The buffalo

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The African buffalo has recently come under threat again because of various diseases. Consequently the intensive breeding of disease-free buffalo has become a lucrative business, but one which must be approached properly to ensure success. The information below should help in the intensive production of buffalo for various sectors of the wildlife industry.

The African buffalo is the largest member of the family Bovidae which includes the antilopes. There are two subspecies, the savanna buffalo *Syncerus caffer caffer* and the red or forest buffalo *Syncerus caffer nananus*, also known as the dwarf buffalo. The buffalo was originally regarded as a type of cattle by Linnaeus in his tenth edition of *Systema Naturae* in 1758 when he named it *Bos caffer*. It is the African mammal with the largest morphological variation, which is the reason why earlier mammalogists described 43 subspecies. Smithers (1983) recognizes only the above two subspecies. However, in the Rowland Ward Records of Big Game (Smith,1986) the geographical distribution is used to distinguish three subspecies:

* The southern buffalo *Syncerus caffer caffer* that occurs in South Africa, Botswana, Angola, Zimbabwe, Mozambique,Tanzania, the Democratic Republic of the Congo, Uganda and Kenya.
* The northern buffalo *Syncerus caffer aequinoctialis* that occurs in Chad, the Central African Republic, Sudan, Ethiopia, Somalia, Nigeria, Mali, Niger, Upper-Volta, Senegal and Benin.
* The dwarf buffalo *Syncerus caffer nananus* that occurs in the central Democratic Republic of the Congo, Gabon, Cameroon, the forest belt along the shore of the Gulf of Guinea through Nigeria, Togo, Liberia, Ghana and Guinea.

According to Rowland Ward the southern buffalo has massive horns curving down to a level below the skull, with a tremendous width at the base (Smith, 1986). In the northern buffalo the horns never curve down to reach lower than the base of the skull. The dwarf buffalo is slightly built, with a reddish-brown colour and small horns that lack the large frontal bosses and a deep curve.

Ansell (1972) distinguished four subspecies:

* *Syncerus caffer caffer* is the largest of the four subspecies, measuring 1.4 to 1.6 m at shoulder height. Females weigh up to 500 kg and males up to 700 kg. The animals are black, with large horns that have a span of up to 1.3 m (51 inches). This group extends from southern Africa and Angola, through Central and East Africa to the southern borders of Sudan and

Ethiopia.

* *Syncerus caffer nananus* is much smaller, measuring 1.05 m at shoulder height, with small horns and a reddish colour. This subspecies is found in the forests from the Ivory Coast westwards towards Liberia.
* *Syncerus caffer brachyceros* is regarded as an intermediate subspecies, occurring from the Ivory Coast through Nigeria to Lake Chad, then southeast through southern Cameroon, the Central African Republic, the Congo (Brazzaville) and the northwestern Democratic Republic of the Congo.
* *Syncerus caffer aequinoctialis* is found from the forests of the eastern Democratic Republic of the Congo, Lake Tanganyika and Lake Kivu and then further north to Lake Chad and eastwards to southern Sudan into Ethiopia and to the Upper Nile.

The above discussion illustrates how mammalogists have tried to use morphological features and geographical distribution to group the buffalo in Africa, without any genetic proof for their classification. For example, the forest buffalo previously occurred in the Quissama National Park (Kissama) in Angola, although such a geographical distribution did not fit the proposed classification system. From an ecological point of view it is easier to follow the classification of Smithers(1983), recognizing only two subspecies, *viz*. the red or forest buffalo *Syncerus caffer nananus* and the savanna buffalo *Syncerus caffer caffer*. The above intermediate form may be a hybrid of these two subspecies, as it occurs in the ecotone (contact zone) between the habitat types of the two major subspecies. This ecologically based classification incorporates the environmental effects on the morphology of the animals and is as follows:

* Savanna buffalo: *Syncerus caffer caffer*
* Ecotone buffalo: *Syncerus caffer brachyceros*/*Syncerus caffer aequinoctialis*
* Forest buffalo: *Syncerus caffer nananus*

The present distribution of buffalo in Africa is indicated in Figure 1. Except for the arid areas, buffalo at present occur roughly in a band through Central Africa, between the latitudes 12☜N and 12☜S. Further south the distribution is patchy, occurring mainly in the eastern regions of southern Africa. These patches are too small to illustrate in Figure 1, and most of these animals are found in fenced wildlife ranches where they have been introduced or reintroduced. Table 1 lists the numbers of diseased and disease-free buffalo in different countries in southern Africa.

[INSERT FIGURE 1 - distribution map]

[INSERT TABLE 1 - numbers in southern Africa]

1 DESCRIPTION

The basic characteristics of buffalo are summarised in Table 2.

[INSERT TABLE 2]

There is a high degree of correlation between thoracic girth and body mass in the buffalo. This relationship can be described by the following equation:

Y = body mass of bulls = $84.36 - 2.346\ x + 0.02338\ x^2$
U = body mass of cows = $-109.76 + 0.774\ x + 0.01131\ x^2$

where: x = thoracic girth in centimetres and Y & U = body mass in kilograms

The mass at birth of a buffalo calf ranges from 35 to 50 kg. Researchers use 45 kg as a mean mass at birth for various calculations. Bull calves are 5.0 to 10.0% heavier than heifers. The maximum growth for both sexes occurs during the first 12 months of life. During the period of maximum tooth replacement (three to five years of age), the growth rate slows down. Growth rates for buffalo up to 42 months of age from different areas are summarised in Table 3. Animals usually maintain their body mass during adulthood but will start losing mass after 20 years of age (Prins 1996). In the Serengeti ecosystem's buffalo population, the mean mass of adult cows in the 12.5 year age group, and of bulls older than 10.5 years is 454 kg and 690 kg respectively. The heaviest bull recorded to date in the Kruger National Park weighed 802 kg.

[INSERT TABLE 3]

The maximum shoulder height of the newborn buffalo calf is 700 mm. The maximum shoulder height for adult cows is 1.38 m and 1.52 m for adult bulls. Shoulder height is not a reliable method to age buffalo because of the variation between individual animals. Height differences from photographic records of known individuals are illustrated in Figure 2.

[INSERT FIGURE 2]

.1 Age determination

Buffalo longevity under natural conditions is unknown, but under intensive farming conditions they have the potential of living to an age of 25 years or more. Age determination of a buffalo can be done by means of its dentition (Figure 3).

The deciduous dentition set in a buffalo consists of four lower incisors, no upper incisors and three premolars on either side of the upper and lower dental arches. The deciduous set of 20 teeth can be

represented by the following dental formula:

Di 0/4 Dc 0/0 Dp 3/3 X 2

where: Di = deciduous incisors, Dc = deciduous canines and Dp = deciduous premolars.

[INSERT FIGURE 3]

The permanent dentition set in a buffalo consists of four incisors, three premolars and three molars on either side of the lower jaw. There are no upper incisors, but three premolars and three molars on either side of the upper jaw. The permanent set of 32 teeth is represented by the following dental formula:

I 0/4 C 0/0 P 3/3 M 3/3 X 2

where: I = incisor, C = canine, P = pre-molar and M= molar

Between the first week and about 9 months of age, all the temporary teeth erupt and are in wear. Under field conditions only the eruption of the incisors can be used to age animals up to five years of age (Figure 2). According to Hornsveld (1991), the first lower incisor appears at an age of two years, the second at three years, the third around four and a half years and the fourth at five years of age. As a bovid, the buffalo does not have upper incisors.

1.2 Horn development and growth

The horn growth of buffalo was described by Pienaar (1969) (Table 3). In calves, growth starts with a sharp upward growth in a V-shape. By an age of two years, the horns are 300 to 460 mm long, by three years they are 410 to 690 mm, and by four years 610 to 860 mm long. The boss starts to thicken at an age of three to four years, and the shape at adulthood in cows is attained at four to five years of age, when the tips also start to sweep backwards. The typical hairy boss develops at an age of five to six years. In bulls older than seven years the two halves of the boss are merged and the horn tips are worn away.

[INSERT TABLE 3 horn growth]

1.3 Coat colour

The coat of a newborn calf is black to dark olive-brown. When the calf is a few months old, it becomes yellow-brown, with long hair that creates a rough appearance. The coat colour darkens with age to a reddish chocolate-brown, and turns black in cows at four years and in bulls at five years of age. During the second year of life the coat becomes short and smooth. In old bulls the coat becomes wavy in texture, and in extremely old animals it has hairless spots. These spots can be due to parasitic infestations (parafilaria). A white coat colour, but not albinism, has been reported in the wild. When such an animal ages, the coat turns a light cream-brown.

1.4 Body composition

The available data for the carcass of an adult buffalo bull can be summarised as follows:

- Mean live mass: 753 kg
- Mean dressed carcass mass: 380 kg
- Carcass mass: 50.0% of the live mass
- Carcass lean mass (without fat): 40.0% of the live mass
- External offal (head and horns, feet, hide and skin): 17.6% of the live mass
- Hide: 9.9% of the live mass
- Full digestive tract (fat free): 19.0% of the live mass
- Contents of the digestive tract: 15.2% of the live mass
- Internal fat deposits: 1.2% of the live mass

The carcass composition is as follows: the hindquarter mass forms 41.5%; the edible products 80.0% and the carcass fat 5.6% of the carcass mass. The carcass muscular tissue forms 40.6% of the live mass (lean constant) and the protein:bone ratio is 0.83. The calorific value of boneless meat is 140 cal/100g.

2. DYNAMICS

2.1 Reproduction

Puberty starts when a heifer starts to ovulate, and sexual maturity is reached when a female reaches her optimum reproductive potential. Female sexual maturity is reached from 3.5 years of age or later, and first calving occurs from 4.5 to 5 years of age. The age at which sexual maturity is reached, is related to body mass. This explains the variation in ages at sexual maturity which is reported by different authors. Bulls are sexually mature from 2.5 years of age, but under natural conditions the dominant herd bulls will not allow other bulls to mate before they reach the age of seven years or more.

Buffalo cows ovulate during the rainy season when the grazing is optimal. In the Kruger National Park conception occurs in February and March, and the peak calving season is in January and February. The buffalo is a long-day breeder, being sensitive to photoperiod (day-length).

The mean gestation period according to data collected in zoological gardens is 343 days (11.2 months). The pregnancy rate is the proportion or percentage of the total number of adult females in the population that is pregnant. In buffalo the mean pregnancy rate of adult cows is 75.0%. The

calving interval is the gestation period divided by the pregnancy rate. In buffalo it is 343 days ÷ 0.75 = 457 days.

Severe drought conditions in the Kruger National Park did not affect the ability of adult buffalo cows to conceive and maintain pregnancy. However, even under excellent grazing conditions, heavy mortalities of calves occur *post partum*. Cows losing calves soon after birth will quickly breed again. The variation in the calving interval is due to *post partum* anoestrus, that varies from 3.6 months as in the Serengeti ecosystem, to 13.3 months as in parts of Uganda. When a calf is removed from the cow within three days of birth, oestrus will occur again within five weeks. If buffalo calves are allowed to suckle for several months, oestrus will occur again in the cow within three to five months *post partum*, because of lactation anoestrus.

Calving usually takes place during the late afternoon, when the herd is resting. Calving is completed within two hours after the onset of parturition. Within an hour after birth, the calf will suckle and follow its mother. As a result of natural selection, dystocias (abnormal labour or parturition because of the size, shape or position of the foetus) does not occur under natural conditions. However, when artificial selection was done to produce larger buffalo in captivity, cases of dystocias have been recorded.

The calf suckles for short periods of up to three minutes at a time. It usually suckles from the rear. When the calf wants to suckle while the mother is lying down, it will nudge her until she gets up. Buffalo milk contains 6.0% protein, 5.0% carbohydrates and 8.0% fat. Milk production decreases rapidly after four months of lactation, and the calves are weaned from five to seven months of age under natural conditions. The cow will reject the calf of the previous year once the next calf is born.

2.2 Population dynamics

The main factors that keep wild buffalo populations in equilibrium with their environment are lack of food (drought), disease and predation. Buffalo densities in East Africa are correlated positively with rainfall, and therefore with their food supply (Table 4). Buffalo populations are susceptible to drought and the population in the Kruger National Park has decreased from 29 359 in 1991 to 14 123 in 1995 as a result of the drought of 1992 and 1993. The population then increased again to 20 000 in 1998 after successive years of good rainfall.

[INSERT TABLE 4]

The daily food intake of buffalo equals 2.5 to 3.0% of its body mass. During the wet season the

protein content of the grasses eaten is above 10.0%, but it will drop to levels below 3.0% in the dry season. The crude protein content (CP) of the food can be calculated by measuring the faecal protein (FP) by using the equation: CP = 2.61FP - 11.9.

Mortality rates for adult buffalo over an eight-year period in the Serengeti ecosystem varied from 3.6 to12.3%. During the same time juvenile mortality varied from 11.7 to 22.6%. In the Serengeti National Park in Tanzania, the lion is the only predator that kills buffalo older than a year. Research in the southern part of the Kruger National Park has shown that non-territorial male lions predominantly kill buffalo (73.0%), while the territorial males kill fewer buffalo (36%). Lions chase buffalo over greater distances than other prey species (mean: 1 090 m as opposed to 129 m). This hunting technique may have developed recently to capitalize on buffalo with tuberculosis infection that usually lag behind the rest of the herd because of pulmonary infection and difficulty in breathing. Therefore, in this case predation is secondary and disease and food shortages are the primary factors for mortality in the buffalo. Predation never accounts for more than 30.0% of all the mortalities under natural conditions.

Poor physical condition as a result of low quality of grazing leads to lower antibody levels in the buffalo, making it a more susceptible host for most diseases. The most important diseases of free-ranging buffalo are anthrax and rinderpest. Rinderpest is an exotic disease in Africa and African herbivores are not adapted to it. The disease is spread from cattle to buffalo, with disastrous effects on wild populations of buffalo. The successful vaccination of cattle has caused rinderpest to disappear in the wild, although the threat of reinfection always exists.

Anthrax is an acute disease that is caused by the bacterium *Bacillus anthracis.* During dry periods, large numbers of wild animals tend to accumulate in close proximity to water. The spores of these bacteria can survive for up to 40 years in old bones. Oral infection caused by the ingestion of spores contained in contaminated food and water sources, lead to mortalities within 10 to 14 days. Infected animals usually die close to waterholes. Vultures spread the disease after feeding on these carcasses and then bathe in nearby waterholes. Flies feeding on infected carcasses contaminate the vegetation in the immediate vicinity. A vaccine that is registered for cattle seems to be effective for buffalo during anthrax outbreaks.

2.3 Population control as a management tool

Large populations that are fenced in, must be managed to prevent a population crash. In the Kruger National Park population numbers are controlled when a pre-determined maximum threshold is reached. The culling quota can be calculated as follows: Q = (A - B) + (D - C), where: A = most

recent count total, B = ceiling population size, C = mean estimated mortality over the past few years, and D = estimated recruitment to the population.

Example:

During 1999, 2500 buffalo were culled in the Kruger National Park. The count of 1999 before culling showed 30 000 buffalo. The ceiling population size was set at 27 500 buffalo. The count of 2000 showed 29 500 buffalo of which 3000 were buffalo calves (10.2% population growth). The expected total buffalo population for the year 2000 was:

The count of 1999 minus the animals culled in 1999 plus calves of 2000

= 30 000 - 2500 + 3 000

= 30 500 buffalo

The percentage mortality was:

The expected total for 2000 minus the actual total counted for 2000

= 30 500 - 29 500

= 1000

= 3.3%

The mortality percentage is therefore 1000 ÷ 30500 X 100 = 3.3%.

The culling quota for 2000 therefore was the actual count for 2000 minus the ceiling population size plus the number of calves in 2000 minus the number of mortalities:

29 500 - 27 500 + 3000 - 1000

= 4000 buffalo.

For large populations it is important to maintain the correct herd structure. Groups to be culled are randomly split from the herd. With selective culling on ranches, surplus bulls are usually hunted, leaving a skewed sex ratio that favours cows. Breeding groups can be sold to potential wildlife ranchers and wildlife farmers at higher prices than the hunting price.

3. HABITAT AND ACTIVITY

The buffalo is the one bovid in Africa that is found from sea-level to 4000 m altitude and in diverse vegetation types ranging from lowland and montane forests to moist and dry woodlands or savannas. However, it is not usually found in arid areas with an annual rainfall of below 250 mm.

In the Serengeti ecosystem the optimum habitat for buffalo herds in the dry season is riverine vegetation. During the wet season they move out to drier woodlands and open grassland. Their

preference for riverine habitat does not protect them from predators hiding in the long reeds along river beds. However, open grassland does not provide shade. The important factors determining the choice of habitat, appear to be food and water rather than protection against predators and environmental factors like heat stress.

Buffalo bulls usually occur in groups of three to four animals only, and show a high preference for riverine vegetation throughout the year. During the dry season the bulls prefer forest vegetation and seepage lines that are not utilised by the breeding herds. The bulls will use these areas because they can utilise patches of green grass and wallows that are abundant in these habitats. They will use open grassland only if wallows are available there, and the green grass flush is tall enough after veld fires. Buffalo bulls will, however, utilise grassland on the periphery of forests.

The five most important factors that determine the suitability of the habitat for buffalo are food, water, shade, wallows and competition from other herbivores.

3.1 Food

Buffalo are mainly grazers, but will also consume forbs and shrubs. They spend most of their activity on either grazing or resting and ruminating (Table 5). In forests they will utilise creeping grasses and tree shoots. Grasses are predominantly utilised in the dry season, and grass, shrubs and evergreen trees in the wet season. Research done on tame buffalo in East Africa has indicated that the grass species and grass parts used were high in protein and carbohydrates. Their feeding preference, therefore, appears to be a function of maximizing nutrient intake.

[INSERT TABLE 5]

3.2 Water

The water intake of buffalo under artificial conditions (22☜C) is 3.4 litres per 100 kg of body mass, or 3.4% of its body mass. The preferred drinking times for buffalo are the late afternoon and early morning. During the dry season, buffalo will drink twice a day, but drinking intervals can vary from 6 to 28 hours, with a mean drinking interval of 16.5 hours. Drinking activity forms part of the grazing activity because buffalo will slowly move towards the water while grazing.

3.3 Shade

The subdermal body temperature for buffalo bulls was measured in the Serengeti National Park

where it varied from 35.2☜C at night to 40.0☜C during the early afternoon. When buffalo graze in direct sunlight, the absorption of heat because of its dark coat leads to an increase in body temperature. Buffalo can prevent such an increase in body temperature by the evaporation of water through the skin. Evaporative water loss to control heat stress equals 2.0% of the body mass. There is a high correlation between body temperature and ambient shade temperature. During the hottest time of day, the buffalo will rest and ruminate in shady areas.

3.4 Wallowing

Wallowing is usually done by bulls, and the wallows are situated in open areas. From research done on the water buffalo *Bubalus bubalis* it appears that wallowing has a moderate effect on temperature control. In the African buffalo, bachelor groups have their own wallows in their range. Although the ranges of various bachelor groups overlap, the wallows that are utilized by different bachelor groups do not overlap.

Termite mounds usually form the start of a wallow. When a termite mound erodes to a shallow depression, the high salt concentration in the soil attracts animals such as the warthog *Phacochoerus africanus* to drink at the waterhole that forms there after rains. The animals then start rolling in the wallow to regulate their body temperature. A succession of animals such as buffalo and elephant *Loxodonta africana* also use these wallows and create an increasingly bigger pool where water eventually accumulates semi-permanently. The creation of these waterholes provides surface water in the beginning of the rainy season and relieves grazing pressure in overutilized areas around permanent water sources.

The mud that sticks to the hide of the animals also protects them against biting insects. Terrapins that live in the bigger pools may also remove ticks from buffalo bulls while they are resting in the mud.

3.5 Competition

Potential competitors to buffalo for grazing are the white rhinoceros *Ceratotherium simum,* blue wildebeest *Connochaetus taurinus*, Burchell's zebra *Equus burchellii,* hippopotamus *Hippopotamus amphibius* and elephant *Loxodonta africana*. However, the different types of animal utilize different habitat types during different seasons and avoid competition in this way. When the natural resources are scarce and competition is severe, buffalo use forests as refuges in the Serengeti National Park in Tanzania.

4. BEHAVIOUR

The buffalo is a social animal that occurs in herds numbering in the thousands at times. Behaviour plays a crucial role in the organisation of the herds, and is vital for maintaining order and productivity. The following aspects of behaviour are especially important:

4.1 Social behaviour

The size of the buffalo herds in the Serengeti National Park in Tanzania varies from 50 to 1500 animals, with a mean size of 350 animals. Herds become smaller as the vegetation density increases. In the montane forests on Mount Meru in Tanzania, the mean herd size is 50 animals, and for the lowland forests in the Congo, it is 20 animals. In large herds there are no families, except for the basic subunit consisting of a cow and calf. In the herd, calves under two years of age usually keep close to their mothers, even when they are resting. When a calf reaches puberty, the bond between it and the cow is broken.

Herds tend to stay in large groups during the wet season, but will split into smaller groups during the dry season. During the dry season, the younger males that live in subgroups will break away from the herd, only to return in the wet season when the rutting starts. A buffalo has a range and not a territorium, because their ranges are not defended against intruders of the same species. The range of each herd overlaps slightly with that of adjacent herds. The size of the range is related to habitat suitability, and the density of animals within the herd is related to food availability. There is little evidence of a dominance hierarchy between females in large herds.
Bulls of ten years and older live separately from the herd. These male groups may sometimes contain young bulls, and are called bachelor herds that form 5.0 to 6.0% of the total population. Bulls of between three and five years of age form their own bachelor group within a herd. The size of these bachelor groups is three to four animals, but it increases during the dry season because of an influx of young bulls then. The degree of range use competition between these young males and the breeding herds is low because the bachelor herds select small and separate areas that are unsuitable for the large herds. The adult bulls regularly use wallows during the wet season.

4.2 Sexual behaviour

Sexual behaviour is a seasonal occurrence. Adult breeding bulls will test the reproduction receptivity of adult cows by licking the vulva, which will stimulate the cow to urinate. The bull then displays flehmen, with the neck in a characteristic extended position, and with the upper lip curled up to expose the gums. When the bull detects that a specific cow is in oestrus, he will remain close to her

for the next two to three days. There is a dominance hierarchy, and the bulls will displace each other until a dominant bull emerges who ends up mating with the cows. The pro-oestrus period can be as long as two days. Therefore, enough time is available for the adult bulls to identify all the cows in oestrus. When a cow is in oestrus, the bull will rest his chin on her rump. If the cow then does not move forward, she is ready for mating and the bull will mount her. Each copulation is short, but the bull will copulate several times while the female is in oestrus. During copulation, submissive bulls will get excited and run towards the mating pair and start fighting with one another.

4.3 Feeding behaviour

During the warm, wet season, food is abundant but of mixed quality from different habitat types. Buffalo will spend a shorter time feeding during the wet than the dry season (Table 5). Because the food resources in the wet season is more nutritious than in the dry season, less time is needed in the wet season to ruminate because of the high degree of digestibility of the food.

During the cold, dry season, the quality of the food decreases and buffalo change to bulk feeding, causing them to ruminate more. With the onset of the warm, dry season, buffalo usually move to wetter habitats like wetlands. Buffalo graze more during the night when the days are hot, although buffalo also extend their resting/ruminating period during cool nights.

5. FARMING WITH THE BUFFALO

Intensive farming with the African buffalo is purely an economic exercise and cannot be based on conservation principles, although the products may be of conservation importance. The emphasis is on the principles of animal husbandry, especially involving the provision of shade, food, water and enough space for exercise. The minimum habitat size of 400 ha to keep buffalo free-ranging, as specified by the various conservation authorities, is not applicable here, because the animals are fed supplementary food.

Buffalo farmers must have a long-term strategy to ensure success. From a hunting point of view, a buffalo hunt is currently worth US $10 000 and will always be a good investment. Should the Rand depreciate with 15.0% per annum against the US Dollar, a single buffalo hunt will be worth R1 348 115 in the year 2020. Under such conditions, buffalo farming is a lucrative enterprise, especially if the animals are sold for release as trophy animals on wildlife ranches.

Moreover, the buffalo farmer can select animals with bigger horns to cater for trophy hunters, or to supply other buffalo farmers and wildlife ranchers with suitable genetic material to improve their

herds. This may be seen by some purists as genetic manipulation. However, the counter argument is that the current sustained hunting of large bulls in the wild is leading to herds with horns that are smaller than 1.12 m (45 inches in bulls). There already is a market to produce "big horn buffalo" purely for economic reasons.

To be successful as a buffalo farmer, the following recommendations are important:

5.1 Farm location

The location of a farm for breeding buffalo depends on the farming system adopted. The following guidelines can be used:

* To breed disease-free buffalo from diseased parents, the farm must be **inside** the veterinary red line because the parental stock cannot be moved to clean farms across the foot-and-mouth and corridor disease control fences.
* To breed animals for trophy hunting and tourism the farm may be **inside** the veterinary red line.
* To breed disease-free animals from disease-free parents, the farm must be **outside** the veterinary red line.
* A buffer or surveillance zone is an area between buffalo herds where no buffalo are allowed. This zone has been established to prevent the flow of diseases from buffalo that are behind the veterinary red line to disease-free populations and livestock that are outside it. Quarantine stations in these buffer zones are important transit stops for the quarantine of buffalo calves that are produced by breeding projects behind the veterinary red line, before they can be moved to clean herds outside the veterinary red line.

5.2 The cost of land and animals

Farms that are behind the veterinary red line are often expensive due to the presence of the ‘Big Five’. Such wildlife ranches are currently valued more than R10 000 per ha. However, the breeding stock is cheaper at R30 000 per animal. Land in the areas free of the brown ear tick *Rhipicephalus appendiculatus* in the arid western parts of South Africa, is much cheaper at R250 to R400 per ha, but disease-free breeding stock is more expensive with prices ranging from R80 000 to R100 000 for bulls, and R100 000 to R150 000 for cows, depending on the age of the animals.

5.3 Facilities

Buffalo holding pens are expensive to build. An existing shed that can be converted into pens will save costs when an intensive breeding project is planned. Irrigation water for forage production is also an advantage. Feed costs can easily amount to 70.0 to 80.0% of the running costs of a buffalo breeding project.

5.3.1 Holding pens for intensive breeding

A clean (calf production) and diseased (cow production) facility must be available and be at least 30 m apart. A schematic layout of the buffalo breeding facilities is given in Figure 4. Each facility must have its own quarantine station (a box in a box). Therefore it will require two fences 5 m apart to secure each quarantine facility. This 5 m boundary strip must be sprayed with weedkillers to keep the area free of grass so as to limit tick infestation and transfer. The inner fence must be robust enough to keep the animals in. The outside quarantine fence must be at least 2 m high to prevent other animals from entering the facility. The fence should contain electrified strands *on the outside* at heights of 0.600 m, 1.20 m and 1.80 m to keep fence-breaking animals like the elephant *Loxodonta africana*, rhinoceroses *Diceros bicornis* and *Ceratotherium simum* and giraffe *Giraffa camelopardalis* out. These strands must have a potential voltage difference of at least 8000 V.

[INSERT FIGURE 4]

The breeding shed that houses the buffalo cows must have a solid roof for shade, and a cement floor that can be cleaned every day. The urine and faecal run-off must be channelled to an oxidation dam where the material is collected. A minimum of 20 m^2 of floor space per animal is required with the feeding trough allowing 1 m of linear feeding space per animal (Figure 5). An outside area with a cement floor is important for the animals to get enough sunlight. An exercise camp of two to three hectare per group is also essential. After the females have calved in the shed, they can be released in the exercise camp with the bulls (Figure 4).

[INSERT FIGURE 5]

The calf-production shed is built on the same principles as that of the breeding shed. The shed is divided into smaller paddocks of 5 x 10 m by means of steel sections that clamp together. Each paddock can house a surrogate mother, usually a Jersey cow, with two to three calves, depending on the age of the calves and the milk production of the animals. A crush is necessary in this facility to handle the Jersey cows and to dip the buffalo calves. An access gate is important to allow trucks to enter the facility and remove waste material or deliver food. This gate must be electrified and locked at all times. Quarantine procedures must be based on an "all-in-all-out" system. A separate feeding

shed is also necessary, and it should be free of rodents. Lucerne must be obtained from a vector-free (brown ear tick free) area.

5.3.2 Holding pens not for breeding

Metal holding pens are preferred to wooden ones, because the former are stronger and last longer. A minimum of two pens is necessary, with a sliding gate between them that can be closed from the outside. The recommended size of the pens is 5 m wide x 15 m long x 2 m high. A general guideline is to have 2 m² of floor space per 50 kg of animal body mass.

Example:
A buffalo cow of 450 kg will need 18 m² (450 ÷ 50 x 2) of floor space. Therefore a pen of 75 m^2 (5 x 15 m) can hold four adult (75 ÷ 18) buffalo cows. However, the shape of the pen is important. A long, rectangular pen ensures that the animals are able to stand far enough from people to minimize aggressive behaviour. These pens also enable animals to settle down sooner. The floor can be of soil, provided that it is well drained. The roof must cover at least a third of the surface area (5 m x 5 m) and must be of zinc. The roof must be at least 2 m high to allow for good ventilation.

The perimeter of the pen must be constructed as follows: Steel posts with a minimum diameter of 200 mm and 2.8 m long must be concreted into holes of 1 m^3 that are set 5 m apart. Horizontal bars at a height of 0.4 m and 1.8 m can be bolted to the concreted posts. Channel iron bars of 100 mm can be used as horizontal bars. Vertical bars with a minimum length of 1.8 m, must be welded to the horizontal bars, with gaps of 200 to 300 mm in between. The pens must be linked to a crush and a loading ramp. The crush must have a sliding door that can be closed with a safety catch. This type of pen is suitable for buffalo, young rhinoceroses and young elephants.
The loading ramp must be 1.4 m high by 2.4 m wide, with a wall construction similar to that of the pens. The ramp must have a slope of approximately 10 to 15☜. Concrete water troughs, like those used for cattle, will last longer than steel troughs, and cannot injure the animals when they get excited. The same type of trough can be used to provide food, but must be placed under the roof to keep the food dry in order to prevent the collection of toxic concentrations of urea during rainy weather.

The ideal site for a pen is:

* elevated and well-drained to prevent the accumulation of water
* close to reliable water sources and electricity
* easily accessible to large transport trucks, and with enough turning space to enable offloading of animals from the back and sides of the truck

* protected against cold winds and facing north to allow for enough radiation from the sun
* away from other animals that can break through the pen
* away from human activities
* in an area with large trees to provide shade.

5.4 Status and source of animals

Buffalo can generally be classified according to their disease status. This includes the following:

* Diseased buffalo that occur behind the veterinary red line (so-called dirty buffalo) may have any of the following diseases: corridor disease, foot-and-mouth disease, brucellosis and tuberculosis.
* Disease-free buffalo (so-called clean buffalo) are free of corridor disease, foot-and-mouth disease, brucellosis and tuberculosis. They are also sometimes referred to as Addo buffalo.
* Diseased breeding buffalo that occur behind the veterinary red line and that are free of tuberculosis and brucellosis. These animals must be kept in quarantine while in the breeding project.

Buffalo can be obtained from the following sources:

* Wildlife ranches and farms: diseased and disease-free buffalo.
* Wildlife auctions: disease-free buffalo.
* Capture operators: these can be diseased or disease-free animals. The prospective buyer must ensure that the relevant tests are done to certify the animals to be clean of diseases like foot-and-mouth disease, corridor disease, tuberculosis and brucellosis.

Always buy from reliable dealers because there is no cheap alternative. Select for good quality breeding stock with the emphasis on trophy quality animals.

5.5 Selection of breeding stock

As in any intensive animal production programme, much of the eventual success of the project will depend upon the selection of the correct breeding stock. For buffalo production the following guidelines are important in doing so:

5.5.1 Bulls

The information that is provided here is based on the selection of buffalo bulls that was done by breeders. The first step is to select animals that are free of tuberculosis and brucellosis. Three

criteria are then used in the subsequent selection of bulls:

Horn length

Research has shown that 8.0% of all the buffalo bulls in a natural population have trophy quality horns. The ideal horn type is one with a boss diameter of more than 400 mm (16 inches), a deep curve with the horn tips pointing backwards, and a wide spread of at least 1100 mm (44 inches). Hunters selected such bulls for their trophies in the past. These characteristics gradually disappeared from clean Addo buffalo populations as a result of the sustained hunting of large trophy animals. It is currently leading to a high demand for stud bulls of excellent trophy size from the buffalo breeding industry.

Temperament

During the selection process only 20.0% of all the bulls will show a good temperament. However, this aspect is most important when buffalo are to be kept under intensive farming conditions. Aggressive bulls can cause injuries to other breeding animals, calves, and to the staff working in the facility and should not be selected for breeding programmes.

Semen quality

The bulls should be selected for semen quality. Samples are taken by means of electro-ejaculation when the bulls are immobilised. Further semen guidelines for selecting bulls for breeding purposes include:

- A scrotal circumference of >400 mm
- A whitish semen colour
- Semen with a thick milky consistency
- A sperm count of >400 x 10^6 per ml
- A frequency of >80.0% of morphologically normal sperm.

5.5.2 Cows

Only two criteria are used when selecting buffalo cows for a breeding programme. The first is that the animals must be certified to be free of brucellosis and tuberculosis. The second criterion is fertility. The buffalo cows are captured during spring (September to October) while they are in late pregnancy, but when the calves of the previous year have already weaned.

5.6 Surrogate mothers

Jersey cows can be used as surrogate mothers for buffalo calves (Figure 6). The Jersey cow is a biological sentinel to detect diseases such as corridor and foot-and-mouth disease at an early stage. However, the buffalo calf must first have obtained colostrum for the first 48 hours from the buffalo cow. This will ensure adequate immunity against diseases under natural conditions. The calves are then also strong enough to suckle from a foster mother. This practice also reduces the chances of infection with foot-and-mouth disease and corridor disease from the buffalo cow to her calf. The buffalo calf imprints on the Jersey cow, but its inherent social behaviour does not change. When the buffalo calf is removed from the buffalo cow, it reduces the inter-calving period for the cow because there is no lactation anoestrus. This increases the rate of production of calves in the breeding populations.

[INSERT FIGURE 6]

The following factors must be considered when selecting Jersey cows as foster mothers for buffalo calves:

* Use animals with long teats. The buffalo calf suckles from the back and when the lower incisors cut, it will cut a short tear at the base of the udder. These wounds will be enlarged in areas where oxpeckers are present.
* Jersey cows with a history of mastitis are not recommended so as to prevent the calves from getting diarrhoea.
* Prevent cows from getting mastitis in the calf-raising facility and do not use cows with a peak milk production of higher than 25 litres per day.
* Select cows from herds with a history that is free from tuberculosis and brucellosis. Test the cows before they are introduced to the breeding facility.
* Black cows have more difficulty to adapt to hot conditions in the Lowveld than pale-skinned ones. However, some pigmentation is important to avoid skin and eye cancers.
* Select cows that are second calvers. They are not as nervous as heifers because they have already been handled in a milking parlour. Avoid kickers in the stable.
* A correct protocol for dipping and vaccination can be discussed with the local veterinarian, because it differs from one area to another. General guidelines for a such a protocol appear in Table 6.* Select animals with a high butterfat production rate because the milk of the buffalo cow has a butterfat content of 6.0 to 8.0%.

[INSERT TABLE 6]

5.7 Management of buffalo calves in captivity

The buffalo calf is left with its mother until about 48 hours after birth. To minimize stress in the breeding herd, the calves are then taken away as a part of the daily routine. The calf is given an ear tag and a microchip for identification. The sex is determined and the calf is weighed. With the birth date these data are kept in a calf register. The calves are then kept in groups of five to eight animals of the same age at a ratio of two to three calves per Jersey cow.

The calves can feed with the foster mothers on lucerne and feed concentrates within a month of birth. The cows and the calves must be dipped weekly to control brown ear ticks. Testing calves for diseases includes the following:

Stage 1: At the age of nine months the calves must have had at least one test that is negative for foot-and-mouth disease, corridor disease, brucellosis and tuberculosis. This test must be done inside the veterinary red line area.

Stage 2: Within 14 days of the above test, another test for foot-and-mouth disease should be done to detect if there has been an infection during the window period before being switched to a foster mother. Another set of tests for all four diseases mentioned in Stage 1 must be done after the foot-and-mouth disease test and before the calves can leave the surveillance zone. The calves must not stay in the surveillance zone for longer than five to six weeks.

Stage 3: The calves must test clean of foot-and-mouth disease, corridor disease and tuberculosis before they will be certified as being clean or disease-free. These tests must be done within four weeks after they have left the surveillance zone. A year of so-called standstill is necessary at the point of arrival. The testing protocol can change from time to time, and it is summarized in Table 7.

[INSERT TABLE 7]

5.7 Problems with raising calves

The hand-rearing of buffalo calves is not recommended for the following reasons:

* The calves imprint on humans and they become extremely aggressive after three years of age.
* After the animals are fed, they still display behaviour of being hungry. In doing so they will suckle the scrotums or teats of other young animals. When the heifers grow up they may have lost up to a quarter of the udder capacity because of teat suckling.

The rearing of calves on buffalo cows in captivity is not recommended for the following reasons:

* The calves do not grow as quickly as on the Jersey cows, and at weaning they go through a

time of weaning stress. However, because they do not grow up in a well-knit social structure, it may lead to social disorders in the herd later in their lives.

* The inter-calving period is longer in buffalo cows with calves because of lactation anoestrus.
* It is not advisable to put bulls with the cows while the calves are with their natural mothers. The foot-and-mouth disease virus is present in the semen of buffalo bulls, and it will be carried over to the lactating female. Therefore, it can infect the calf. In one case study, buffalo bull calves were left with their mothers for approximately 20 months in the absence of a breeding bull. These calves tested free of foot-and-mouth disease, which may be an indication that foot-and-mouth disease may be a venereal disease in cloven-hoofed animals.

Other problems that may be encountered when rearing the calves on buffalo cows include:

* Diseases like *Escherichia coli* and coccidiosis lead to diarrhoea and mortalities in young calves. Especially overcrowding and wet conditions can lead to these problems.
* Buffalo have dark skins and hot branding does not work for longer than two years, after which the branding starts to fade away. Ear tags tend to hook on objects and tear out of the ear. Microchips can get damaged or may migrate in the tissue so that the reader cannot detect it. However, experimental tests show promising results with freeze-branding.
* Hoof problems such as overgrown hooves sometimes develop in some animals. The hooves must then be cut to correct the defect. Overgrown hooves develop more in animals that were fed on citrus pulp.

5.8 Feeding of buffalo in captivity

The buffalo is a bulk feeder under natural conditions and no studies have been done on their feeding in captivity. A good quality hay should be supplied. This can consist of weeping love grass *Eragrostis curvula*, buffalo grass *Cenchrus ciliaris*, and lucerne. A cattle lick can be added to the hay to supply the essential minerals, vitamins and protein that are lacking in the winter grazing.

The ration must have the following characteristics:

- it must be palatable
- it must be digestible (fibre content of 12 to 14% and yielding energy of 10 to 12 MJ per kg)
- it must have enough protein (total crude protein content 8 to 10%)
- the energy concentration in the balanced ration must not be too high, so as to avoid acidosis and laminitis especially when the animals are kept on concrete floors.
- to prevent urea poisoning the animals must not have a salt hunger before a mineral lick with ureum is provided.

- licks must also be protected from rain water and the containers must have holes at the bottom to prevent the accumulation of rain water
- it must have a balanced calcium and phosphate ratio (0.3 to 0.4% Ca and 0.25 to 0.3% P) and enough vitamin A. The phosphate and vitamin A are important for good reproductive performance
- the daily food intake should be at least 2.2% of the animal's body mass.

The following guidelines should be considered for the management of the feeding area:

- The feeding areas must be under roof.
- The trough space must be large enough (1.0 m per animal) to prevent overcrowding. Dominant cows will keep submissive animals away. A trough with a solid floor is important to catch the finer food and prevent spilling. The trough must be large enough that animals can get out when they have accidentally fallen into it.
- The area next to the trough must not be slippery to prevent animals breaking legs when they get are alarmed and run away.
- The feeding areas must be under roof.
- The floor around the feeding area should be cleaned on a daily basis.
- The water and food supply must be separated to prevent contamination of the water troughs. Leaking water points will give rise to worm and coccidia infestations.
- Analyse the mineral content of the water sources. Case studies of fluorosis have been recorded where young bull calves broke bones after the dominant bulls chased them away from cows in oestrus.
- Do not feed mouldy lucerne.
- The hay must be obtained from areas that are free from brown ear ticks to prevent larvae from carrying corridor disease to calves. For example, good quality lucerne can be obtained from the Vaalharts area.

5.9 The diseases of buffalo in captivity

In captivity buffalo are prone to five major diseases that may require prevention or cure. These are the following:

5.9.1 Foot-and-mouth disease

Foot-and-mouth disease is a highly contagious disease that is caused by the *Picorna* virus that affects cloven-hoofed animals like ruminants and pigs. It is characterized by a high morbidity (the number of animals affected), but a low mortality (deaths). The most important clinical signs are

vesicles and lesions in the mucosa of the mouth and the interdigital skin. The importance of the disease lies in the fact that most countries do not want to import the disease via agricultural products. Although the animals infected often do not die, there is a great loss in production. Moreover, the livestock of countries outside Africa are often quite susceptible to this disease.

The African buffalo is an important carrier of foot-and-mouth disease. In individual animals the virus may persist in the pharyngeal region for up to five years. There are seven serotypes of virus and at least 80 subserotypes. The seven serotypes have the following geographic distribution: types A, C and O are prevalent in South America, Europe, Africa, the Middle and the Far East, and the Balkans. Types SAT 1, 2 and 3 are restricted to sub-Saharan Africa, and I is prevalent in Asia.

The mechanism through which the virus is spread from the buffalo to cattle is unknown. It can spread by direct or indirect contact, but the most common route is direct contact between animals that excrete the virus and infect other susceptible animals. Indirect contact can be through mechanical carriers or contaminated objects. The three most important factors that play a role in the transmission of the virus are: the quantity, duration and means by which the virus is spread into the environment; the ability of the virus to survive outside the animal's body; and the quantity of virus required to start an infection.

All animal excretions and secretions contain the virus, with saliva having the highest concentration. The virus is highly labile outside the animal's body, and it is susceptible to acid. Meat that is kept for 48 hours at 4☜C will be free of the virus. However, the virus can survive in the lymph nodes for up to 120 days. At a relative air humidity of lower than 55.0%, the virus shows a poor survival rate. This explains why long distance contamination does not occur in southern Africa.

The clinical signs of foot-and-mouth disease appear after an incubation period of two to eight days. The first clinical signs are dullness, loss of appetite, fever, a drop in milk production, and animals that stop ruminating. This is followed by lameness, unwillingness to stand, salivation and smacking of the lips. Lesions of the tongue occur on the tip and dorsal surface. These vesicles rupture easily, and when handling the tongue, the epithelium will slough away easily, leaving a raw, bleeding surface. The foot lesions occur at the interdigital spaces and the bulbs of the heel. The chorion band is a more common place for lesions in smaller species. Milk cows may show lesions on the teats, and a virally induced mastitis may occur.

Buffalo play an important part in carrying the disease and spreading it to other species. The loss of income for any country through a ban on the export of agricultural products is why there are strict control measures when farming with buffalo. The disease is controlled by the government,

focussing on border control. Declared foot-and-mouth disease control areas are the Kruger National Park, the districts adjacent to the Kruger National Park, Mozambique, and a 10 to15 km zone bordering Swaziland, Zimbabwe and Botswana. The control measures are:

* at least monthly inspections of all cloven-hoofed domestic animals
* keeping records of all livestock numbers on farms
* movement control by permits for animals and their products into and out of the controlled area
* vaccination of animals within the danger zone
* owners of the animals must report suspicious cases to the state veterinarian
* quarantine of all cloven-hoofed animals that may leave the area
* cattle leaving the area should be hot-branded with an F-symbol on the right side of the neck, to prevent them from being exported via export abattoirs
* wildlife fences are erected between buffalo and cattle herds.

The diagnosis of foot-and-mouth disease is by the direct complement fixation test. This is a rapid and specific test. Isolation and characterization of the virus can be done with oesophageal-pharyngeal samples. The differential diagnosis of foot-and-mouth disease is:

* vesicular stomatitis that affects cattle, pigs and horses
* swine vesicular disease that affects pigs
* blue tongue that affects cattle and sheep
* foot-rot
* rinderpest that mainly affects ruminants
* snotsiekte that affects cattle.

During outbreaks, a slaughter policy of all infected animals is important to limit the spread of foot-and-mouth disease from the foci of infection. Vaccines can also be used, but the immunity period is usually short.

5.9.2 Tuberculosis

Tuberculosis in buffalo is caused by the bacterium *Mycobacterium bovis*, which is also responsible for tuberculosis in cattle. The disease spread from cattle to buffalo in the southern section of the Kruger National Park in the 1950s. Once a buffalo is infected, the infection spreads spontaneously within the herd. Studies done in 1998 indicated a regional infection rate of 42.0% for the southern district, 20.0% for the central district, and 1.5% for the buffalo in the northern district of the Kruger National Park.

The spreading rate in a herd is not known, but it can be assumed that the incidence will double every

five years. The disease spreads when cough droplets in the atmosphere are produced by infected animals and are inhaled by others. Contaminated food and water can also be a medium of transmission. Lions that feed on contaminated buffalo carcasses also become infected with tuberculosis.

Tuberculosis is life-threatening to buffalo populations. The time from infection till death is unknown, but infected animals are known to survive for several years. Buffalo are a maintenance host for the bacteria. Therefore buffalo do not need further exposure to infected cattle to maintain the infection. They are the ideal reservoir because large herds of a few hundred buffalo gather close to a waterhole and create the perfect mechanism for aerosol transmission. It is known that other maintenance hosts infect the environment, thus making it impossible to eradicate the disease.

When tuberculosis reaches a specific level of prevalence in a buffalo herd, the infection apparently spills over to other wildlife. Animals that have probably contracted the disease from buffalo in southern African nature reserves are the lion *Panthera pardus*, cheetah *Acinonyx jubatus*, spotted hyaena *Crocuta crocuta*, baboon *Papio ursinus*, kudu *Tragelaphus strepsiceros* and black rhinoceros *Diceros bicornis*. Carnivores and omnivores contract the disease by ingesting infected tissue.

The clinical signs of tuberculosis are coughing and swollen lymph nodes that can rupture. In chronic cases, emaciation and a rough hair coat with hair loss can be seen. In dead animals the diagnosis can only be confirmed by means of a bacterial culture. It can take up to three months to isolate the bacterium. Diagnosis in the live animal can be done with the intra-dermal skin test, using avian and bovine tuberculin. This test will detect more than 90.0% of infected animals, but it must be repeated after three months. The gamma-interferon test is more sensitive than the intra-dermal test. The blood samples for the gamma-interferon test must reach the laboratory within six hours of collection to be of any diagnostic value.

There is no vaccine or treatment for buffalo with tuberculosis yet. Therefore animals from infected areas must be tested negatively three times, three months apart, before being certified as clean. If only one animal from a group tests positive, it must be removed and the test procedure must start all over again.

5.9.3 Brucellosis

Brucellosis is also known as contagious abortion. It is caused by the bacterium *Brucella abortus*. The organism is usually transmitted orally, but in certain cases via the semen of infected males.

Milk from infected cows can be a potential source of infection too. Under certain circumstances wildlife can act as reservoirs for this disease. For example, the black-backed jackal *Canis mesomelas* can pick up the organism when it feeds on the placentas or aborted fetuses of infected herbivores.

The most important sign of brucellosis is abortion in the latter half of gestation. Calves may also be born weak or immature, with retained placentas. Chronic infection in the joints leads to the classic house maid knees syndrome (hygromata) when the carpal joints are swollen. Infection of the testis, known as orchitis or epididymides, may also occur.

The age of an aborted foetus (t) can be calculated by using the following equation:

$$t = [W^{0.33} \div 0.1307] + 68 \text{ days}$$

where: W = body mass (g) of the foetus.

The above equation is not valid for foetuses weighing less than 170 g. However, if, for example, a farmer picks up a foetus of 20 kg, then its age (t) will be:

$$\begin{aligned} t &= (20\,000\ g^{0.33} \div 0.1307) + 68 \text{ days} \\ &= (26.3/0.1307) + 68 \text{ days} \\ &= 201 + 68 \text{ days} \\ &= 269 \text{ days.} \end{aligned}$$

It is important to handle aborted fetuses with care because brucellosis is a zoonosis. A zoonosis is an animal disease that is transmissible to humans. The organism localizes in the uterus, placentomes and intercotyledon areas, which become thick and leathery in appearance and interfere with the blood circulation of the fetus, eventually causing abortion. The diagnosis is done with the complement fixation test. Test titre values of below 30 are regarded as negative. It is recommended that breeding should only be done with buffalo cows with a nil titre.

Of a sample of buffalo from the Kruger National Park, 15.0% tested positive for brucellosis on a population basis. On a herd basis it varied from zero to as high as 85.0%. Breeding is not allowed with buffalo that test positive for brucellosis.

5.9.4 Corridor disease

Corridor disease or buffelsiekte as it is also known, is an acute and usually fatal disease of cattle, caused by the protozoa *Theileria parva lawerencei*. It is transmitted by the brown ear tick *Rhipicephalus appendiculatus* from buffalo to cattle. This tick occurs in the eastern, wetter parts of

South Africa. The disease is called corridor disease because of its occurrence in the former corridor region between the Hluhluwe-Umfolozi Park in KwaZulu-Natal.

The protozoan parasite is ingested by the larvae of the brown ear tick when they feed on an infected buffalo. The larvae moult and fall off, to climb onto a new host. The nymph will moult again, fall off and the adult will climb onto a new host. The protozoan parasite will die off when the adult tick dies, and can therefore not be transmitted to the eggs by trans-ovarial passage and infect the new generation of larvae. Two years after infected buffalo have been removed from the veld, the ticks there can be regarded as free from corridor disease.

The brown ear tick is known as a three-host tick because it feeds on three different hosts, that may be three different types of animal, during its life cycle. Adults occur during the rainy period from December to March in South Africa, and the larvae from late summer into the cool period following the rains from March to July. The nymphs occur in the winter and early spring from June to October. These ticks prefer to attach to the ears of animals. The optimum control of these ticks is in the summer months, and the aim should be to prevent the adult ticks from laying eggs. Dipping with an ascaricide must be done on a weekly basis. The life cycle of the parasite is illustrated in Figure 8.

[INSERT FIGURE 8]

The clinical signs of corridor disease in cattle appear after an incubation period of nine to 20 days (mean: 12.0 days). Clinical signs are an increased body temperature, swelling of the lymph nodes, fever, listlessness, swelling of the eyelids, a nasal discharge, diarrhoea and emaciation.

A diagnosis of corridor disease can be made by looking for the parasite in smears of the lymph nodes by using PCR technology to demonstrate the presence of the DNA of the parasite.

The disease can be prevented by:

* limiting the contact between buffalo and cattle
* controlling ticks by dipping cattle on a weekly basis.

Chemotherapy is not allowed in South Africa because of a carrier state that can be created.

5.9.5 Parafilariosis

Lesions in the withers and the sides of the thorax are caused by a microfilarial worm *Parafilaria bassoni*. Bleeding spots from a raised nodule, where the worm is situated in the superficial tissues,

can be seen from November to February. Secondary infection of these wounds can happen, but the parasite itself does not affect the buffalo adversely. Oxpeckers will feed on these bleeding spots, causing ulcers and eventually open wounds. Infected buffalo can be treated with Ivomec at 1 ml per 50 kg of body mass to control the parasite.

5.10 Capture

Buffalo herds can be captured with the Oelofse plastic boma and helicopter method. When this method is used, the boma must be reinforced, especially at the loading area. This method is potentially dangerous for the capture staff, and should only be done by operators with experience. Intensive farming with buffalo necessitates the capture of animals for treatment, collection of blood for tests, or selecting specific animals from breeding herds by darting. When buffalo are captured with chemical drugs the following must be considered:

5.10.1 Before darting

* Dart the animals when the air temperature is below 25º C. Cool mornings are preferred.
* Avoid darting the animals after they have drunk water. Buffalo tend to drink in the afternoon. Wet mud marks will indicate that the animals have already visited a waterhole. Buffalo in pens must be deprived of water for 12 hours before darting. If this is not done, the animals will regurgitate and the stomach content is inhaled into the lungs. This is usually fatal and the animals will die of foreign body pneumonia.
* When a buffalo is immobilised it must be kept in sternal recumbency. To do so, two handlers per buffalo are necessary.
* Do not catch animals after heavy rains when the ground is wet and slippery. Muscle and tendon damage may occur and result in capture myopathy.
* Be careful of bloating when animals are immobilised for longer than ten minutes. Have 15-gauge needles and stomach tubes at hand.
* In hot weather enough water should be available to cool the animals down during capture.
* Darting equipment that ensures that the total dose is administered, as well as long, thick needles (2 x 40 mm minimum), should be available. Avoid colourful darts with a sharp colour contrast when darting a group of animals. The undarted buffalo will pull the darts out and swallow them. The needles can then puncture the stomach wall and cause reticula peritonitis. Buffalo will leave the darts if the darts have been sprayed with a deodorant such as Mum-for-men.
* The best darting sites are the neck and rump. Buffalo are inquisitive animals and will look at the person with the dart gun, making it difficult to place the shot. They also tend to shake

their heads to fend off insects. Especially a neck shot can miss when the big boss deflects the dart while the animal shakes its head.

* Avoid darting heavily pregnant animals.

5.10.2 Capture drugs

* Etorphine-hydrochloride (M-99) is the drug of choice. The current dosage is 1 mg M-99 per 100 kg body mass. Therefore an adult buffalo is captured with 6 to 9 mg M-99; subadults with 3 to 5 mg, and calves with 1 to 3 mg. For buffalo in bomas the dose can be reduced, but for pregnant females the dose must be increased. The drug is reversed with diprenorphine (M-5050) at double the dose of M-99.
* Azaparone is a safe tranquillizer to use with M-99, at a dose of 1 mg per 5 kg body mass. The total dose for an adult buffalo is 150 to 200 mg, for subadults it is 80 to 120 mg, and for calves 20 to 60 mg.
* Lubricating eye ointment (ISSE) is used to prevent desiccation of the cornea.
* Intra-mammary antibiotic preparations should be used for the treatment of dart wounds to avoid absessation.
* For external parasites, spray the animals with an ascaricide, especially around the ears, under the tail, inside the forelegs and around the scrotum and penis sheath of bulls. Internal parasites can be treated with injectables such as Ivermectin preparations.

5.10.3 Loading immobilised buffalo

Before loading immobilised buffalo, ensure that the dart is removed and the animal is blindfolded. Pull the animal onto a stretcher made of a conveyer belt. Click-on chains must be attached to the stretcher to hoist it with a hydraulic crane. The buffalo can then be lifted into a mass crate for transport (Figure 8).

[INSERT FIGURE 8]

5.11 Transport

The following factors are important in the successful transport of buffalo:

5.11.1 Before transport

* Avoid transporting buffalo when they are immobilised, because they can bloat, regurgitate

and inhale the stomach contents.

* Ensure good ventilation to avoid hyperthermia.
* Do not mix animals from different herds during transport because the animals will fight.
* Transport the adult bulls individually to prevent injuries to other animals.
* All the necessary permits for import, export and transport that may be required from veterinary and conservation authorities must be obtained in advance.

5.11.2 Crates and vehicles

Mass crates for buffalo must consist of several compartments that can be separated by sliding doors. The doors must be reinforced so that the buffalo cannot damage them, and the inside of the compartments must be free of protrusions to prevent injuries to animals, or the breaking of horns when they become hooked on some object. Trapdoors in the roof that can be opened for ventilation and temperature regulation or the administration of drugs with pole-syringes, are important.

A mass crate of 3.25 m long x 2.4 m wide can keep three to five adult animals. This equates to 1.6 m^2 to 2.6 m^2 of floor space per animal. A closed circuit video camera with a monitor in the cabin enables the driver to monitor the animals without disturbing them.

In the case of journeys exceeding eight hours, two drivers should be available. The drivers must have road maps, permits and the necessary telephone numbers and equipment (cell phones) with them. Sudden braking and acceleration should be avoided at all times. Stops to inspect the animals must be taken at two- to three-hourly intervals. Stopping sites must be in areas with no traffic or people and on level ground. The truck must be mechanically sound, with at least two spare wheels, an emergency toolbox and basic spare parts.

5.11.3 Other equipment

The following equipment must also be available during the transportation of buffalo:

* electrical prodder
* dart gun and darts
* pole-syringe
* drug box with capture drugs
* ropes
* blindfolds.

5.12 Economics

Buffalo will always be a good investment for the wildlife farmer and rancher because it is more difficult to steal than cattle and the animals have a hunting value in USdollars. The animals will become very expensive in the future for the following reasons:

- The poor economic situation and political instability in Zimbabwe leads to an increase in the bush meat consumption with a decrease in their buffalo population.
- The infection of the buffalo populations in the Kruger National Park and Hluhluwe-Umfolozi Park with tuberculosis.
- The introduction of disease free buffalo in the Transfrontier Parks in southern Africa.

Buffalo are expensive animals and some economic details appear in Tables 8 and 9.

[INSERT TABLE 8]
[INSERT TABLE 9]

In Tables 8 and 9, the following assumptions have been made: the breeding unit can produce 40 calves per annum, the breeding period is six years, the project starts in 2001 and terminates in 2020 after 20 years to build up a disease-free herd of 120 cows and six breeding bulls, the sex ratio is equal, the calving percentage is 90.0%, the hunting value of a buffalo bull is R75 000 (US$10 000) in the year 2001, and the Rand devalues at 15.0% per year. Clean buffalo cows are sold at the same price as the buffalo trophy value, and the bulls can be hunted from an age of six years and onwards.

The potential gross income of a disease-free herd is calculated in Table 11. Buffalo farming is a financial exercise with a high risk but it is an excellent investment on a US dollar basis. The mean prices for clean buffalo at wildlife auctions from 1990 to 2002 were: R28 812 (1991); R16 391 (1992); R17 250 (1993); R23 750 (1994); R47 163 (1995); R65 038 (1996); R74 854 (1997); R101 784 (1998); R74 607 (1999); R114 246 (2000); R81 409 (2001); and R116 624 (2002). The South African record price for a buffalo is R250 000.

5.13 Legislation

Before a farmer can buy a buffalo, he must register his farm with the Directorate of Veterinary Services. The breeding of disease-free buffalo from diseased maternal stock requires special permission from the Director of Veterinary Services. A red cross permit is required to transport buffalo inside the veterinary red line area. A transport permit from the state veterinarian is required for the transport of buffalo that are certified clean. According to Article 18 of the Animal Diseases Act, Act 35 of 1984, the Director of Veterinary Services may erect permanent fences along or across

any public road to control animal diseases.

5.14 Useful contact addresses

BREEDERS
Buffalo Breeders Association
P O Box
HOEDSPRUIT
1380
Tel.

FEEDING COMPANY
Meadow Feeds
P O Box 11
DELMAS
Tel. 013-665-5011

DIRECTORATE OF VETERINARY SERVICES
Private Bag X138
PRETORIA
0001
Tel. 012-3196000

VETERINARY MEDICINE
The Big Five Veterinary & Pharmaceuticals
P O Box 12780
ONDERSTEPOORT
0110
Tel. 012-546-5005

DIAGNOSTIC TESTING
Onderstepoort Veterinary Institute
Private Bag X5
ONDERSTEPOORT
0110
Tel. 012-529-9111

INSURANCE
Wildlife Broker Services
P O Box 9739
EDENGLEN
1613
Tel. 011-450-3047

INFORMATION
Onderstepoort Library
Private Bag X4
ONDERSTEPOORT
0110
Tel. 012-529-8000

Big Five Veterinary & Pharmaceuticals
http://bigfive.jl.co.za

AGENTS
Game Cor
P O Box 13223
CASCADES
3202
Tel. 033-3865159

BIBLIOGRAPHY

Ansell, W.F.H. 1972. Order Artiodactyla. In JAJ Meester & H.W. Setzer (Eds) *Identification manual for African mammals*. Washington DC; Smithsonian Institute. Part 15.

Bengis, R.G. 1993. Chemical capture of the African buffalo (*Syncerus caffer*). In AA McKenzie, A.A. (Ed.), *The capture and care manual*. Pretoria: Wildlife Decision Support Services. pp. 583-590.

Bertschinger, H.J. 1996. Reproduction in the African Buffalo: A review. In BL Penzhorn (Ed.), *Proceedings of a symposium on the African Buffalo as a game ranch animal*. Pretoria: Wildlife Group of the South African Veterinary Association: 62-74.

Erasmus, J.M. 1986. *Foot-and- mouth disease - control measures*. Office International des epizooties. 17th Conference. Paris: France.

Funston, P.J. 1999. *Predator - prey relationships between lions and large ungulates in the Kruger*

National Park. Ph.D. thesis. Pretoria: University of Pretoria.

Grimsdell, J.J.R. 1973. Age determination of the African buffalo *Syncerus caffer*. *Sparrman. East African Wildlife Journal* 11: 31-53.

Hedger, R.S. 1981. Foot-and-mouth disease. In JW Davies, LH Karsted & DO Tranier, (Eds), *Infectious diseases of wild mammals*. Ames: Iowa State University Press. pp. 87-90.

Hornsveld, M. 1996. Applied anatomical aspects of the African buffalo. In BL Penzhorn, (Ed.), *Proceedings of a symposium on the African Buffalo as a game ranch animal*. Pretoria: Wildlife Group of the South African Veterinary Association. pp. 6-20.

Kriek, N.P.J. 1996. Tuberculosis in the African buffalo. In BL Penzhorn (Ed.), *Proceedings of a symposium on the African Buffalo as a game ranch animal*. Pretoria: Wildlife Group of the South African Veterinary Association. pp. 121-125.

Ledger, H.P. 1968. Body composition as a basis for a comparative study of some East African mammals. In M A. Crawford (Ed.), *Comparative nutrition of wild animals*. *Symp. Zool. Soc. London* 21: 289-30.

Pienaar U de V. 1969. Observations on the development biology, growth and some aspects of the population ecology of African buffalo in the Kruger National Park. *Koedoe* 12: 28-52.

Prins, H.T.H. 1996. Ecology and behaviour of the African buffalo. London: Chapman & Hall.

Raath, J.P. 1993. Transportation of the African buffalo (*Syncerus caffer*). In McKenzie, A. (Ed.). *The capture and care manual*. Pretoria: Wildlife Decision Support Services. pp. 590-595.

SA Wild & Jag. 2000. Wildveilingpryse. p. 11.

Sinclair, A.R.E. 1974. The natural regulation of buffalo populations in East Africa II: Reproduction, recruitment and growth. *East African Wildlife Journal 12*: 169--183.

Sinclair, A.R.E. 1977. *The African buffalo: a study of resource limitation of populations*. Chicago: University of Chicago Press.

Smith, S.J. 1986. *Rowland Ward's records of big game - Africa and Asia*. Rowland Ward Publications: San Antonio: Texas.

Smithers, R.H.N. 1983. *Die soogdiere van die Suider-Afrikaanse substreek*. Pretoria: Universiteit van Pretoria.

Taylor, C.R. 1968. The minimum water requirements of some East African bovids. In M A. Crawford (Ed.), *Comparative nutrition of wild animals*. *Symp Zool Soc Lond*, 21:195-205.

Thomson, G.R. 1994. *Infectious diseases of live stock with special reference to southern Africa: foot-and-mouth disease, Vol II,* Cape Town: Oxford University Press. pp. 825-851.

Whyte, I.J., Pienaar, D. & De Vos, W. 1984. *Report on findings of an investigation into buffalo reproduction conducted at culling operations*. Unpublished report. National Parks Board.

Whyte, I.J. 1996. The management of large buffalo populations. In BL Penzhorn (Ed.), *Proceedings of a symposium on the African Buffalo as a game ranch animal*. Pretoria: Wildlife Group of the South African Veterinary Association. pp. 21-36.

Winterbach, H.E.K. 1998. Research review: The status and distribution of Cape buffalo *Syncerus caffer caffer* in southern Africa. *South African Journal of Wildlife Research* 28: 82-87.

Winterbach, H.E.K. & Bothma, J. du P. 1998. Activity patterns of the Cape buffalo *Syncerus caffer caffer* in the Willem Pretorius Game Reserve, Free State. *South African Journal of Wildlife Research* 28: 73-81.

Captions to Figures

Figure 1 Distribution map of the African buffalo. Source: Smithers (1983).

Figure 2 Field criteria to age buffalo by means of shoulder height and horn growth. Source: Grimsdell (1973).

Figure 3 Age determination of buffalo by dentition. Source: Adapted from Hornveld (1996).

Figure 4 Schematic layout of buffalo breeding facilities.

Figure 5 Enough trough space should be provided in a breeding facility.

Figure 6 Buffalo calves raised on Jersey cows.

Figure 7 The life cycle of the *Theileria* parasite.

Figure 8 Loading buffalo bulls.

Table 1 The current estimated number of the African savanna buffalo in southern Africa. The diseased buffalo may have foot-and-mouth disease, corridor disease, tuberculosis, brucellosis or a combination of these diseases. Source: Winterbach (1998)

Country	Diseased animals	Disease-free animals	Total
Zimbabwe	47 690	511	48 201
South Africa	29 077	2 446	31 523
Botswana	29 367	0	29 367
Namibia	2 690	150	2 840
Total	108 824	3 107	111 931
Percentage	97.2	2.8	100

Table 2 The basic characteristics of the African buffalo

Mean mass at maturity: Bull	690 kg
Cow	454 kg
Mean shoulder height at maturity: Bull	1.50 m
Cow	1.38 m
Feeding spectrum: Grass and forbs	78%
Browse and fruit	22%
Water dependent	Yes
Water requirements in litres per day	15 - 25
Preferential feeding time	Day/night
Horns present on cows	Yes
Number of mammae	4
Peak mating season	February - March
Gestation period	343 days
Peak birth season	January - February
Weaning age	150 - 210 days
Age when sexually mature: Bull	30 - 36 months
Cow	36
Age at first mating: Bull	84 - 96 months
Cow	42 - 48 months
Age of cow at birth of first calf	54 - 60 months
Mass of calf at birth	45 kg
Time between successive calves	20 - 26 months
Life expectance	22 years
Ratio of cows per bull at adulthood (nature)	5 - 15
Ratio of cows per bull recommended for a wildlife farm	20
Mean breeding herd size	20 - 350
Size of bachelor herds	4 - 20
Mean annual population growth	6 - 12%
Dressing percentage	50%
Approximate mass of carcass	255 - 295 kg
Trophy size: Rowland Ward: minimum	1.067 m (42 inches)
Trophy size: Rowland Ward: record	1.626 m (64 inches)
Large Animal Units (LAU) per animal	1.1
Animals per Large Animal Unit	0.9
Browse Units (BU) per animal	2.68
Animals per Browse Unit	0.4
Period of hiding calf in weeks	No
Nursery herds	N o
Territoriality: Bulls	No
Cows	No
Range: Bulls	50 - 400 km^2
Cows	50 - 400 km^2

Table 3 Growth rates in kg per buffalo per year for the African savanna buffalo up to 42 months of age from different regions. Source: Sinclair (1977)

Region	GROWTH RATE	
	Males	**Females**
Kruger National Park, South Africa	113	108
Serengeti ecosystem, Tanzania	103	99
Ruwenzori, Uganda	103	92
Northern Uganda	105	100

Table 4 Horn growth of buffalo related to age in years. Source: Pienaar (1969)

Growth Form	**Age**	**Age Group**
Strong upward growth in V shape	<1	Calf
Upwards, with slight outward curve; length 300 to 460 mm	1- 2	Juvenile
Growth outwards with tips towards each other; length along curvature 410 to 690 mm	>2-3	Subadults
Continuation of above process with thickening of the boss in bulls; length 610 to 860 mm	>3-4	Subadults
Adult shape attained, tips sweep backwards, dip and widening of curvature	>4-5	Cows
Boss will develop, covered by hairy skin	>5-6	Bulls
Horn layers grow forward to centre of the skull with a little patch of skin in between	>6-7	Bulls
Horn layers meet, horn tips worn away	>7	Old bulls

Table 4 The relationship between buffalo densities in animals per km² and the mean annual rainfall in mm for some African national parks. Source: Sinclair (1977)

Nature Reserves	**Density**	**Rainfall**
Mount Meru	22.8	1968
Ngurdoto	20.0	1524
Lake Manyara	17.8	725
Virungu	12.3	863
Ruwenzori	12.0	1200
Masai-Mara	7.0	1100
Northern Serengeti	7.4	1000
Southern Seringeti	3.6	800
Tarangire	1.9	678
Ruaha	1.4	625
Zambezi Valley	1.2	560
Tsavo	1.0	510
Mkomazi	0.23	445

Table 5 Seasonal comparison of the percentage time spent on different activities of buffalo in the Willem Pretorius Game Reserve, South Africa. Source: Winterbach & Bothma (1996)

Activity	**Season**		
	Warm and dry	**Warm and wet**	**Cold and dry**
Grazing	48.2	39.4	36.9
Standing	8.4	12.2	10.9
Walking	12.5	14.7	12.8
Drinking	0.8	0.6	0.9
Resting or ruminating	28.0	31.9	38.3

Table 6 Guidelines for a vaccination and dipping protocol for the prevention of various diseases in buffalo and surrogate Jersey cows

Disease	Jersey	Buffalo
Vaccination: Anthrax Botulism Blackquarter Lumpy skin Rift Valley	 + + + + +	 + + + + +
Dipping: Alternate pyrethroids and formamidines	Weekly	Weekly during six weeks before calving

Table 7 A testing protocol to determine the disease-free status in terms of the four major diseases for African buffalo calves.

Item	**Stage 1**: **Red Line**	**Stage 2**: **Surveillance Zone**	**Stage 3**: **Clean Area**
Age:	Minimum 9 months	Minimum 9.5 months	Minimum 11 months
Tests:	Foot-and-mouth disease Corridor disease Brucellosis Tuberculosis: gamma-interferon test	Foot-and-mouth disease: Minimum 10 months Corridor disease Tuberculosis: gamma-interferon test	Foot-and-mouth disease Corridor disease Tuberculosis: skin test Must stay in quarantine for a year at point of arrival

Table 8 Estimated fixed and running expenditure per year to start a breeding programme for a herd of 60 disease-free buffalo

Item	**Expenditure in Rand**
Fixed expenditure:	
Land (25 ha)	250 000
Quarantine per adult	1 000 000
Quarantine per calf	250 000
Animals: 60 cows	1 800 000
4 bulls	400 000
Jersey cows: 20	80 000
Water provision	100 000
Tractor, trailer and grader	100 000
Staff quarters	100 000
TOTAL	**R4 080 000**
Running Expenditure Per Year:	**Rand**
Feeding	600 000
Electricity	17 000
Veterinary medicine	100 000
Diagnostic tests	50 000
Labour	150 000
Fuel	30 000
Banking costs	6 000
Accountant	7 000
Herbicides and pest control	5 000
Maintenance	35 000
TOTAL (RAND)	**R1 000 000**

Table 9 The predicted gross income (Rand) from disease-free buffalo over a 20-year period

Year	Hunting price (L)	Bulls (2n)	Bulls (3n)	Cows	90% of Total X Actual Total		Income R
2001	75 000	-	-	-			-
2002	86 250	-	-	-			-
2003	99 188	-	-	-			-
2004	144 066	-	-	-			-
2005	165 676	-	-	-			-
2006	190 527	-	-	10	10	9	1 714 743
2007	219 106	20	-	20	40	36	7 887 816
2008	251 972	20	-	30	50	45	11 338 748
2009	289 768	20	-	40	60	54	15 647 472
2010	333 234	20	10	50	80	72	23 992 848
2011	383 218	20	20	60	100	90	34 489 620
2012	440 701	20	30	60	110	99	43 629 399
2013	506 806	-	40	60	100	90	45 612 540
2014	582 827	-	50	60	110	99	57 699 873
2015	670 251	-	60	60	120	108	72 387 108
2016	770 789	-	60	60	120	108	83 245 212
2017	886 408	-	60	60	120	108	95 732 064
2018	1 019 369	-	60	60	120	108	110 091 852
2019	1 172 273	-	60	60	120	108	126 605 484
2020	1 348 115	-	60	60	120	108	145 596 420
Total	-	-	-	-		-1 242	875 671 199

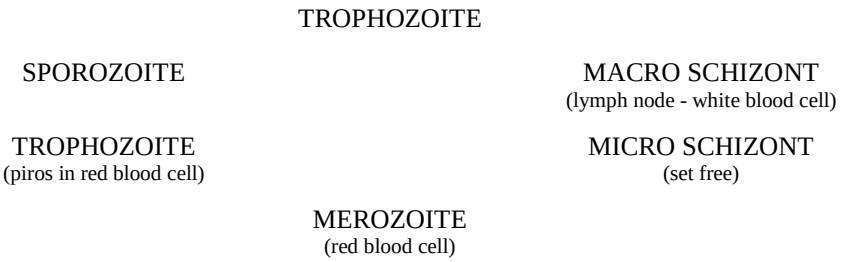

Figure 5 The life cycle of the *Theileria* parasite.

(Onthou om pyle in te voeg)