Literature Review

2.1 Deer

Deer belongs to the genus *cervus* which is one of the sub - family of *cervidae*. Together with *bovidae* (antelope, cattle, sheep, goat), *giraffidae* (giraffe), *trangulidae* (mouse - deer) and *moshidae* (musk deer), they form the sub - order *rumanatia* of *artiodactyla* which literally means `four-toes animals'. The *cervidae* is a very extensive family, consisting more than 17 genera, 40 species and more than 190 subspecies (Whitehead, 1984 ; see Figure 2.1).

Deer can be found practically throughout the world except in the desert and in the antarctic. In many instances, many indigenous species have been distributed to several countries, initially as game animals but a number of which subsequently captured and domesticated. Deer originated from temperate countries acclimatized well in temperate countries such as Australia, New Zealand and in tropical countries in South East Asia. The deer mature body size, ranges from as small as water deer *Hydropotes inermis* (10 kg) to the biggest, Elk/ Wapiti *Cervus canadensis* (up to 500 kg).

2.2 General biology

Being ruminants, deer has the ability to convert fibrous, often low in nutrient quality feedstuffs into edible products such as venison and antlers and skin as valuable byproduct. Interestingly, deer has certain physiological and biological peculiarities that differs from other ruminants. For instance, it can be distinguished from cattle by its narrow, hairy and cleft upper lip which allows them to graze closer to the ground and exercise more selective feeding than cattle. On a higher quality diet, deer is almost twice as efficient as cattle in feed conversion (Blaxter, 1974).

The biology of deer species belonging to the genus *cervus* is generally

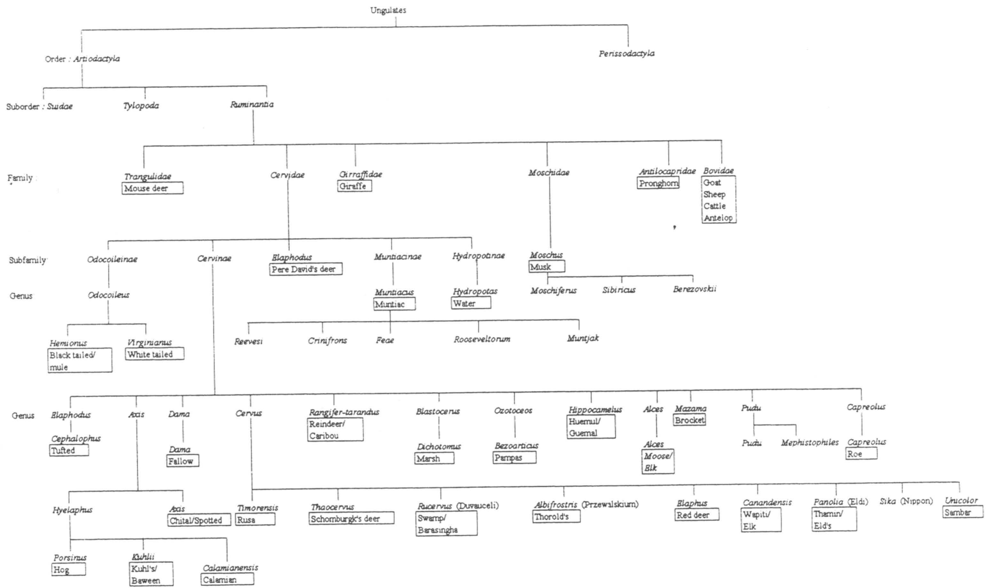


Figure 2.1 : Classification of the deer in the Ungulates (adapted from Whitehead, 1972 and Van Soest , 1982)

similar (deVos, 1982). Most deer possess pre - orbital glands located in the immediate proximity of the eye and consist of sacs which open on the skin surface (through a slit - shaped cavity), which discharge a strong smell. Deer distinguish themselves from the rest of *artiodactyla* due to the present of various shape of antler with tines.

Deer ruminate or chew the cud during the process of mechanical digestion of fibrous feed. Each mouthful, instead of being completely masticated or chewed up, was immediately swallowed and passed into the lobe of the stomachs (rumen) in which it remains moist for the bacterial digestion phase. The complex stomach consists of four chambers; omasum, abomasum, rumen and reticulum.

Deer are both grazers (Habsah, 1983b, 1985) and browsers (Vidyadaran et al., 1991). There is a clear distinction between browsers and grazers; grazers obtain feed by inhibiting grassland whereas browsers feeds on leaves and buds in the fringes between grassland and forest/bushes. Through browsing, deer becomes concentrate selectors which enable it to digest cell solubles easily and to rapidly remove indigestible particulate matter (Barnes, 1989).

The feeding behaviour of deer is comparable to goat. Both have unique preference for shrubs and tree leaves, either deciduous or evergreen, and are adapted to browsing better than cattle and sheep. These animals have a dexterity of tongue and mouth parts that allow it to efficiently select their feed. Deer are able to select from a wide variety of plants, particularly woody plants of high nutritional value. They also use their forefeet to pull down lower branch to gain access to younger leaves in the manner practised by goats (Van Soest, 1987) thus showing that it is generally more active, selective and relish variety of feeds (Devendra, 1989) compared to other ruminants.

Deer are always selective while feeding. It seeks for the highly palatable food, in preferences to food of medium or low palatability. The problem of palatability also affects the ranking of forages by animals of differing appetite. Deer select the most nutritious plants parts available and digest large quantities of medium quality feed, by virtue of symbiotic microrganisms in the rumen (deVos, 1982).

2.3 Domestication of deer

Domestication of wild animals commenced when man gradually reduced their hunting activities in favour of agriculture during the middle ages. Ruminants appeared to have been among the first animals to be domesticated by man. Trapped ruminants were brought home alive and kept within their home boundaries as a source of food (milk and meat), draught power and transportation. The animals were used initially as ancillary food sources especially for peasants and then for recreational hunting (game animals), pet, food, oriental medicines (Yerex, 1982) and recently as a component of agrotourism for tourist attractions (Crandall, 1965).

Although deer and mankind have had a long and close association, most serious efforts to farm these animals have been attempted only recently (Chardonnet, 1993). In addition several species of wild ungulates including the eland (*Taurotragus sp.*), *Oryx oryx sp.*, Thomson's gazelle (*Gazelle thomsoni*), wildbeast (*Connochaetes sp.*) and horse have been a subject of domestication attempts (Bigalke, 1986). In both cases, chances of climate acclimatization and natural feed availability determine the choice of animal species for domestication and/or farming.

For instance; in Europe, Australia and New Zealand, most farmers rear the red deer (*Cervus elaphus*) and fallow deer (*Dama dama*), whereas in the tropical Asian countries, the rusa/javan/timor deer (*Cervus timorensis*) and chittal (*Axis axis*) are the type of deer most commonly farmed. The sika (*Cervus nippon*) and musk deer (*Moshus moschiferus*) are the most popular deer species domesticated in the region between Himalayan and the islands of Japan.

2.4 Population of deer in Malaysia

The first officially recorded importation of deer into Malaysia was in 1980 (DVS, 1986). Since then the total number of deer from several species including the fallow, sika, chittal and rusa deer has increased manifold as a result of continued importation and breeding (see Table 2.1).

Table 2.1 : Deer population in Malaysia (1980 – 1995)

Year	Numbers
1980	34
1985	100
1989	3700
1993	10101
1995	12863

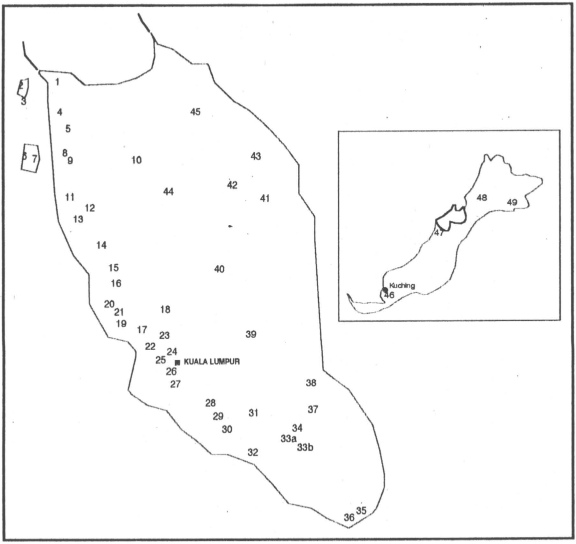
Annual report Dept. of Vet. Services, Ministry of Agriculture (1980 - 1997)

Most deer farms are located throughout the Peninsular Malaysia with 4 farms located in Sabah and Sarawak (see Figure 2.2).

2.4.1 Species of indigenous and exotic deer in Malaysia

The sambar deer (*Cervus unicolor*) is the only indigenous deer species in Malaysia. This species is protected by the National Forest and Wildlife Proctection Department (PERHILITAN) and are available as game animals only during the hunting season. Sambar deer being the biggest tropical deer in the world

FIGURE 2.2 : DEER FARMS IN MALAYSIA



1. Titi Tinggi, Perlis
2. Datai, Langkawi
3. Pulau Singa, Langkawi
4. Anak Bukit, Kedah
5. Pendang, Kedah
6. Balik Pulau, Pulau Pinang
7. Bukit Jambul, Pulau Pinang
8. Juru, Pulau Pinang
9. Seberang Prai Utara, Pulau Pinang
10. Grik, Perak
11. Taiping, Perak
12. Ulu Kati, Perak
13. Sg. Siput, Perak
14. Sungkai, Perak
15. Behrang Ulu, Perak
16. Sg. Nilam, Selangor
17. Rawang, Selangor
18. Rasa, Selangor
19. Batu Arang, Selangor
20. Parit Baharu, Selangor
21. Sg. Besar, Selangor
22. Padang Jawa, Kelang
23. Shah Alam, Selangor
24. Taman Tasik Perdana, Kuala Lumpur
25. Bgn. Parlimen, Kuala Lumpur
26. Ulu Kelang, Selangor
27. Serdang, Selangor
28. Serting, Negri Sembilan
29. Juasseh, Negeri Sembilan
30. Siliau, Negeri Sembilan
31. Gemenchih, Negeri Sembilan
32. Air Keroh, Melaka
33a. Kluang, Johor
33b. Kluang (Porim), Johor
34. Segamat, Johor
35. Desaru, Johor
36. Johor Bahru, Johor
37. Bukit Redan, Pahang
38. Rompin, Pahang
39. Jenderak, Pahang
40. Taman Negara, Pahang
41. Jerangau, Terengganu
42. Cermin Kiri, Terengganu
43. Sekayu, Terengganu
44. Gua Musang, Kelantan
45. Jeram Pasu, Kelantan
46. Kuching, Sarawak
47. Bintulu, Sarawak
48. Keningau, Sabah
49. Tawau, Sabah

(Chardonnet, 1993), is generally bigger than most deer farmed in Malaysia.

Table 2.2 : Morphometric characters of deer species

Species	Appearance	Size	Speciallity
Rusa deer (*Cervus timorensis*) intermediate feeder	Dark brown, less coarse coat, less bushy tail	Medium built Weight : 65 – 150kg	Venison
Fallow deer (*Dama dama*) grass preffered	Greying brown, long tail, flatten antler and palmate	Medium built Weight : 50 – 80 kg	Velvet Venison
Red deer (*Cervue elaphus*) concentrate selector	Glossy reddish brown, short tail	Large/ bigger built Weight :100–200 kg	Venison Velvet Deer byproducts*
Sika deer (*Cervus nippon*) concentrate selector	Rich chestnut to yellowish brown with white spots and white rump patch	Medium built Weight 45 – 80 kg	Velvet
Chittal deer (*Axis axis*) grass preffered	Reddish brown, longest tail with larger white spot, dark brown muzzle	Medium built Weight 60 – 90 kg	Venison
	Dark brown,large ear (batlike), coarse hair and bushy tail	Large/bigger built Weight 150 – 300 kg	Velvet Venison Deer byproducts*

* : pizzle, sinew, testicles, canine teeth, antler, heart, liver, tongue, kidney tail

(adapted and extended from Hoffman., 1973; Van Soest, 1987 and de Vos, 1982)

Table 2.2 illustrates six different species of deer farmed in Malaysia for several economic reasons. These animals show various degree of ease of adaptation towards domestication. The chittal deer (*Axis axis*) has a nervous temperature and is difficult to keep in captivity. Rusa or timor deer (*Cervus timorensis*) are native animals of the Timor island in Indonesia and has been imported from New Caledonia and Mauritius into Malaysia since 1986 for experimental deer farming. This species is more favourable than other deer species for the purpose of farming because of its tractability and hardiness. In addition, it has a higher twinning rate than those of red deer (*Cervus elaphus*) and has higher velvet market value than those obtainable from fallow deer (*Dama dama*) (Fletcher, 1991).

The rusa deer (*Cervus timorensis*) is a medium sized deer with dark brown in colour. Mature stags usually have antlers and weigh between 65 to 150 kg. Rusa deer are similar to sambar deer (*Cervus unicolor*) in appearance but its coat is less coarse and its tail is less bushy. This animal has a unique preferred habitat, briefly described as the open grass woodland and forest, either hilly or lowland. They live either singly, in pairs or in small herds. Its activity is predominantly nocturnal.

2.4.2 Deer farming in Malaysia

The first large scale deer farming project was started by DVS at Ijok, Ulu Selangor (Babjee et al., 1984). Red deer was first brought in because of the farming success of this species in Britain and Scotland. However because of their relatively large body size and different feeding behaviour, these animals do not adapt and thrive well in Malaysia. Fallow, rusa and chittal (Chang et al., 1989) which are medium size animals, were introduced as an alternative to red deer farming. The number has grown from 100 in 1985 to 12000 in 1995.

2.5 Natural feed resources for deer in captivity

The population density in deer farms in Malaysia range from 1/ha to 2000/ha. Availability of green materials for free choice foraging and browsing depends on the area available within the confinement. In densely populated area (10 animals /acres; typical in Zoological garden or research station), over-consumption and soil compaction make it impossible for the regrowth of shrubs and grasses. Feeding of animals based on cut and carry system is a norm under such situation. Under a more spacious farming system (between 1 - 5 animals/20 acres) which can be observed in commercial deer farms, ecotourism) soil compaction is less significant and this enable the growth of woody plants, grass and shrubs for both sources of feed and shades.

2.5.1 Grass, creeping legumes and weeds

Due to its wild nature, deer are suitably reared under confinement in large areas. For instance; Segamat deer farm (see Plate 5.2) in Johore allocated land area of 1000 acres for 200-500 deer. The landscape resembles grazing field with a few islands of secondary forest and trees planted as hedges and for shades. It has become normal practice in many deer farms to use cultivated grass (pasture) such as guinea (*Panicum maximum)*, napier (*Pennisetum purpureum)*, paragrass (*Brachiaria mutica)* and Setaria *(Setaria splendida)* as sources of roughage during free grazing. The nutritional value of grass grown in the tropics however is generally lower than those planted in the temperate condition (Garret, 1980).The nutrients intake from these grasses, are insufficient because they mature at faster rates and their qualities deteriorates rapidly; especially due to a decline in palatability and digestibility.

Several creeping legumes such as *Peuraria phaseloides*, *Stylosanthes guyanensis* and *Centrosema pubescens*, which are widely grown as covercrop in oil palm plantation are also eaten by deer (Dolmat and Basiron, 1995). In many cases, tropical forage legumes generally are more palatable and consumed in greater quantities than tropical grass of similar digestibility (Minson,1981). Intake from these legumes alone however is insufficient to improve the animals' growth rate (Skerman, 1977).

Several species of plants regarded as weeds are *Asystasia gangetica*, *Mikania micrantha*, *Mimosa invisa*, *Calopogonium mucunoides* and *Centrosema pubescens*.. These legume (*C. mucunoides* and *C. pubescens*) are initially used as covercrop in tree crop (oilpalm/rubber) plantation but in many occasions invade neighbouring area and subsequently become weeds. These weeds can be used as potential feed resources for ruminants including deer.

2.5.2 Browse plants

In the present study, browse plants are defined as plant materials other than grass eaten by deer in selective manner. These may include leaves, shoots, smaller branches and cambium layers of larger accessible branches of woody plants, shrubs and trees. Browse foliage of woody species is generally of high nutritional status and palatability. Browse plants offers considerable potential for enhancing animal productivity in the tropics by virtue of fast growth rate. A primary forest cleared after logging activities will be covered by bushes within 6 months and secondary forests within 3 years. Browse legumes are an important source of fodder for ruminant in the tropics, especially during prolonged dry seasons when pasture grass and legumes are in short supply.

There are substantial number of research carried out on browse plants in East Asia and the Pacific to improve the productivity of goat, sheep and cattle (Lowry et al, 1981; Van Mele and Athonsamy, 1984; Ngamposai, 1987; Devendra et al. 1989; Rangkuti et al. 1989; Ibrahim et al., 1990; Morand – Fehr, 1991). Browse and grain legumes due to its high protein content despite low digestibility, offer considerable potential for enhancing animal productivity in the tropics (Babjee and Chin, 1991). They provide a major portion of deer's daily water and mineral requirement which are only available in limited amount from pasture species. They are also a good source of plant protein and other nutrient at certain times of the year when pasture are dormant (Vercoe, 1980). Local shrubs and trees can be grown easily and many parts of the tree such as bark, leaves, shoots and stems have the potential to be used to supplement the usual animal feed.

There appear to be limited number of studies on the nutritional importance of browse plants in feeding deer kept in confinement. The present studies aims at gathering as much information as possible with regards to green material consumed by deer kept in captivity.

2.5 Nutrient contents of feeds : Proximate Analysis

Proximate analysis (PA) is the most widely used analytical methods in the initial nutritional evaluation of feedstuff. It is a system which approximates the values of feed for feeding purposes, without actually using the feed in a feeding trial. It was first introduced by Henneberg and Stohmann in 1862 (Close and Menke, 1986). At best, this method describe the potential nutrient content available from feed analysed. The procedure lack the precision since these feed fractions are not individual chemical entities but a mixture of substances that cannot be characterized chemically (Fonnesback, 1977).

2.6.1 Dry matter

Dry matter (DM) content of feed represent the dry weight of total nutrient content of a feed in the absence of water. It is used as a common denominator for the comparison of feed particularly in terms of energy value.

2.6.2 Crude protein

Crude protein is a conventional term for all nitrogenous substances. CP is often the main limiting nutrient for livestock in tropics with approximately 7 % as the minimum requirement for the nitrogen balance in mature grazing animals especially dietary level for deer (Urness, 1969). CP percentage in feed samples analysed is based on the calculation that most nitrogen-containing macromaterials in most feeds are proteins and proteins on the average are about 16 % nitrogen.

CP content in feed is calculated as N x 6.25, where N represents the concentration of nitrogen in the feed samples. Although N x 6.25 may be a rough estimates of the total portion and a little or no estimate of its quality, it is still reasonably satisfactory on an index of the feed for protein and of the portion included in practical livestock ration (Crampton and Harris, 1969).

2.6.3 Ether extract (Crude fat)

This fraction refers to all that portion of a feed soluble in ether. Crude fat in feed is mostly true fats and it may consist of varying amount of other ether-soluble materials such as the fat-soluble vitamins, carotene, chlorophyll, sterols, phospholipids, waxes, etc. However, the amount of ether-soluble materials in a feed which are not true fats usually represents only a very small percentage of the overall feed. Therefore, it is safe to assume that the ether-soluble fraction of a feed is mostly true fat.

The EE will differ in composition among different food. The nutritional usefulness of EE obviously depends on the extent to which it is digested. Neutral fats are normally over 90% digested but not true in EE from animals fats.

2.6.4 Crude fiber

The CF is the portion of the carbohydrate which is resistents to succesive boiling in dilute alkali and dilute acids. It is the undigestible portion of feed which can only utilised by ruminants by virtue of the presence of cellulolytic microrganisms in rumen which break down the cellulose portion of feed to VFA (ie. acetic, proporic and butyric acids). These acids are mainly absorbed through the rumen wall. This fraction refers to materials in a feed which are low digestibility. They include celulose, certain hemicellulose and some of the lignin.

2.6.5 Ash

Ash value is mainly in the contents of mineral P, Ca or Ca and grass ash contains large amount of silica, about 50 % of its total weight.

2.6.6 Nitrogen free extract

Nitrogen-free extract (NFE) includes mostly sugars and starches and some of the more soluble hemicelluloses and soluble lignin. This fraction is designed to include the more digestible carbohydrates. Thus, any lignin, which may be included will tend to distort the meaning fullness of the NFE value because lignin is essentially indigestible. NFE is primarily a non – specific source of energy to the animals. Its digestibility is ordinarily a little higher than protein, fat or CF of the same feed.

2.6.7 Mineral

Minerals constitute approximately 5 % of the body weight of an animals. They are inorganic elements essential for animal physiological and structural functions (see Table 2.3). This include maintenance of acid - base balance of the body, support of metabolic reactions. Some may become part of a part of the molecule of the vitamin (e.g. cobalt is a part of vitamin B_{12}).

Minerals are required in either as macro (large) or micro / trace (smaller)

Mineral	Functions	Critical level	Optimal needs
Calcium (Ca)	Bone. teeth and muscle formation blood coagulation. cell permeability	1.5 %	0.17 – 0.58 %
Potassium (K)	Major cation of intracellular fluid and muscle activity. enzyme stabilizer	3.0 %	0.5 – 2.0 %
Sodium (Na)	Major cation of extracellular fluid and cell permeability	7000 ppm	0.04 – 0.25 %
Magnesium (Mg)	Normal skeletal development. enzyme activator. decrease tissue irritability	1.2 %	0.10 – 0.40 %
Phosphorus (P)	Bone and teeth formation. metabolic energy transfer	0.25 %	0.25 – 0.30 %
Copper (Cu)	Hemoglobin synthesis. hair pigmentation. cofactor in oxidation-reduction enzyme	100 ppm	6 – 16 ppm
Cobalt (Co)	Synthesis of Vit B12. rumen bacteria growth enzyme activator	500 ppm	0.1 – 0.2 ppm
Zinc (Zn)	Normal protein synthesis and metabolism. component/cofactor enzyme	500 ppm	7 – 40 ppm
Iron (Fe)	Cellular respiration. component of hemoglobin and certain cell	1000 ppm	30 – 60 ppm
Manganese (Mn)	Essential for normal bone formation. activator and constituent of enzyme	1000 ppm	7 – 40 ppm
Molybdenum (Mo)	Component of several enzymes, purine metabolism. stimulates rumen organism	13 ppm	0.35 – 2.37 ppm

Table 2.3 : Functions of minerals needed by the animals (Condensed from Mc Dowell et al.,1993)

amounts. Macrominerals include calcium (Ca), pottasium (K), phosphorus (P), sulphur (S), magnesium (Mg) and sodium (Na). Ca and P are required in certain amount and in optimum ratio to each other for bone growth and repair and for other body functions. Essential microminerals include cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), selenium (Se), fluorine (Fl) and molybdenum (Mo).

Mineral imbalances (deficiencies/excesses) in forages has been responsible for low production and reproductive problems among grazing ruminants in the tropics (McDowell et al, 1993). Excesses of a number of minerals may be quite harmful. For instance, excess amount of aluminium, fluorine, molybdenum and selenium are highly toxic (Williams and McDowell, 1985). Forages grown on tropical soils can be highly deficient in the number of the macro and micro mineral elements needed by the grazing animals because of lack of humus and bacteria activities (McDowell et al, 1993).

2.7 Anti - nutritional factor (ANF)

There are certain factors limiting the wider use of the browse plants which is the ubiquitous distribution of a diverse array of natural compounds which are capable of precipitating adverse effects in animals or minimizing forage nutritional benefit. Plants may contain natural compounds collectively termed as anti-nutritional factor (ANF) which deter feeding through strong odour or taste and function as natural defence against animal browsing.

Browse (leaves and twigs of shrubs and trees) and forb generally contain higher level of CP and P during the growing season than grassess, but many palatable browse species are limited in value because of one or more inhibitors that may bind or otherwise prevent utilization of nutrient contained in plants (Brewbaker, 1986). The toxic factors may occur in some or all parts of the plants but the level of deleterious substances vary with the species of plants and cultivar. Certain trees can be toxic when used alone but they may be very useful as protein supplements in a mixed diet of grasses or pastures legumes (Brewbaker, 1985).

Not all animals are susceptible to the presence of toxic substances. There are evidence indicating that deer is less susceptible to toxins when fed with a variety of poisonous plants (Qin and Liang, 1983). This may be attributed to its behavioural feeding whereby they eat a broad range of plants to maintain a varied, but limited consumption of secondary chemicals. Deer are also capable of selecting only plants containing particular chemicals (McArthur et al., 1992). Manifestations of toxicity depends on the level of intake of the plants and the rate of metabolism of the anti - nutritive constituents (D'Mello, 1992).

Problems with potentially toxic plants usually arise under conditions of nutritional stress and forage scarcity such that less desirable plants are also consumed. As a result, both animal growth and production may be affected. Some example of the ANF are tannin (hydrolyses and condensed), cynide, phenolic compound, alkaloid and oxalate.In the present studies (browse) plants ANF are broadly classified under as saponin, terpenoid and alkaloid.

2.7.1 Saponin

Saponin are non-nitrogenous compound which are inactivated by complex formation, containing medicagenic acid, form complexes with bile cholesterol and are eliminated in the feces (McArthur et al., 1992).

2.7.2 Terpenoid

Terpenoid is a non - nitrogenous compound. Terpenoids compound occur freely in plant tissue or may combined with glycosides.

2.7.3 Alkaloid

Alkaloid is a nitrogen - based compounds, occurs mainly or largely in plants and are represented by some drug such as morphine, cocaine and nicotine. The physiological activity of an alkaloid manifest itself as in an extreme toxicity, which exhibit therapeutically useful pharmacological properties at sublethal dosage. It is also a valuable drug in general medical practice.

3.0 An evaluation of deer farming

Deer farming provides another alternative for diversification of the livestock industry. Deer farming has the potential to grow rapidly in the future since there is an uptrend demand for local and imported venison. In recent past, due to limited importation from Australia and New Zealand local demand for venison, were supplied mainly from illegal sale of hunted deer meat. Through deer farming, controlled slaughter of deer to ensure sustained supply of venison can be realised. The venison market is expected to grow as public awareness and acceptance of slaughtered under proper supervision becomes more widespread.

Very little is known about the deer and their related species with respect to feeding requirement under farming conditions in the humid tropics. Most information currently available and applied in deer farms were derived from deer farming experience in temperate countries (McMahan, 1964; Morcan, 1973; Dixon, 1975; Drew and McDonald, 1976; Quinones,1976; Anderson, 1979; English, 1979; Qin and Liang, 1983; Reiken, 1990; Klien, 1991).

Modification on the feeding of deer is a continous process as more information on the nutrient requirement of deer farmed under tropical climate are being reported from studies carried out in both research institutions and private farms (Habsah, 1985; Chang et al., 1989; Ishak et al., 1991; Kardin, 1992; Mohd Nasir et al., 1994; Dolmat and Basiron, 1995; Semiadi et al., 1995).

3.1 Govermental farms vs commercial farms

Each state in Malaysia, with the help of the Department of Veterinary Services (DVS) has established their own deer farms for multiplication and research and development (R&D) purposes. As there is a potential market for locally produced of deer product, several private enterprises have also stated to invest in deer farming. These include Johor deer farm in Desaru, Johore; Petroleum National (Petronas) deer farm in Jenderam Hulu, Selangor (Dahlan, pers. comm) and Arab Malaysian Development (AMDB) deer farm in Segamat, Johore (Khalid, pers. comm).

The location of deer farms, both big and small scales are shown in Table 1. The approach adopted in the rearing of the animals depends on factors including the land area available (landscape, irrigation), manpower and size of capital (thus the number of animals to rear). Most commercial farms use free range system (Vidyadaran et al., 1992), which appears more economical and efficient than those in intensive deer farming.

3.2 General management

Several key farming requirement will now be decribe which influence methods and approach of feeding adopted in deer farming.

3.2.1 Fencing

Boundary fence are normally 1.8 m or higher, but even then the animal can jump at these heights after a short run. The best fencing system in use is cyclone fencing whereby it can withstand constant buffeting without injuring the animals. Nevertheless, deer generally prefer to attempt to go through a fence and readily go under the fence if at all possible. Therefore, it is good to have a concrete base under the fence. Gateaways should be reasonably wide because these semiwild animals can readily pass through a narrow gap when driven from one pen to another. Three meters (3m) is a minimum practical width especially with large group of animals. The deer spend most of the time strolling along the fence when feeding as well as trying to find an excape opening.

3.2.2 Paddock

Rotating paddock within flatland or hilly area with good quality pasture is a norm. This is to prevent from overgrazing which is detrimental to the pasture. It cheaper to fence high quality pasture than shrub or bushland. It is a common practices to purposely create islands of trees within the paddock to provide the animals various selection of feed. The animals are normally shifted to the next paddock after 7 - 10 days, depends on the pasture. The animals cherish tree shades to protect them from sunlight and sometimes likes to wallow endlessly in the tree islands. The problem with wallowing is that the potentiality of diseases spreading through water is higher.

Carrying capacity may be increased with irrigation or supplementary feeding, however high stocking rates may predispose the herd to disease, parasite problem and stress. Breeding may also depressed if normal behaviour associated with mating is prevented by overcrowding. The farm should be as free as practical from the likelihood of natural disaster (fire, flood, drought, etc) which may potentially cause expensive losses.

3.2.3 Feeding system

Deer thrive well solely on adequate good pasture. Supplementary feeding however helps to improve the animals nutrition and tame the animals. Mineral lick is needed when animals did not get enough minerals from plants. Deer has quite a selective feeding habit, thus each paddock should be planted with various type of plants and improved pasture (grasses and legumes).

Certain selected plants which has the potential animals feeds can be planted around the farm especially near the fence as hedge. The animals might use the tree as shade during the heat of the day and for mobbing (removal of the velvet and marking of rutting stand) that can destroy the tree.

3.2.4 Stag to hind ratio

The recommended stag to hind ratio is 1 : 25. Excess means problem because the dominant stag spend most of his time protecting his harem. Rather than eating and mating which may lead to low percentage of hinds calving. The gestation period is approximately 246 days (7 - 8 months) and usually produce single animals from each pregnancy.

3.2.5 Taming

Apart from using supplement feeding such as concentrate to tame the animals. It isuseful to let the animals exposed to human around the area. Individual domestication is recommended as early as few days old. (i.e after colostrum feeding). The fawn can be separated from the doe at the age of one week and fed with bottle. It is recommended to stroke the young twice or trice a day. The duration of stroking depends on the reaction from each individual. Fawns that have become used to being handled are led along in enclosure on a helter. It is necessary to have a nursery in the farming area to separate young animals from the does and stags. Feeding routines fixed quantities of food on regular hours must always be adhered to.