changes in dry matter intake and observed that both the hay intake per day and that per kg body weight increased from spring, reaching the maximum in summer, but decreased in autumn, reaching the minimum in winter. The dry matter intakes of hay per kg body weight were 1.99%, 2.44%, 1.58%, and 1.35% in spring, summer, autumn, and winter, respectively. The dry matter intake of *Sasa senanensis* per body weight in spring was lower, but that in autumn and winter was slightly higher than the dry matter intake of hay per kg' body weight in each season. These results suggest that

the dry matter intake of *Sasa senanensis* in yeso sika deer is similar to or higher than that of hay, and *Sasa senanensis* is an important feed resource for nutrient intake in winter was evaluated by Souma et al. (1998).

Worden and Pekins, (1995) pointed out that the reduction in DMI during winter has been largely attributed to physiological adaptation of energy conservation under low environmental temperature. A faster passage rate of feed particles during winter was related to variation in digestion ability caused by the changes in the endocrine and autonomic nervous system. This in turn is caused by the decline of photoperiod and decreased environmental temperature. A close relationship between feed intake and digestibility and the seasonal metabolism of deer was investigated by Sasaki et al. (1987).

2.2: Production and reproduction profile

Chapple et al. (2003) pointed out that mean duration of the estrous cycle of chital hinds was 19.3 ± 1.3 days, with a range of 17-21 days. Serum progesterone profiles are shown, with minimum progesterone concentrations near estrous less than 2.7 n/mol and maximum lateral values, 16-26 n/mol, mean duration of gestation was 234.5 ± 3.0 days. Chital deer hinds living in a temperate region exhibited regular patterns of estrous cyclicity throughout the year as evidenced by concentrations of serum progesterone monitored over a 14-month period and detection of behavioural estrous by vasectomized stags. The mean length of the estrous cycle was 18 ± 0.7 days (range 12-23 days). Profiles of serum progesterone showed concentration of $< 0.5 \text{ ng/m}$ at the time of estrous, which rose to a peak (range 1.5-5.0 ng/m) about day 13, and then declined to low concentrations at the next estrous. Observations following parturition showed that the first detected estrous occurred at a mean time of 26.9 ± 3.0 days. The mean length of the estrous cycle after the post-partum estrous was 16.6 ± 1.0 days (range 7-20 days). The presence of a stag may influence the length of the post-partum period in chital deer hinds was investigated by Mylrea et al. (2004).

Ables. (1977) showed that the reproductive pattern in axis deer is similar to that in domestic cattle. Each buck seems to have a reproductive cycle of its own which

may not be synchronized with that of other bucks in the herd. Consequently, when some bucks are coming into rut, others are going out or are in a non-breeding condition, females experience estrous cycles throughout the year with each cycle lasting about 3 weeks. The major breeding season lasts from Mid-May through August with a June-July peak in activity. Only one fawn is produced per pregnancy after a gestation period of 210-238 days, reflecting the summer peak in rutting activity. Nearly 80% of Texas fawn are born in early January to Mid-April although fawns may arrive in all seasons. Following parturition females again mate during the subsequent breeding period so that adult females tend to produce one fawn each other, twins are rare. Adult size is reached at 6 years for females and 4-5 years for males and females mature sexually and first breed at fourteen to seventeen months of age with a weight of 150 pounds and also males are probably capable of breeding as yearlings but must achieve adult size to compete for females with a weight of 200 pounds.

Vos. (1982) reported that successful deer fanning requires an understanding of the basic reproductive characteristics of the deer species concerned and the factors which may alter their performance. There is a positive correlation between body weight and fertility: experiments at Germany, New Zealand, Showed that the percentage of red deer calves dropped by yearling hinds less that 65 kg in live weight was only 50%, while above 65 kg it could be about 90% was evidenced by Kelly and Moore. (1978).

Mitchell and Brown. (1974) stated in their study that a live weight of 75 kg for hinds should give calving percentages of 50%. The authors developed a model of the relationship between age, weight and fertility for red deer. They also stated that the highest fertility for red deer lays in year classes 5 to 8 and there is a definite difference between hinds with and without calves. Puberty in doe fallow deer is reached in 15 months and a weight of 50 kg for sexual maturity. Small herds of red deer generally have a better reproductive performance than large herds from birth to weaning, a calf death rate of 5-10 in normal and virtually all these occur within a few days of birth. Stress of capture and transport results in abortions and two years old hind having a lower calving performance was reported by Vos. (1982).

Kelly and Moore. (1978) stated that a stag: hind ratio at mating of 1:10 is an excessive use of stags. In Scotland in mating groups, ratios are used of one stag to eight hinds or two stags to 25 hinds, there may be an advantage in admitting a second younger stag at the same time as an older, dominant stag is put with his group of hinds were concluded by Sharman, (1978). The sex ratio of musk deer in large enclosures is male to 3-7 females. Groups generally contain 10-15 animals. As juvenile males will fight each other with the help of their canines, they should be kept in individual enclosures studied by Vos. (1982).

Kay and Staines. (1981); Mulley et al. (1990) pointed out that fawn birth weight generally approximated 10% of their mother. Considering the relationship between the weaning time and the body weight of hinds or does, weaning time will consequently influence the birth weight of fawns and calves. The weight of the hind did not influence the weight of calf at birth, suggesting the supply of nutrients in the early stage of lactation appears to be more crucial for growth was stated by Landete et al. (2001) found that usually deer calves begin to consume solids from about 2 weeks-of-age. Good quality pasture, meal or other palatable concentrates should be provided from an early age to develop their digestive system was pointed out by Wilson, (1984). Weaning generally takes place between (14 and 21) weeks at an average weight of 18 to 21 kg was investigated by Mulley et al. (1990).

The nutrient requirements of a weaned hind is about half that of a lactating hind. The body condition of early weaned hind and does recovers before mating, which ensures high pregnancy rates (greater than 80%) in the first 18 day cycle. Breeding females need 4 weeks to recover any lactation loss of body weight before mating. For high conception rates, adults does should be greater than 42 kg at mating, with 16 month old does between 35-38 kg (Pearse, 1996).

Pollard et al. (2002) pointed that weaning early is expected to have a positive effect on hind conception date and winter hind condition. Post weaning losses can also occur with early-weaned fawns, due to stress and adverse weather conditions were stated by Christie. (1993).

Pollard et al. (2002) concluded that weaning early could have a negative effect on calf growth rate but management could override negative effects of early weaning.

In New Zealand, some farmers believe that young deer survive harsh winter climates better when not weaned.

2.3: Herd rear management

2.3.1: Capturing procedure

Nielsen. (1988) concluded that methods of capturing deer can be categorized as mechanical, chemical and a combination of mechanical and chemical. Both mechanical techniques include drop nets, standing tangle nets, clover traps, panel traps, box traps, rocket nets, corrals, or enclosures. Chemical immobilization involves using drugs to capture and restrain animals. Sometimes a combination of these methods is used, and animals are caught mechanically and subsequently immobilized using chemicals. Each method has advantages and disadvantages. Many factors must be considered when determining which capture method to use, including reason for capture, terrain, number and type of animals to be captured, and amount of money and human resources available was reported by Clark. (1995).

Beringer et al. (1996) reported that capture method and the number of deer captured during each attempt were strongly related to a deer's survival. Hawkins et al. (1967) reported that capture by remote immobilization resulted in higher mortality rates than capture with box traps or drop nets.

Conner et al. (1987) reported that modified handling procedures contributed to a reduction (>50%) in mortality between trapping periods. Trapping mortality is also influenced by whether the animal is trapped and released on site or trapped and trans-located to a site unfamiliar to the animal. Drugs used in New Zealand for immobilization of red deer include xylazine (Rompun, Bayer) and a Fentanyl Azaperone mixture (Fentaz, Ethnor Ltd.).

Intramuscular dose rates used for red deer are: Rompun 0.2-5.5 mg/kg (average 0.4 mg/kg) live weight. Fentaz may be administered as 2.0-4.0 ml/100 kg of live weight. Both Rompun and Fentaz are required in higher doses an open range and also for stressed animals. Fentaz effect is relatively consistent and rapid and an antidote is available. Dose rates of 1ml/45 kg are quiet for farmed deer and of

1ml/22 kg for range deer. Xylazine is a slow acting sedative with a considerable safety margin. Male deer require a high dosing rate than females. Intramuscular injection of immobilizing drugs is effected by syringe if deer are confined to yards with free ranging or paddock animals, drugs are administered either by tranquilizer dart guns or by blow darts. The major advantage of a blow dart in confined areas is its lack of noise and hence the decreased likelihood of panic and tramping.

2.3.2: Provision for Shelter

Pollard and Little Jeon. (2000) distributed a questionnaire on shade and shelter among deer farmers throughout New Zealand. Most respondents' felt that shelter improved deer health and growth, and shade was beneficial to deer health; vegetative covers for hiding improved neonatal calf survival. Farmers provided opinions on sitting for shade and shelter, techniques for protecting trees and suitable species to plant.

In order to keep deer in good physical condition and also to meet their behavioral requirements, it is essential that some elements of natural range conditions be provided on deer farm range. These include cover, certain food plants, which are preferred in the wild and permanent source of water. Cover or shelter is essential to protect the deer against wind-chill, excessive sunshine. Some cover should be available in each paddock for the deer to retreat. Cover should be dense in places. Newly born deer generally preferred sheltered location as reported by Vos. (1982). Deer, being well insulated are particularly sensitive to weather conditions and if adequate to photographic or vegetative shelter is not available, the provision of suitable artificial shelter is recommended. Calving hind and calves tend to seek suitable in natural cover, for example in patches of bracken. Where there is absent, suitable cover should be provided well in advance of calving's of that the hind is used to her surroundings (Codes of Recommendation, 1989).

CHAPTER-III

METHODS AND MATERIALS

3.1: GENERAL INFORMATION OF SPOTTED DEER

3.1.1: Scientific classification of spotted deer

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Mammalia
Order	:	Artiodactyla
Family	:	Cervidae
Subfamily	:	Cervinae
Genus	:	Axis
Species	:	<i>Axis axis</i>

The chital (*Axis axis*) also known as chital deer, spotted deer or axis deer is a deer which commonly inhabits wooded regions of Sri Lanka, Nepal, Bangladesh, Bhutan, India, and in small numbers in Pakistan. However it occupies a wide range of habitats from mainly grass, shrub vegetation in Wilpattu National Park, Sri Lanka (Esinberg and Lockhart, 1972) to denser areas in the Gir forest of India. The spotted deer is found in large numbers in dense deciduous or semi-evergreen forests and open grasslands. They do not occur at higher elevation forests where they are usually replaced by other species such as the Sambar deer. Chital are primarily grazers and feed on short, sprouting grasses. However, they will also browse as well as eat forbs, fruit and branches of trees, especially when they are thrown down by monkeys. Chital prefer to be near water and will drink mornings & evenings in hot weather. Predators of the chital include tigers, Asiatic lion's leopards, dholes and mugger crocodiles. Red foxes also sometimes prey on chital fawns. The chital can run up to 40 mph (65 km/h) to escape his predators. Axis deer most commonly occur in herds of ten to fifty individuals of both sexes. Chital hinds have three week long estrous cycles. A stag will follow and guard a hind in estrous. During this time the stag will not eat. The pair will do several bouts of chasing and mutual licking

before copulation. Stags guarding estrous females will make high-pitched growls at lesser stags that hung about. When alarmed, chital will bark. These barks usually occur among females and juveniles and is repeated back and forth. Fawns that are separated from their mothers will squeal. When in danger, they run in groups. They will make bursts of high-speed running and then soon tire and dive into heavy cover to hide. The Chital is listed by the IUCN as Least Concern "because it occurs over a very wide range within which there are many large populations". However population densities are below ecological carrying capacity in many places due to hunting and competition with domestic livestock. Two primary reasons for its good conservation status are its legal protection as a species and a network of functioning protected areas. It seems success in rearing Chital in many parts of the country. In Private farm of Laharepauwa, Rasuwa district it was very successful. Although they have no formal record they had increased about three times in number of Chital within five years i.e. from 15 to 44. It is also in good condition in Musk deer research center, Godawari, Kathmandu. Breeding in captivity at the center seems to be satisfactory. So, Chital is suitable species for breeding and farming in Nepal.

3.1.2: Other Common Names

- * French : Chital deer
- * Spanish : Chital deer
- * German : Axishirsch
- * English : Spotted deer
- * Bangali : Chittra deers

3.1.3: Natural History

The first artiodactyls (even-toed ungulates) were present in the Eocene forests. The axis deer are probably descended from small animals like the chevrotains which browse and eat fallen fruit in forests. Like the chevrotains, deer use fermentation in their gut to digest plant material more efficiently - called rumination. As the forests began to open up in the Oligocene, ancestors of deer grew larger and browsed on the vegetation or grazed the new grass. They probably also formed herds for safety

against predators. In the Miocene, the first horned deer appeared, with the males having horns to fight rather than using their canine teeth.

3.1.4: Morphometric

The Spotted deer is considered the most beautiful of all cervids. The deer are born and have for life a bright reddish coat, which is marked with white spots. These spots usually run in uneven longitudinal rows. There is a dark dorsal stripe which runs along the along the deer's spine. The underside of the deer are white as are the inner legs and the under tail. (texas)

The dental formula of the deer reported in by Chappelle (1989) is:

Incisors 0/3 Canines 0/1 Premolars 3/3 Molars 3/3 = 32

A canine is present at birth on each side of the upper jaw and is later lost.

3.1.5: Mass and Basic Body Measurements

Shoulder height	:	30 – 38 inch (75cm)
Body length	:	42 – 55 inch (110 – 140cm)
Tail length	:	8 – 12 inch (20 – 30 cm)
Weight	:	165 – 220 lb (75 – 100 kg)

Stags are bigger than hinds. The average weight for mature spotted deer hind range from 46kg in Sri Lanka to 57kg in India. The stag from 64kg in India to 98kg in Hawaii.

3.1.6: Sexual Dimorphism

- ◆ Males are larger bodied than does with thicker necks and broader chests.
- ◆ Males have antlers which shed annually.
- ◆ Males have darker facial markings with a more pronounced “scowling” expression the older they get. (Comanche Spring Ranch).
- ◆ Males have a dark dorsal stripe running down the length of it's back (Albes, 1977).

3.1.7: Distinguishing Features

- * Spotted bucks can be in hard horn any time of the year. They grow and shed antlers throughout the year so in one herd there may be a newly shed buck, a

hard horn buck and a buck in the velvet. Antlers are usually 22 to 27 inches. Trophies range from 30 to 36 inches. Axis have a typical antler structure of three points on each side consisting of a main beam, one secondary point halfway up the beam, and a brow tine. Four points on a side are not uncommon. (Comanche Spring Ranch)

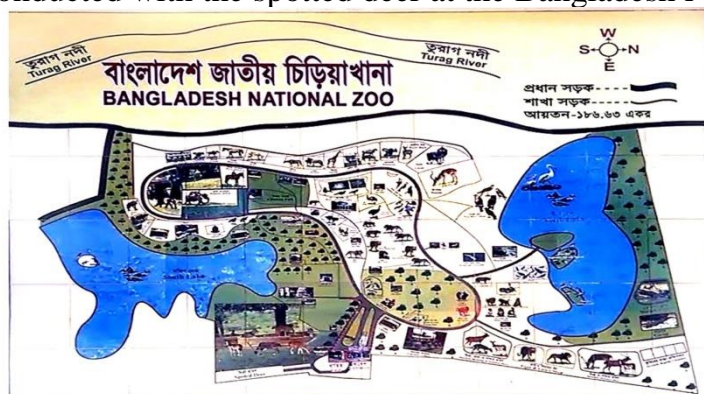
- * Chappelle says the various morphological characteristics reveal that chital are one of the most primitive cervids, having been present during the Pliocene and Pleistocene in Europe and Asia. There is a simple three-tined antler reaching about 81cm in length, with only a brow point and a single fork at the extremity, with bez and trez times absent

3.1.8: Distribution and Habitat

- * Axis deer are native to India but have been introduced to Queens land, Australia, Texas in the United States and Hawaii. Large numbers of free range herds live in theses' area.
- * In their native lands, the deer occupy grasslands and very rarely move into areas of dense jungle that may occur adjacent to them.
- * Short grasslands are an important area for them due to a lack of cover for predators such as the tiger (Moe and Wegge, 1994)
- * The forest also provides good foraging with regard to fallen fruit and leaves that are high in nutrients needed by the deer. Therefore, the deer require open areas as well as forested areas within their home ranges for optimum habitat.
- * Their total range incorporates a core area of about 32 hectares (ha) surrounded by foraging and cover areas of about 140 ha for females and 195 ha for males (Moe and Wegge, 1994).

3.2: Location of the study

The study was conducted with the spotted deer at the Bangladesh National Zoo.



Photograph-5: Map of Bangladesh National Zoo.

3.3: Study period

The experiment was carried out from January 15th to December 15th 2018 for a period of one year.

3.4: Environmental condition of the study area

The production of spotted deer in a Zoo, tourist and their interaction are greatly influenced by the local environmental condition. Therefore, environmental condition of the study area is overviewed. Maximum and minimum temperatures as observed in May and January ranged between 33°C and 15-20°C. Summer season continued from April to June 25- 30°C and winter lasted from December to February. Rainfall started in May and continued up to September. About 95% of the annual rainfall occurred during the monsoon. The maximum humidity was observed 96% from July to September and the minimum about 45% from January to April (BBS, 2000).



Photograph-6: Spotted Deer (Fawn) at Bangladesh National Zoo.

3.5: Experimental animals

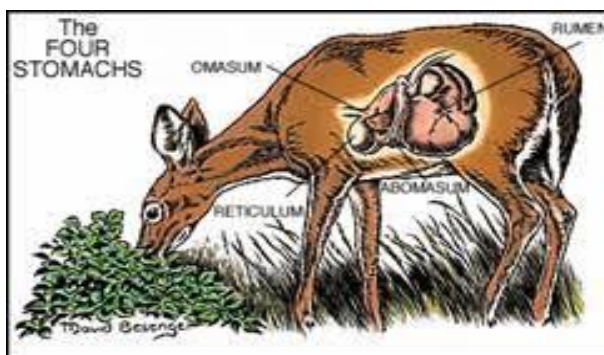
The necessary data for this experiment was collected from the following numbers of deer such adult male, adult female, Juvenile, Infant as 15, 15, 15, 15 respectively at Bangladesh National Zoo.

3.6: Parameters studied

The present study covered the following aspects of spotted deer such as feeds and feeding, production and reproduction profile and herd management.

3.7: Feeding Requirements

Chital deer are ruminant herbivores. (Sub order Ruminantia).



Photograph-7: Digestive System of Spotted Deer.

Deer have a four-chambered stomach. The first chamber, called the rumen, is for storage. The rumen allows for the deer to gather a lot of food at once and then digest it later. The deer bring the food back up into their mouth and chew it again. This process is called chewing their cud. It is also called ruminating, named after the rumen. Animals that can do this are called ruminants. The reticulum is the second stomach chamber. This is where the microorganisms live. The microorganisms attack the chewed food that the deer has eaten. This process is called fermentation. This helps to break the cellulose down into simpler substances that can be absorbed by the deer and the microorganisms. Fermentation produces a gas (methane), which the deer must discharge very regularly. When deer chew their cud again, mixed in with the digested food are microorganisms. The deer chew the microorganisms and a lot of deer's nutrition comes from them. There are plenty of microorganisms left in the reticulum. This time when it goes back down, the chewed food goes to the third chamber the omasum. This is where water is absorbed. Finally, the resulting cud enters the last chamber, (the abomasum), where gastric juices continue digestion. Gastric juices are liquids, like the acids in your stomach that help digest food. Last, it moves on to the intestines. This is where the food is absorbed by the animal's body. This is where the animal receives the nutrients for his body. The deer's intestines are 28 feet long. When the animal has absorbed everything it can use, everything that isn't digested is passed off as waste droppings.

3.8: Feeds and feeding

This part covered the following aspects-

- * Feed sources
- * Chemical composition of feed
- * Water sources
- * Supplemental feeding and
- * Seasonal effect on feed intake.

3.9: Production profile

This part covered mainly the following aspects-

- * Birth weight of male and female
- * Adult weight to female
- * Weaning weight of male
- * Weaning weight of female
- * Weaning age
- * Length of estrous
- * Age at first fawning
- * Gestation length and
- * Sex ratio.

3.10: Herd Management

This part covered mainly the following aspects such as capturing procedure and provision for shelter.



Photograph-8: Herd Management of Bangladesh National Zoo.



Photograph-9: Herd Management of Bangladesh National Zoo.

3.11: Housing Requirements

3.11.1: Exhibit/Enclosure Design

There are no EAPA spatial requirements set in NSW for ungulates in the captive environment. The spotted deer are a flighty animal and need a large flight distance. The exhibit should have tall fences with a perimeter fencing.

3.11.2: Holding Area Design

In designing holding yards for deer there are factors to be considered:

- * A design that be easy to separate into small groups or individuals with many pen areas.
- * Deer like to move around corners.
- * Ideally the main area should have concrete floors that are sloped to allow drainage and ease of cleaning.
- * A deer crush is essential.
- * A set of scales is essential and can often be incorporated into a crush.
- * The design must provide adequate ventilation and air movement without drafts.
- * The design must allow adequate lighting.
- * The site should have electric power and running water.
- * Gate latches should be designed to minimize opportunity for injury to stock.
- * Walls inside the shed are usually 2.0 to 2.5 meters high. The bottom 1.2 to 1.5 meters is constructed of solid paneling or similar product. Above the solid paneling boards are spaced to provide horizontal viewing slits for the deer. Receivable yards are used in deer farming and are constructed with solid walls using ply board sheets. There needs to be no protrusions that can injure deer. The laneways to access holding yards ideally should be narrow but allow the deer's to move freely into the holding yards.



Photograph-10: Housing of Bangladesh National Zoo

3.12: Spatial Requirements

There are no EAPA spatial requirements set in NSW for ungulates in the captive environment.

3.13: Position of Enclosures

The position of the enclosure is irrelevant as long as the deer have shade from large trees and have a sheltered area for poor weather conditions.

3.14: Weather Protection

The enclosure needs to have a sheltered area for the deer to retreat to in poor weather. There are no size requirements but will need to protect the total number of deer's within the exhibit.

3.15: Temperature Requirements

There are no temperature requirements. Deer prefer warmer environments with cool areas and this can be provided with trees as it would replicate the forest.

3.16: Substrate

Preferred substrate materials: mulch and pine chips, dolerite other suitable materials: Grass Materials to avoid: Cement (as the harshness to hoofs and joints)

3.17: Bedding Material

Straw and saw dust are the preferred materials for bedding. Which should be completely changed at least once a week? Heat lamps offered in bedding area in the cooler months will provide deer with extra warm, especially when fawn are in the herd. Bedding areas should be under shelter to avoid wet materials.

3.18: Enclosure Furnishings

Suitable furnishings would include large tall trees. Mud wallows and scratching poles would offer enrichment to the chital deer. Large logs and nature items.

3.19: General Husbandry

3.19.1: Hygiene and Cleaning

Daily cleaning tasks:

- Spot cleaning feces
- Cleaning drinking water
- Removing old browse and left over foods

Weekly cleaning tasks:

- Complete change of bedding material

Monthly cleaning tasks:

- Scrub any cement areas

Half yearly

- New substrate – mulching

Cleaning agents suitable:

Animal house bleach 4% - cleaning holding and cement areas

3.19.2: Pest control

Pest control boxes should be placed in areas in and around enclosure and checked weekly and are refilled and any pest removed. Disposing of pests-follow intuitions procedures . Taranga's – all dead animals are to be taken to VQC for post mortem.

3.19.3: Record Keeping

All animals should be individually identifiable, with the use of colored or numbered ear tags. Each animal should have its own file which contains the following information:

- ✓ Identification numbers or tags of animals
- ✓ ARKS number
- ✓ Health problems
- ✓ Veterinary examinations
- ✓ Veterinary treatments
- ✓ Behavioral data
- ✓ Reproductive stages, condition and behaviors
- ✓ Gene pool information
- ✓ Parents
- ✓ Birth dates
- ✓ Changes in diet
- ✓ Movements within and between institutions
- ✓ Body mass and measurements.
- ✓ History of animal
- ✓ Enrichment behaviors and reactions.
- ✓ Transfer details
- ✓ Individual characteristics

ISIS (International species inventory system) uses the basic biologic information (age, sex, parentage, place of birth, circumstance of death, etc.) to manage genetic and demographic programs for their animal collections. ARKS (Animal record keeping system) are used by zoo's in the Australasian region and information is available to all zoo's. Information such as age, parents, genetics are available.

3.19.4: Routine Data Collection

Most information is on deer farming. Some of this information does work for deer in captive intuition but most is for the production of venison. There have been

many studies on wild deer and many on farming deer's. Information that may be acquired for long term studies include

- Weights/growth – development charts
- Contraception/genes/parenting behaviors
- Blood biochemistry

3.20: Reproduction

The mating system of these deer is not known. However, in other, related deer, the most common mating system is polygyny. Males compete with one another for access to estrous females. Competition often involves sparring and vocalizing. Successful males are typically older and larger, and able to drive away younger, smaller males. These successful males are the ones who mate with the females. It is likely that Visayan spotted deer have a similar mating system.

In the wild, *Axis axis* bucks are found throughout the year with hardened antlers and in rutting condition. The reproductive cycle of each individual is not synchronized with that of other males in the herd. Concurrently, throughout the year, some bucks are coming into rut, while others are going out of rut, or are in a non-breeding condition. Females also experience non-synchronized estrous cycles, with each cycle lasting about 3 weeks. Bucks do not retain harems of does, but instead mate with does in each herd as they become receptive. One fawn is typically produced per pregnancy and gestation lasts 210-238 days. Following parturition, females again mate during the subsequent breeding period. Adult females tend to produce one fawn each year.

3.20.1: Reproduction and selection

The current reproduction system may be defined as a controlled, single-sire and natural mating:

3.20.2: Mating System: Polygynous

The breeding season (rut) of Visayan spotted deer takes place from November to December. Following the breeding season there is a 240 day gestation period, with births in May and June.

3.20.2.1: Controlled mating:

The farmer knows precisely when the stags will mate the hinds because he separates the sexes outside the appropriate time.

3.20.2.2: Single-Sire Mating:

The farmer knows precisely which stag is the parent of each fawn because he chooses the stag to mate a hind.

3.20.2.3: Natural mating:

No artificial reproduction for the time being

3.21: Parental Investment

Precocial, pre-fertilization (provisioning, protecting: female) pre-hatching/birth (provisioning female protecting: female) pre-weaning/fledging (provisioning female protecting: female)

3.22: Lifespan/Longevity

It is not known how long Visayan spotted deer live. Related deer species can live a maximum of 12-17 years.

3.23: Nutrition.

Axis axis consume an extremely wide range of forage items throughout their native range and in introduced locales. They eat over 75 species of plants, as well as the full spectrum of plant parts including leaves, stems, fruits, seeds, flowers and bark. Their diet consists largely of grasses in all seasons, augmented with browse. Green grasses less than 10cm high are preferred. In Texas, they graze on grasses such as peplum, switch grass and little bluestem. Sedges are favorite spring foods. Browse species include live oak, hackberry and sumac.

3.24: Key Reproductive Features

Iteroparous, seasonal breeding, gonochoric/gonochoristic/dioecious (sexes separate) sexual viviparous

Breeding interval	Breeding season	Range number of offspring	Average number of offspring	Average gestation period
Visayan spotted deer breed once yearly	Breeding occurs in November and December	1 to 2	1	8 Month

Information on the parental care is not available. In most cervids, parental care is strictly by females. Females give birth to one, sometimes two, offspring. The period of nursing lasts from a few weeks to a few months. Young may stay with their mothers past the time of weaning.

3.25: Lifecycle stages.

Report that *Axis axis* fawns begin eating green forage by 5½ weeks of age, but weaning is delayed until they reach 4-6 months of age. Permanent dentition is acquired when 2½-3 years of age and adult size is reached at 6 years for females and 4-5 years for males. The natural lifespan of axis is 9-13 years, although zoo animals may reach 18-22 years of age. Axis are gregarious and found in herds ranging from a few animals to 100 or more. The leader is usually an old, experienced doe. Adult males are normally found living with herds of young and old animals of both sexes. Rutting males vocalize via a bugle-like bellow and both sexes have alarm calls or barks.

3.26: RESTRAINT SYSTEMS

3.26.1: Mechanical Restraint Systems

Mechanical restraint systems fall mainly into three types: bail, cradle or crush, each with variations.

3.26.1.1: Bail Restraint

A bail restraint is basically a structure at the end of the tunnel with a slot or hole for the animal to poke its head out of, again using the principle of the animal being

attracted to the light. Variations have the head coming out of the front or side of the structure. It is best used when working on the head or neck of the deer:

- * Ear tagging;
- * Drenching and vaccination;
- * Removing antlers under an aesthetic, if the head hole is large enough .The advantages are that it is reasonably cheap to manufacture, it allows for a high number of animals through puts and it's an easy one-person operation. The disadvantages are that access to the animal is limited to the head and neck and animals can injure themselves if entering too fast.

3.26.1.2: Cradle Restraint

This is a Y-shaped structure with a drop floor and hinged side, mounted with the floor half to two-thirds a meter above the shed floor. When the animal has entered the cradle, the floor is dropped. With the cradle off the floor, access to the legs and feet is possible. Doors in the side of the cradle allow access to the body. The animal is released by opening the hinged side which allows the animal to drop to the floor and move away.

Operations possible through this system are the same as for the bail plus artificial insemination, assisted fawning, harnessing of sire bucks, foot inspections and treatment. Advantages of the system are all around access to the animals and they are less likely to injure themselves. Disadvantages are that a cradle is more expensive to manufacture and has a slower through put.

3.26.1.3: Crush System

This structure is similar to the cradle except the animal is held by the action of one side of the crush being forced against the animal and usually the floor is also dropped. Access to the animals is more restricted than with the cradle as the sides of the crush are physically restraining the animal and so cannot be as readily opened. Access is usually from above, over the top of the side of the crush. Operations, advantages and disadvantages for the system are the same as for the

cradle. As crushes are often pneumatically or hydraulically operated, manufacturing costs are high.

3.27: OTHER RESTRAINT SYSTEMS

3.27.1: Manual

A deer may be picked up, most easily out of restraint, by putting both arms around the its chest with the its back held tightly against the holder's chest. The deer can be comfortably held in this position, particularly if the holder is seated with the deer's rump on his lap. The person working on the underside of the animal is advised to watch out for flailing legs or head.

3.27.2: Chemical restraint:

Chemical restraint will be necessary for more complicated operations such as electro-ejaculation, intrauterine AI or embryo transfer. This will normally be carried out by a vet but a mechanical restraint will be required to allow administration of the drugs. There are a number of sedative drugs available and the choice of which to use will be the responsibility of a veterinarian.

3.27.3: Weighing Animals

The systems available are electronic or mechanical and are suspended or platform. All of the restraints can be mounted on either system. Using the restraint as a weight crate means the animals can be weighed each time they are in the restraint. It also means they have to enter the restraint each time they are weighed. The alternative is to put a separate weigh crate in the tunnel, most easily with platform scales, with the facility to draft the animals after the weigh scales and before the restraint. This is most easily achieved with a long tunnel.

3.28: HEALTH MANAGEMENT

It is not possible to provide a complete summary of health management requirements in this fact sheet. Contact your veterinarian for answers to specific questions. A reference list for further reading is provided in this fact sheet.

One key component of herd management is disease control. It is the responsibility of each farmer to manage his animals in such a manner that they are healthy and in good condition because it makes the animals more resistant to infections and disease.

Prevention of disease is better than any possible cure. It is important to establish a good working relationship with a veterinarian. Together, the farmer and the veterinarian can work out a program tailored for any individual farm to control disease and to maximize the health and productivity of the animals.

Getting to know each animal is one of the best ways to spot a problem before it gets out of hand. Out of character behavior or activity is a clear signal that something is wrong -- investigate and act.

Well fed animals, with minimum stress during handling will be healthier and more disease-resistant. The causes of diseases can be categorized as:

- * Intrinsic flaws:
 - ◆ Nutritive deficiencies.
- * Exogenous poisons:
 - ◆ Trauma;
 - ◆ Tumours (neoplasms). or
- * Parasitic or other living organisms (i.e. parasites, bacteria, fungi, viruses, mycoplasma and rickettsia)

3.28.1: Intrinsic Flaws

Intrinsic flaws refer to hereditary or congenital disorders. These animals should be culled to eliminate future problems in the herd.

3.28.1.1: Nutritive Deficiencies

Selenium and copper deficiency and winter death syndrome are examples of nutritive disorders in fallow deer. Selenium deficiency occurs when supplementary feeds (hay, ground grains) which have had natural stores of selenium (vitamin E) destroyed by oxidation, are not supplemented with a selenium rich additive. Selenium deficiency has been shown to cause muscular dystrophy, reproductive

failure and death in deer. Veterinarian advice should be sought on the amount of selenium to be added to the diet, as too much selenium can cause poisoning.

Copper deficiency causes a progressive disease known as enzootic ataxia. This disease begins with loss of coordination followed by brain and spinal cord damage. If the deficiency is not detected prior to this stage, there will be no recovery of affected tissue. Liver samples, obtained via a liver biopsy, are the best indication of copper deficiency. With veterinarian confirmation, copper deficiency can be treated by adding a copper supplement to the mineral mixture. Winter death syndrome is simply known as starvation.

Winter-death syndrome is caused by gross mismanagement the failure to meet the winter feed and energy requirements of the herd. Live weight monitoring in midwinter and early spring and comparison to the expected live weights will indicate a problem. As a general rule, the maintenance dietary requirement of a deer is roughly 2% of live weight in digestible dry matter.

3.28.2: Exogenous Poisons

Exogenous poisons can be supplied by natural or artificial sources. Environmental pollutants in the air, ground and water all can cause poisoning. Excessive use of selenium can cause death within one day. Selenium is rapidly absorbed by the gut and after showing a wide range of clinical signs (distress, rapid and weak pulse, labored respiration, bloating, colic, or frequent urination) terminates in blindness and/or behavioral changes and finally death.

3.28.2.1: Trauma

Many mortalities are attributable to basic mismanagement, including:

- * Inadequate yard and gateway design;
- * Lack of, or inadequate handling facilities;
 - ◆ Collisions with fences, gates, races, and yards;
- * Handling a group that is too large; or

- * Exerting excessive pressure when "mustering". Fractures are commonly due to deer being caught in gaps alongside and under gateways combined with pressuring during mustering. Site boards and sacking can stop fence collisions in races.

In general, gentle handling and logical, well-designed facilities can greatly reduce these types of mortality.

Additionally, feed and exposure stresses, exacerbated by the low-fat, high muscle composition of the deer body, can cause associated diseases. Gastro intestinal ulceration and stress enteritis shock syndrome have been shown to occur in recently transported deer, in deer undergoing a change in feed and those not accepting a supplemental feed.

3.28.2.2: Tumors

Tumors or neoplasm are generally uncommon and not usually infectious (epizootic). Parasitic or other living organism in general, parasitism in conjunction with other stress (especially nutritional) will be responsible for the majority of losses in deer not on a regular anthelmintic (deworming) program. Deer are also susceptible to attack by the array of ruminant flies and their parasitic larvae (warbles and bots), also ruminant lice, mites and ticks. Treatment and control would be the same as for the other food-producing ruminants. Signs of internal parasitism are weight-loss, rough hair coat, diarrhea and in cases of lungworm infection, sometimes a soft cough (unlike lung Worm infected cattle who have a hacking cough). In addition to lungworms, gastrointestinal and other body system nematodes, deer can also be parasitized internally by several species of trematodes (liver flukes) and cestodes (tapeworms).

Most of the deer parasitology literature available focuses on lungworm infection, because lungworms cause the greatest number of parasitic deaths in deer. For the most part, dewormers that kill lungworms in deer are effective against other internal nematodes or roundworms.

Management techniques such as pasture rotation and off the ground feeding (combined with strategically-timed, sequential dewormings) should all help to fight parasitism. For details of all the parasite life cycles, control programs and treatments, consult your veterinarian or refer to books and articles on this specific subject.

3.28.3: Diseases

Deer at low population densities on natural range are generally not affected by disease to any significant extent. Deer in their first 12-15 months of life are more Susceptible to disease than adults. Treatment of sick deer is analogous with that of domestic animals. Prevention of diseases by nutritional management, testing, Vaccination, drenching and dipping, is more important than treatment. The deer's in Bangladesh National zoo, veterinary facility is provided periodically or when necessary. So, cost of veterinarian services is no regular or uniform and it is mentioned under the heading contingencies. Any unwanted situation if seen is quickly reported by the security person recruited there. At the Central Zoo, during 8-10 am in the morning, the person recruited for management should look at the cleanliness and situation of deer in the cage. A vaccine is given which contains BQ, HS, and FMD within 3-4 days of newly born deer.

After the birth of a baby deer, the workers put a tag on the body of the spotted deer within 2-3 days of birth. The weight of the newly born baby has not been measured yet because it doesn't stay a minute with its mother after the birth but according to them it may approx. weigh about 1.5kg during birth. The funding of spotted deer in zoo is mainly from the ticket bought by the visitors. Nearly about 4-5 Hounded /day is collected from ticket collection .The funding of BN zoo is through the government.

Table-4: Common parasites report in deer:

Internal parasites reported in deer	
<p>Lungworm Nematodes</p> <p>Dictyocaulus</p> <p>Elaphostrongylus</p> <p>Protostrongylus</p> <p>Gastroenteric Nematodes</p> <p>Abomasum</p> <p>Haemonchus</p> <p>Ostertagia Rinadia</p> <p>Skrjabinagia</p> <p>Spiculopteragia</p> <p>Trichostrongylus</p> <p>Small Intestine</p> <p>Bunostomum</p> <p>CapillariaCooperia</p> <p>Nematodirus</p> <p>Strongyloides</p> <p>Trichostrongylus</p>	<p>Large Intestine/Cecum</p> <p>Chabertia</p> <p>Oesophagostomum</p> <p>Trichuri</p> <p>Other Nematodes</p> <p>Elaeophora (circulatory system-arterial worm)</p> <p>Parelaphostrongylus (nervous system meningeal worm)</p> <p>Trematodes (liver flukes)</p> <p>Fasciola Fascioloides</p> <p>Paramphistomum</p> <p>Dicrocoelium</p>

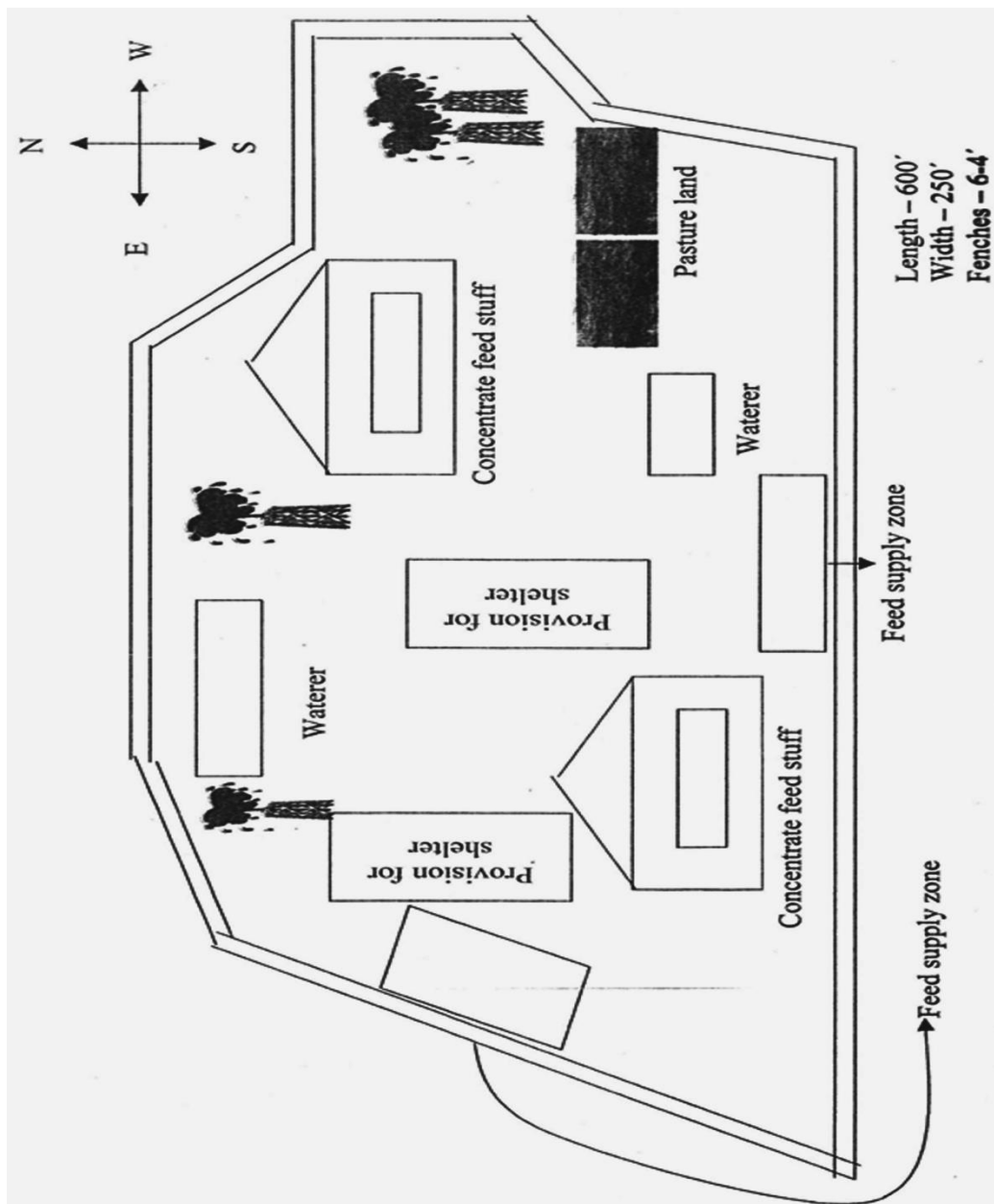
Table 5: Common Deer Diseases:

Diseases reported in deer	
<p>Bluetongue</p> <p>Brucellosis</p> <p>Clostridial infections:</p> <ul style="list-style-type: none"> ▪ blackleg, ▪ Malignant Edema, ▪ Enterotoximia <p>Facial Eczema</p> <p>Louping ill</p> <p>Pneumonia</p>	<p>Foot Disorders:</p> <ul style="list-style-type: none"> ▪ foot scald ▪ foot abscess ▪ foot rot <p>Kerato conjunctivitis</p> <p>Leptospirosis</p> <p>Ryegrass staggers</p> <p>Salmonellosis</p> <p>Tuberculosis</p>

Yersiniosis and malignant catarrhal fever have not been recorded in fallow deer farmed in BN Zoo. Deer develop severe clinical illness very quickly in these serious diseases, which can rapidly progress to decumbency and death. The progress of these diseases is exacerbated by their nervous temperament, making these diseases potentially very dangerous.

3.28.4: Statistical analysis of data

Data recorded for different parameters were compiled and tabulated in proper way for statistical analysis. Analysis of mean, standard error of mean, standard deviation and variance was done with the help of SPSS (Version 20.0).



Figur- 1: Layout of the Spotted Deer Premises used in the experiment at Bangladesh National Zoo

CHAPTER-IV

RESULTS AND DISCUSSION

The results of following parameters such as feeds and feeding, production and reproduction profile and herd. management have been presented in this chapter.

4.1: Feeds and feeding

Table-6: Chemical composition of feed consumed by experimental spotted deer at Bangladesh National Zoo.

Name of feed				
Local name	Botanical name	% DM	% CP	ME (Kcal/kg)
Maize fodder / Jambu grass	<i>Zea mays / sesbania bispinosa</i>	18	7.91	230
Gourd spinach	<i>Impomoea aquatica</i>	15	8.1	131
Cabbage	<i>Brassica oleracea</i>	10	1.3	260
Pumkin	<i>Cucurbita moschata</i>	14	2.1	430
Gourd	<i>Lagenaria Siceraria</i>	14	1.9	420
Cucumber	<i>Cucumis Sativus</i>	14.1	1.8	410
Grain	<i>Cicer Arietinum</i>	12.51	19.68	720
Soybean meal		88	45	2500
Wheat bran		88	14	1600
Common salt		90		-
Vit-min premix	-	-	-	-

The chemical composition of the feeds supplied to the deer are showed in the (Table-6).

From the table 7, it was observed that the total amount of feed intake was 8.12 kg as fresh basis and 2.079 kg as DM basis. During the experimental period maize fodder (*Zea mays*) and gourd spinach (*Impomoea aquatica*) as leafy vegetable, pumkin (*Cucurbita moschata*) and cucumber (*Cucumis Sativus*) as vegetable, grain (*Cicer Arietinum*) and as concentrate soybean and wheat bran were supplied to the

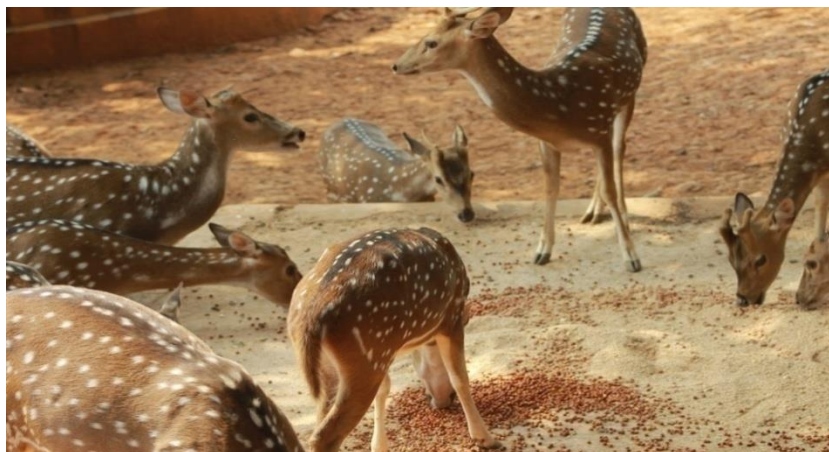
deer at BN Zoo. The percentage of crude protein (CP) and amount of metabolisable energy of the supplied ration for an adult deer were 13.63% and 14.38 MJ per day (Table-7).

Table-7: Nutrient intakes by the spotted deer at Bangladesh National Zoo.

Name of feed		Amount supply (kg)/deer	DMI (kg)/deer	% CP intake/deer	ME (kcal/kg)/deer
<u>Local name</u>	<u>Botanical name</u>				
Maize fodder / Jambu grass	<i>Zea mays / sesbania bispinosa</i>	3.0	0.54	2.07	690
Gourd spinach grass	<i>Impomoea aquatica</i>	2.0	0.3	1.15	262
Cabbage	<i>Brassica oleracea</i>	0.5	0.05	0.033	130
Pumkin	<i>Cucurbita moschata</i>	0.6	0.084	0.086	258
Gourd	<i>Lagenaria Siceraria</i>	0.5	0.07	0.063	210
Cucumber	<i>Cucumis Sativus</i>	0.4	0.056	0.048	164
Grain	<i>Cicer Arietinum.</i>	0.2	0.177	1.68	144
Soybean meal		0.26	0.229	4.95	650
Wheat bran		0.6	0.528	3.55	960
Common salt		0.05	0.045		-
Vit-min premix	-	0.01			
Total		8.12	2.079	13.63	14.38 MJ

Spotted deer that are free browsers intake a various types to grasses, creepers, shrubs, tree leaves, vegetables etc. But deer at Bangladesh National Zoo, that are confined can not take any feed other than supplied. A little amount of grasses was browse there. This amount is very negligible. From the data of BN zoo authority it was observed that green fodder, leafy vegetables and succulent vegetable were changed in the various seasons and depends on availability in the market. Khira

(*Cucumis sativas*), *Sasa (Saha Senanensis)*, Misty Cumra (*Cucurbita moschata*), Cabbage (*Brassica oleracea*) were supplied in the various seasons of the year.



Photograph-11: Concentrate Feeding of Bangladesh National Zoo.

The crude protein is far below than the requirement to the findings of Moon et al. (2000) but metabolisable energy is more or less near to the requirement. They investigated that DMI is around 2.0% in winter increasing to 2.3% in summer for adult spotted deer. DM is around 2.7% to 3.8% for fallow deer (Wilson, 1979). Adam (1994) stated that in autumn, winter, spring and summer DMI is 1.7, 2.0, 2.3, 3.0 kg/d/hinds whereas 1.4, 1.3, 2.0, 2.2 kg/d/growing calves. Fennessy (1981) stated that an adult spotted deer required for maintenance energy was 16-18 MJ where as a protein diet in the 13-16% range is required for the successful growth, antler development and reproduction (Verme and Ullrey, 1972).

A high level of crude protein (approximately 16%) is advantageous for fallow fawns to achieve their target live weights (Malley et al., 2001). Adam (1994) stated that in calves, hinds and stags for the season of autumn, winter, spring and summer CP is required as 17, 10, 12-17; 10, 14, 17 and 10, 12% respectively. Female fawns (white-tailed deer) required 13% crude protein for maximum growth (Ullrey et al., 1967). Denholm (1984) stated that estimates of dietary crude protein requirements for optimum growth vary within the range of 13 to 15%. French et al., (1956) concluded that young male fawns (white-tailed deer) required 13% to 16% crude protein.

The energy concentration for empty body weight is 17.5 MJ/kg and 21.7 MJ/kg and protein content is 150 g/kg and 146 g/kg (ARC, 1980). From Adam (1994) standard

of nutritional requirement of spotted deer, it was observed that crude protein deficiency was 4.5% and the ME deficiency was 1.66 MJ per day that are supplied to the deer (Table-8).

Table-8: Nutrient balances for the spotted deer

Characteristics	CP %	ME (MJ)
Requirement	14.5	16.
Supplied	13.63	14.38
Balance	-0.87	-1.62

Source: Azad et al., 2005.

There is an imbalance of crude protein and energy supply to the deer of BN zoo. Proper growth and development both in productive and reproductive may not be perform due to insufficient protein supply and in balance of CP and ME. Recommended ration for deer is shown in table-9.

Table-9: Recommended rations for spotted deer

Name of feed		Amount supply (kg)	DMI (kg) deer	% CP intake / deer	ME (kcal/kg) / deer
<u>Local name</u>	<u>Botanical name</u>				
Maize fodder / Jambu grass	<i>Zea mays / sesbania bispinosa</i>	3.00	0.54	2.07	690
Gourd spinach	<i>Impomoea aquatica</i>	2.00	0.30	1.15	262
Cabbage	<i>Brassica oleracea</i>	0.5	0.05	0.033	130
Pumkin	<i>Cucurbita moschata</i>	0.6	0.084	0.086	258
Gourd	<i>Lagenaria Siceraria</i>	0.6	0.08	0.066	252
Cucumber	<i>Cucumis Sativus</i>	0.5	0.060	0.058	164
Grain	<i>Cicer Arietinum.</i>	0.3	0.187	1.78	216
Soybean meal		0.3	0.239	0.500	750
Wheat bran		0.7	0.548	3.65	1120
Common salt		0.05	0.045		-
Vit-min premix	-	0.001	-	-	-
Total		8.5	2.088	13.893	15.82 MJ

4.2: Production and reproduction profile

Table-10: Body weight of spotted deer at Bangladesh National Zoo.

Traits	No. of animal	Mean	Standard error of mean (SEM)	Standard deviation (SD)	Maximum	Minimum
Male birth wt. (kg)	15	2.97	0.17	0.67	4.10	1.8
Female birth wt. (kg)	15	2.73	0.17	0.65	3.90	1.70
Adult male wt. (kg)	15	78.08	2.17	8.39	88.90	62.20
Adult female wt. (kg)	15	60.97	1.77	6.87	74.50	51.30
Male weaning wt. (kg)	15	19.05	0.76	2.96	24.30	15.30
Female weaning wt. (kg)	15	18.49	0.58	2.24	22.30	15.20

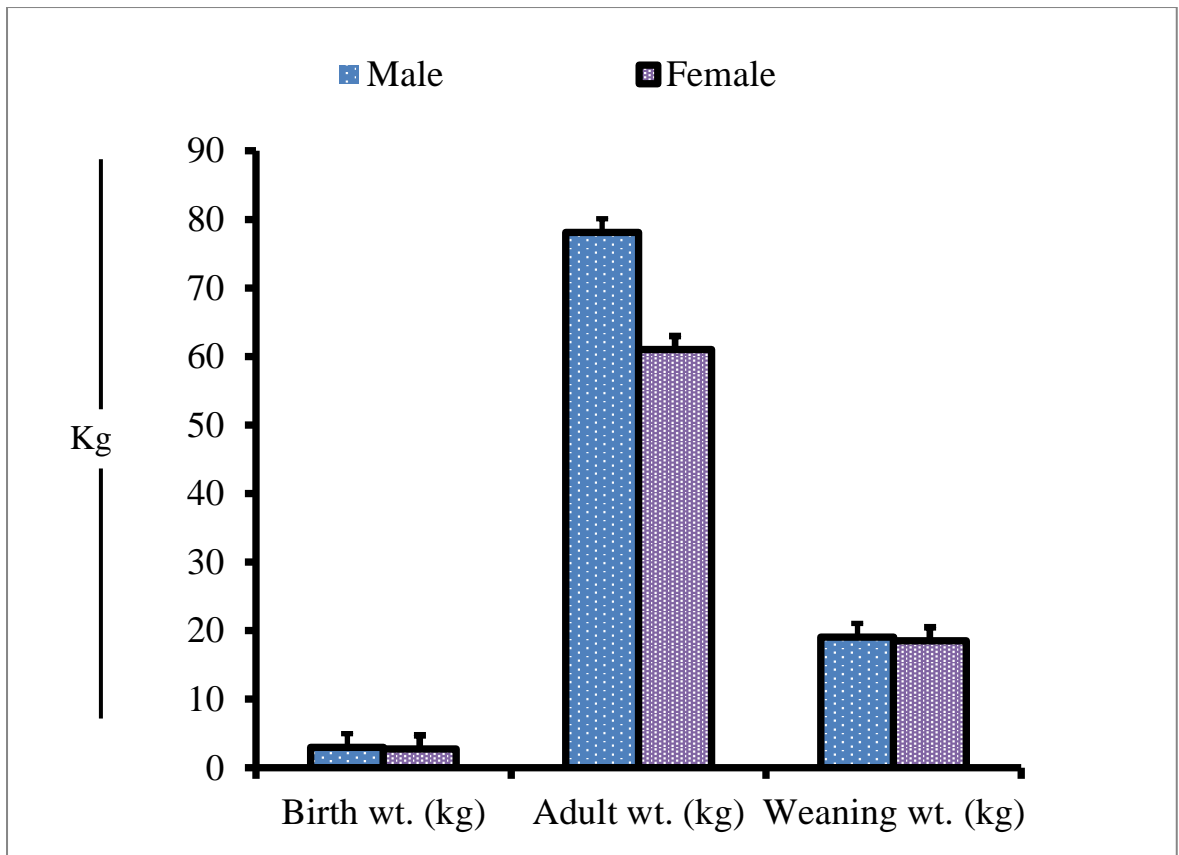


Figure-2: Body weight of spotted deer at Bangladesh National Zoo.

Body weight of spotted deer at BN Zoo is presented in table-10 & figure-2. The average birth weight of males and females spotted deer fawn were 2.97 ± 0.17 kg and 2.73 ± 0.17 kg. The highest and lowest birth weights of them were 4.10 kg to 1.80 kg and 3.90 kg to 1.70 kg respectively.

The average birth weight of males and females fawn of spotted deer were more or less similar to the findings of Mulley, (1984). He reported that the mean birth weight of male and female spotted deer fawn was 4.5 kg and 4.2 kg respectively. Ables, (1977) reported that the average birth weight of males and females spotted deer fawn were 3.5 kg and 3.0 kg respectively. Fawn birth weight is generally 10% of their mother's weight reported by Kay and Staines. (1981); Mulley et al., (1990). In the present study, the adult males and females weights were 78.08 ± 2.17 kg and 60.97 ± 1.77 kg respectively. The highest and lowest adult males and females weights were 88.90 kg to 62.20 kg and 74.50 kg to 51.30 kg respectively.

The average adult males and females weights were more or less similar to the findings of Ables. (1977). He concluded that the average adult males and females weights must be attained within 85.00 kg and 70.00 kg. There is strong relationship between body weight and reproduction. Sharman, (1978) stated that young hinds weighing less than 60.00 kg at rutting did not produce calves. Kelly and Moore, (1978) showed that the percentage of red deer calves dropped by yearling hinds less than 65 kg in live weight was only 50%, while above 65 kg it could be about 90%. Mitchell and Brown, (1974) suggest that a live weight of 75 kg for hinds should give 80% of calving percentages.

Table 10 showed that the average males and females weaning weights were 19.05 ± 0.76 kg and 18.49 ± 0.58 kg respectively. The highest and lowest weights of them were 24.30 kg to 15.30 kg and 22.30 kg to 15.20 kg respectively.

The average males and females weaning weights in this study were more or less similar to the findings of Mulley (1984) who stated that the mean males and females weaning weights were 19.4 kg and 18.5 kg. Weaning generally takes place at an average weight of 18.00 to 21.00 kg reported by Mulley et al. (1990).

Table-11: Reproductive performance of spotted deer at Bangladesh National Zoo.

Traits	No. of animal	Mean	Standard error of mean (SEM)	Standard deviation (SD)	Maximum	Minimum
Length of estrus (Days)	15	17.40	0.54	2.10	21.10	14.50
Age at 1st estrus (Months)	15	14.48	0.43	1.65	18.30	11.50
Gestation period (Days)	15	232.6 9	1.48	5.73	241.10	223.70
Age at 1st fawning (Months)	15	14.58	0.43	1.68	18.20	12.00
Weaning age (Months)	15	5.19	0.18	0.68	6.20	4.00

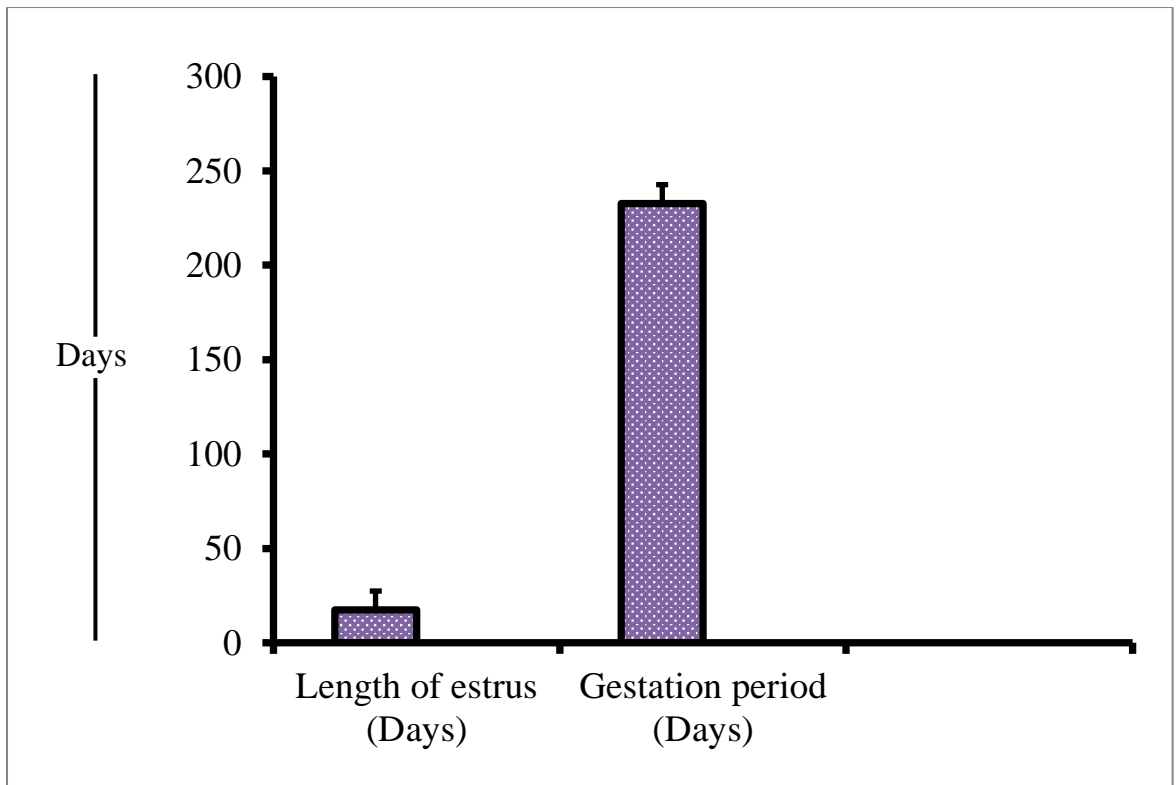


Figure-3: Length of estrus and gestation period of spotted deer at Bangladesh National Zoo.

In the present study, the average length of estrous cycle was 17.40 ± 0.54 day. The highest and lowest lengths of estrous cycle were 21.10 day and 14.50 day respectively.

The mean length of estrous cycle was more or less similar to the findings of Chappelle et al. (2003). They reported that mean duration of estrous cycle of chital hinds was 19.30 ± 1.30 day with a range of 17-21 days. Vos. (1982) showed that the mean length of estrous cycle in spotted deer was 18.20 days. The mean length of estrous cycle was 18 ± 0.7 days with a range of 12-23 days concluded by Mylrea et al. (2004).

From the table-11 and figure-3, showed that the average duration of gestation length was 232.69 ± 1.48 days. The highest and lowest lengths of gestation period were 241.10 days and 223.70 days.

The average length of gestation period in this study were almost similar to the findings of The mean duration of gestation period was 234.5 ± 3.0 days at chital hinds reported by Chappelle et al. (2003), that is more or less similar to the present study. Ables. (1977) showed that only one fawn is produced per pregnancy after a

gestation period of 210-238 days. Vos. (1982) reported that only one fawn and rarely twin is produced per pregnancy after a gestation period of 226-233 days.

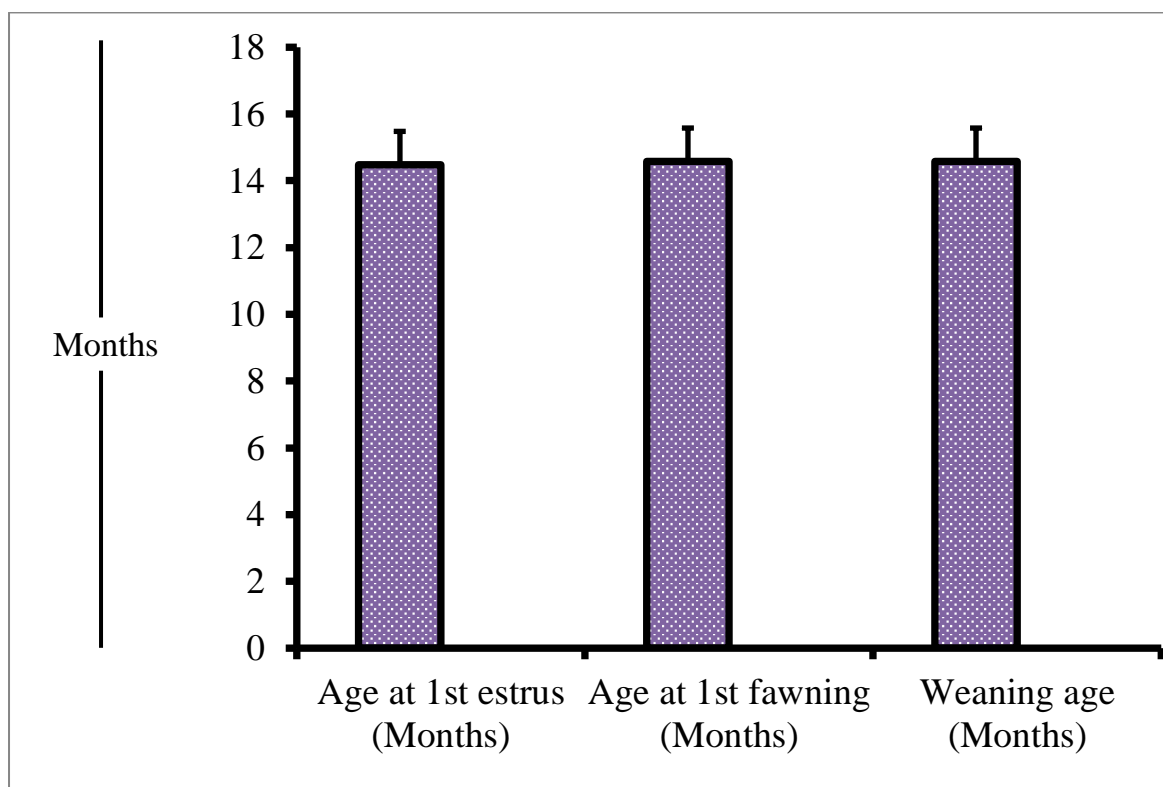


Figure-4: Age at 1st estrus, fawning and weaning age of spotted deer at Bangladesh National Zoo.

From the table-11 and figure-4 was observed that the average age at first fawning was 14.58 ± 0.43 months. The highest and lowest age at first fawning were 18.20 months and 12.00 months respectively. In the present study the average age at first fawning were almost similar to the findings of Ables, (1977) who reported that does may first bred at an age of 14-17 months. Vos. (1982) showed that does may be first bred within 1.5-2 years.

From the table-11 and figure-4 it has been observed that the average weaning age was 5.19 ± 0.18 months. The highest and lowest weaning age were 6.20 months and 4.0 months respectively. This is an agreement with the findings of Mulley et al. (1990). They reported that weaning generally takes place between 14-21 weeks. Flesch et al. (1999) showed that weaning age ranged between 12-20 weeks. Mulley and Flesch. (2001) cited that deer must be weaned within 16 weeks of its age.

4.3: Health Status of Experimental Animals

Deer Disease:

Table-12: Experimental Deer Disease

Identify of Experimental Animals	Deer Disease Name														
	Deer1	Deer2	Deer3	Deer4	Deer5	Deer6	Deer7	Deer8	Deer9	Deer10	Deer11	Deer12	Deer13	Deer14	Deer15
Calves (Fawn)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Buck or Stags	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Doe or Hinds	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Pregnant Deer	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Weaning Animals	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×

During the examination period, no deer was sick in the Bangladesh National Zoo. The deer we identified did not see any disease in the year (table-12). But We tried very well to observe it clearly. Here we have learned from past history that due to the absence bacteria, viruses, parasites and nutrition there usually diseases.

However, during the examination, we did not use any medicines in deer. Management of good deer does not cause in disease. So the deer is a great gain animal.

4.4: HERD MANAGEMENT

Deer rapidly adapt to the presence of man and machinery when they are enticed with palatable feeds. When deer are confined, they should not be overcrowded, so that a handler can move amongst them and carry out drenching, ear tagging, vaccination and pour-on dipping. Normally a supervisor of deer section maintains the following activities:

Table-13: Schedule of day to day operations on spotted deer premises

Approximate time(hours)	Farm operations
7.00 9 00 A.M	<ul style="list-style-type: none">❖ Check all fences surrounded by deer premises❖ Count the total numbers of deer and adjust previous numbers❖ Find out or observe if any mortality occurred❖ Inspection within the area if any hazard happened at sight❖ Clean out the dumping wastage material such as cons, bottle or any plastic product which was thrown by visitors❖ Cleaning all the equipment's such as feeder, waterer❖ Cleaning the entire feed supply zone❖ Arrange the necessary vehicle to transport feed or other's❖ Cleaning farm premises
9.00-12.00 A.M	<ul style="list-style-type: none">❖ Feeding of concentrate feed to deer herd❖ Feeding of dry/green fodder❖ Isolation of sick deer❖ Treating sick deer

Approximate time(hours)	Farm operations
12.00-3.00 P.M	❖ Lunch cum rest period for labourers
3.00-4.00 P.M	❖ Miscellaneous jobs of deer premises such as, periodical vaccinations, Repair of farm fences, Fittings and repair of equipment, weekly scrubbing and white washing of drinking water tank, attending to sale of deer and their transportation, periodical spraying of deer premises with suitable pesticides
4.00 P.M — 7.00A.M	❖ A Night watchman on duty.

Date:

Signature

Concerned Zoo Officer

Table-14: Category of age-sex classes of the spotted deer during study period. For the determination of group size and composition, only visual observation techniques were used in this study. Data on group composition were recorded to age-sex classes, which were previously categorized. The major age-sex class of the spotted deer adult male, adult female, juvenile and infant which were described in table-14.

Type	Description
Stag or Buck	Prominent antler and bigger in size as well as in body weight.
Doe	Absence of antler and more than one year but bigger than the Juvenile
Juvenile	More than four months but less than one year and smaller than the female and male
Infant	Less than 3-4 months of age and has a close relationship with its mother.

The Name "Chital": is a Hindi word for "Spotted". "Axis" is an unknown word, but possibly comes from an Indian word for the animal. "Deer" comes from the German word "Tier" which simply means "animal".

A moderately large, spotted deer with three tines on each antlers, the brow tine fond nearly a right angle with the beam and the front (or outer) tine of terminal of fork is much longer than the hind (or inner) tine; a gland-bearing cleft is present on the front of the pastern of the hind foot. Females smaller and usually without antlers (table-15).

Table-15: Facts of spotted deer used in the experiment

Character	Brief summary					
Description	The spotted deer (<i>Axis axis</i>) are considered to be the most beautiful of the cervids. They have a black dorsal stripe and are profusely spotted with which on, fawn background shading from almost black or pinkish brown on the back to white on the under parts. Bucks are larger than does, with broader chest and darker facial markers. The males antlers curve in a lyre shape with up to three points on each antler, the antlers are shed annually on the deer's own clock, so in					
Classification	Phylum	Sub phylum	Class	Order	Family	Species
	Chordates	Vertebrates	Mammals	Artiodactyla	Cervidae	<i>Axis axis</i>
Distribution	Bangladesh, India and Sri Lanka.					
Habitat	Terrestrial, woodland, forests with glades and clearings near water ways					
Behavior/ Habits	Axis deer are inhabitants of secondary forest lands broken there here and by glades, with on under story of grasses, forbs, and shoots tender which supply adequate drinking water and shade. They tend to avoid rugged terrain, their food consists					

	largely of grasses seasons at all, augmented with browse. They graze in the morning evening and rest during the day.
Society	These animals are gregarious and usually are found in herds ranging from a few animals to 100 or more. The each herd leader is usually an old, experienced doe. Unlike our native deer adult male axis deer normally are found living with herds of young and old animals of both sexes. Rutting male axis deer emit bugle like bellows, and both sexes have alarm

CHAPTER-V

SUMMARY AND CONCLUSION

The study was conducted at the Bangladesh National Zoo to evaluate the following parameters such as feeds and feeding, production profile and herd management of spotted deer from January 15th to December 15th 2018 for a period of one year. The collected data were compiled, tabulated and analyzed systematically. At Bangladesh National Zoo, the total amount of feed intake per spotted deer was 8.12 kg on fresh basis and 2.079 kg on DM. The percentage of crude protein and amount of met-abolishable energy in supplied feed were 13.63% and 14.38 MJ per day. There was variation of supplied green fodder, leafy vegetables and succulent vegetables with availability in the market and seasons.

From the results it was observed that the average birth weights of males and females spotted deer fawn were 2.97 ± 0.17 kg and 2.73 ± 0.17 kg. The highest and lowest birth weights of male and female fawn ranging from 4.10 kg to 1.8 kg and 3.90 kg to 1.70 kg, respectively. The average adult males and females weights were 78.08 ± 2.17 kg and 60.97 ± 1.77 kg. The highest and lowest weights were 88.90 kg to 62.20 kg and 74.50 kg to 51.30 kg respectively. The average length of estrous was 17.40 ± 0.54 days. The highest and lowest lengths of estrous cycle were 21.10 days and 14.50 days respectively. The average age at estrus was 14.48 ± 0.43 where minimum value was 11.50 and maximum was 18.30. The average length of gestation period was 232.69 ± 1.48 days. The highest and lowest lengths of gestation period were 241.10 days and 223.70 days. The average males and females weaning weights were 19.05 ± 0.76 kg and 18.49 ± 0.58 kg. The highest and lowest weights ranged from 24.30 to 15.30 kg and 22.30 kg to 15.20 kg respectively. The average weaning age was 5.19 ± 0.18 months. The highest and lowest weaning age was 6.20 months and 4.00 months respectively. The average age at first fawning was 14.58 ± 0.43 months. The highest and lowest age at first fawning was 18.20 months and 12.00 months respectively.

From the results it could be concluded that to keep balanced nutritive conditions along with productive wellbeing of the spotted deer in the zoo, recommended rations needs to be fed with effective management systems to be build up permanently. Then it will largely contribute to the national economy of Bangladesh.

RECOMMENDATION

In contrast to the habitat situation of Bangladesh National Zoo is more crowded in space. Habitat is more natural in BN zoo with large, open and forested area where they can be safe from fluctuating weather which is not possible in BN zoo. Management of water system is much easier and good in BN zoo.

Commercial deer farming is very profitable like other livestock farming business. Deer meat is highly expensive than cow, buffalo, goat, sheep, duck or chicken meat. Usually deer eats grass, leaves or grains like other livestock animals such as goat, cow or sheep. So it is very easy to feed them. There are many good reasons for why you should start deer farming business.

I found the worker very generous, experienced and punctual in case of feeding feeds to deer's. No any illegal trade of spotted deer and its other important body part has been reported yet. The dead deer's are buried under the soil for the prevention from microbes, germs and bad smell. Deer farming business has a great opportunity for earning better livelihood and creating good employment sources. Deer is among the most beautiful wild animals of the nature. And all types of people love them, especially for their beauty. Body of deer is covered with multiple colors. As deer is a wild animal, so you can hardly see any around you. Nowadays world population is increasing rapidly, and people are searching for some new farming business ideas which can ensure food security and create a sustainable and profitable income source.

Commercial deer farming business can be a part of this. Deer is a wild animal, and the population in the wild decreasing gradually. So by raising deer commercially, we can make a good income source and at the same time can save this animal form being extinct. Deer products have huge demand and high value in the market. But there are some problems with this lucrative business. Commercial deer farming business is permitted by the Government.

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GLOSSARY

The following is a glossary of some words associated with fallow deer farming. Some are unique to New Zealand and may be helpful when reading reference materials from there.

Abattoir – Slaughter house

Advancer (Advancer) - Forward tine (or tray) of fallow buck head

Back Antler (Black Antler) - Rear tine (or tray) of fallow buck head

Bare Buck - Male in his fifth year

Bragged - Pregnant doe

Braunch - Brow point of a fallow buck head

Break (Brittle) - To skin and cut-up a fallow deer

Buck (Gries) – Male

Buck of the first head - Fallow buck in its fifth year

Button - Vestiges of hard antler

Calve – Fawn

Cast - Shed (i.e. antlers)

Clean weight - Generally with lungs, stomach and intestines etc., only removed but with heart and liver
Clostridial diseases - Bacterial disease (i.e. Blackleg, Enterotoxemia, Tetanus)

Colostrum - Milk secreted for a few days after parturition and characterized by high protein and antibody count

Comely - Description of a "fair" doe

Cotying - Excrement of fallow deer

Doe - Female fallow deer

Fair - Description of a good doe

Fawn - The young of fallow deer in first year

Fench Month - The season for does to have young

Finishing - Carrying deer from weaning to slaughter purely for venison

Gralloch - Removing the stomach, entrails etc. from a deer

Grease - A fat buck was said to be "in grease"

Great - Description for a good buck
Great Buck (Great Head) - Male fallow in his sixth year
Groan (groaneth) - Sound emitted by a fallow buck
Havier - A castrated deer
Hind – Female, doe
Joining - Putting stags and hinds together Lodging - A fallow buck is lodged when it is in cover
Mating - The actual act of mating
Menil - A color variety of fallow deer that is spotted winter and summer
Moss - The velvet on antlers
Near Antler - The left antler
Oestrus– Heat
Off Antler - The right antler
Palm - The palmated top of the fallow buck's antler
Parturition - Birthing
Pedicle - A permanent bony outgrowth from the frontal bone
Pelage - The coat of deer
Pizzel - Penis of an animal (or) whip made of a bull's pizzle
Polling - Cauterising the primordial pedicles to permanently inhibit pedicle and antler development of fallow bucks
Pomeled - Spotted as young deer
Prick or pricks - First head of a fallow buck
Pricket - Male fallow deer in second year
Prickett's Sister - Female fallow deer in second year
Roaring - Being sexually active
Rut - Mating season
Shovel head - Head of old fallow buck
Soar - Fourth year of a male fallow buck
Sorel - Third year of male fallow buck
Spellers - The top points of a fallow buck's head
Spoon-head - Head of young fallow buck

Suet (tallow) - Fat of fallow deer

Tegg (teg) - Female fallow deer in her second year

View - Footprint of a fallow deer

Velvet - "Immature antler". The soft vascular skin that envelops and nourishes the developing antlers of deer

Weaner - Weaned calves

Yearling - One year old

APPENDICES

Appendix 1: Sample Data Collected During Research work

Production Traits:

Traits	Deer														
	Deer1	Deer2	Deer3	Deer4	Deer5	Deer6	Deer7	Deer8	Deer9	Deer10	Deer11	Deer12	Deer13	Deer14	Deer15
Male birth weight (Kg)	2.4	1.8	2.5	3.0	2.3	2.6	3.2	4.1	2.5	3.7	4.0	3.8	2.9	2.8	3.0
Female birth weight (Kg)	2.2	1.7	2.4	2.7	3.2	3.1	2.5	3.0	2.8	2.6	1.8	3.10	3.9	2.6	1.9
Adult Male weight (Kg)	62.2	73.8	78.3	80.2	77.5	88.0	74.9	85.5	88.9	80.6	82.3	77.6	88.8	63.9	68.7
Adult Female weight (Kg)	55.2	62.3	67.4	74.4	71.2	69.4	56.3	61.2	51.3	55.9	60.1	61.0	56.3	52.9	59.7
Male weaning weight (Kg)	15.7	18.2	15.3	20.1	23.4	21.2	24.3	16.2	21.4	17.2	19.4	22.3	16.9	18.6	15.6
Female weaning weight (Kg)	15.4	16.03	18.4	22.3	21.9	19.5	15.2	17.5	19.6	18.7	21.2	17.9	19.8	16.2	17.5

Appendix 2: Sample Data Collected During Research work

Reproduction Traits:

Traits	Deer														
	Deer1	Deer2	Deer3	Deer4	Deer5	Deer6	Deer7	Deer8	Deer9	Deer10	Deer11	Deer12	Deer13	Deer14	Deer15
Weaning age (Month)	4.2	4.4	4.7	5.1	6.2	4.8	4.0	5.2	5.5	5.3	5.6	5.8	6.1	5.0	5.9
Age at 1 st estrous (Month)	18.3	14.8	15.5	16.5	13.6	15.6	14.1	13.2	14.5	14.2	14.9	12.4	11.5	13.5	14.6
Length of estrous (Days)	17.5	18.2	21.1	19.4	18.9	17.3	14.4	15.1	16.4	21.2	17.2	15.3	15.0	17.7	16.3
Age at 1 st fawning (Month)	12.6	18.2	15.3	15.9	14.3	12.5	14.4	15.0	13.4	13.1	12.00	16.2	14.5	15.2	16.1
Gestation length (Days)	240.9	238.5	235.4	233.4	232.2	234.2	229.3	225.1	224.6	223.7	241.1	237.5	236.3	225.0	229.5