SCIENCE EDUCATION SERIES

NO. 31

THE SRI LANKA WATER BUFFALO

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FOREWORD TO THE SERIES

The dissemination of scientific information is one of the main functions of the Natural Resources, Energy & Science Authority. The Journal of the Natural Science Council published by this Authority provides a medium for the publication of scientific research papers, and "Vidurava", the quarterly science bulletin contains scientific articles of a general nature which is of interest to the public.

There is still a wide gap in the availability of reading material on scientific subjects of local interest. One result of this is that science students confine their reading only to their school notes and to the few available text books which are mostly published abroad. In an attempt to improve this situation, the Working Committee on Science Education Research of the Natural Resources, Energy and Science Authority decided to publish a series of booklets on scientific topics of local interest as supplementary reading material for students and the general public. The authors who have been selected by the Committee to prepare these booklets are experts in their respective fields. The manuscripts that were submitted by the authors were examined by referees before being accepted for publication. The views expressed in these publications are those of the authors and are not necessarily those of the Natural Resources, Energy & Science Authority.

I must thank the Working Committee on Science Education Research of the Natural Resources, Energy & Science Authority, and in particular Prof. V. Basnayake who is the Hony. Director of the Working Committee for the work they have done to make this project a success.

R. P. Jayewardene
Director-General

PREFACE

The water buffalo of South East Asia was long considered a 'neglected' animal in terms of scientific attention. During the last ten years or so, however, the situation has changed, both in Sri Lanka and neighbouring countries, with a flurry of research activity surrounding the buffalo. In Sri Lanka, several investigators have studied the management practices adopted by buffalo farmers and the patterns of utilisation of buffaloes. Many of these surveys also investigated, among others, the herd sizes and their composition, breeding patterns, feeding, management and diseases in small buffalo farms.

In addition to these surveys, a number of research studies on several aspects of the indigenous Sri Lanka buffalo have been completed. Many of these projects were funded by the International Atomic Energy Agency of the United Nations. Since 1982, the Swedish Agency for Research Cooperation with Developing Countries (SAREC) has provided generous funds for research on the indigenous buffalo. These studies have covered many aspects of buffaloes and the subjects have ranged from the socio-economics of buffalo rearing to the major diseases affecting buffaloes in Sri Lanka. SAREC support for the buffalo project is channelled through the Natural Resources, Energy & Science Authority (NARESA) and coordinated and evaluated by a Research & Advisory Committee appointed by NARESA.

The surveys and research studies have resulted in a wealth of information on the water buffalo in Sri Lanka. These findings, which have been presented and discussed at scientific meetings, although well known to the scientists involved, are not available outside this small group. The Advisory Committee, therefore, invited the different specialists to contribute chapters to a monograph on the indigenous buffalo, in order to disseminate this information.

This book is intended for groups such as teachers of Agriculture and Animal Science, high school students, managers of farms and extension workers. It is also hoped that undergraduates, scientists in allied fields and practising veterinarians will find it useful. Science writers, journalists and others such as the general reading public should also find the book informative.

This publication was prepared by a panel who were invited by NARESA to contribute chapters. Their names are given below.

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Several others have also contributed by making valuable suggestions.

The book is organised into seven chapters. Chapter I is a general introduction to buffaloes as a domestic animal species. Chapter II summarises information obtained in surveys of small buffalo farms in Sri Lanka. The other five chaptes describe the findings from research studies and are arranged according to individual disciplines.

The information presented in this book is drawn from the work of several invetigators from both within and outside the panel of contributors. A list of some of the original publications are given at the end of this book. These papers will enable those who wish to do so, to obtain more details regarding these studies.

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CHAPTER 1

INTRODUCTION

The earliest records of domesticated water buffaloes date back to 2500 B.C. in the Indus valley of present day Pakistan. They are now used in over 40 countries of the world for draught, milk and meat production. Over 90% of the world's domestic buffaloes are found in Asia.

1.1 Zoological classification

Domestic water buffaloes were given the scientific name *Bubalus bubalis* by the well-known Swedish scientist Linneaus in 1758. Table 1.1 shows the taxonomy (zoological classification) of buffaloes and related species. This classification is based on anatomical differences, ability to interbreed and on cytogenetic (chromosomal) status.

TABLE 1.1 — Taxonomy of buffaloes and related species

ORDER — Artiodactyla

SUB-ORDER — Ruminantia

FAMILY — Bovidae

TRIBE — Bovini

GROUPS

1. Bovina (Cattle)

Genus 1.1 Bos (domestic cattle)
Species - *Bos taurus typicus* (European cattle)
Bos taurus indicus (Zebu cattle)

1.2 *Poephagus* (yak)

1.3 *Bibos* (banteng, gaur, kouprey)

1.4 *Bison* (American & European bison)

2. Bubalina (Asian buffaloes)

Genus 2.1 Bubalus
Species — *Bubalus bubalis* (domestic water buffalo)
Bubalus arnee (arni)
Bubalus depressicornis (anoa)
Bubalus mindorensis (tamarao)

3. Syncerina (African buffaloes)

Genus 3.1 *Syncerus*
Species - *Syncerus caffer caffer* (cape buffalo)
Syncerus caffer nanus (Congo buffalo)

Buffaloes belong to the order Artiodactyla (even-toed ungulates) and to the sub-order Ruminantia (ruminants, having a complex stomach). They are included in the family Bovidae (other families under the Ruminantia contain deer, giraffes and camels) in the tribe Bovini (other tribes under the Bovidae contain sheep, goats and antelopes). The Bovini in turn consists of three groups, the Bovina (cattle), the Bubalina (Asian buffaloes) and the Syncerina (African buffaloes).

The group Bovina contains four genera, *Bos, Poephagus, Bibos* and *Bison*. The genus *Bos* includes the two types of domestic cattle, *Bos taurus typicus* (European cattle) and *Bos taurus indicus* (zebu cattle). They both have a diploid (2n) chromosome complement of 60, with the only difference being in the morphology of the Y chromosome (the male sex chromosome). They can interbreed freely and the offspring are fertile. *Poephagus* is the yak of Tibet and Nepal, which thrives at high altitudes. The genus *Bibos* has three wild species. The banteng of Southeast Asia *(Bibos banteng* or *Bibos javanicus)* has been domesticated as Bali cattle. Both the yak and the banteng have the same chromosome number as domestic cattle. The gaur or gayal (*Bibos gaurus*), found in northern India and the Malay peninsula, has 58 chromosomes. The Louprey *(Bibos sauveli)*, the Cambodian grey forest ox, is now extremely rare.

The genus *Bison* has two species, the American bison *(Bison bison)* and the European bison *(Bison honasus)*. They are the so-called 'buffaloes' of North America. However, they have 60 chromosomes and are closer relatives of cattle than buffaloes. It is also noteworthy that yak, banteng, gaur and bison can all interbreed with domestic cattle. Only the female bybrids resulting from such matings however, are fertile, the males being sterile. There is no evidence that any of the genera under bovina can interbreed with those under Bubalina.

The group Bubalina has only one genus, *Bubalus*. Domestic water buffaloes *(Bubalus bubalis)* are the only domesticated species under this genus.

MacGregor in 1939 classified water buffaloes into two main 'types' depending on their external (phenotypic) characters and behaviour. He called the buffaloes on the Indo-Pak subcontinent the river-type, due to their origin around river valleys and general preference of clear running water for wallowing. These include the specialized dairy breeds, which have subsequently spread to the regions around the Mediterranean, as well as to South America. The classical working (or draught) buffaloes of southeast Asia were classified as swamp-type, due to their habitat in swampy areas and their preference for wallowing in stagnant pools and mud-holes. Subsequent studies on their cytogenetic status have shown that river buffaloes have 50 chromosomes while swamp buffaloes have 48. However, they can be interbred and the offspring are fertile.

The genus *Bubalus* includes three species of wild buffaloes confined to Asia. The arni *(Bubalus arnee)* is distributed in India and Indochina. The wild buffalo of Sri Lanka is also thought to belong to this species, although there are divergent views on this (see Chapter 2). The wild arni of India is a very large animal, weighing upto 1,000 kg and reaching a height of 150-180 cm at the shoulder. Their numbers have been decreasing rapidly due to loss of habitat, hunting and disease. The anoa *(Bubalus depressicornis* or *Anoa depressicornis)* is a small wild buffalo confined to the island of Sulawesi in Indonesia. It reaches only 60-100 cm in height, and is now quite rare. The tamarao *(Bubalus mindorensis* or *Anoa mindorensis)* is one of the rearest animals in the world, and is found only on the island of mindoro in the Philippines. The anoa and the tamarao have 46 chromosomes, while the status of the arni is not clear. It is likely that the arni can interbreed with domestic buffaloes, but whether the anoa and the tamarao can do so is not known.

The group Syncerina has only one genus, *Syncerus*. The cape buffalo of Africa *(Syncerus caffer caffer)* has 52 chromosomes, while the Congo buffalo *(Syncerus caffer nanus)* has 54 chromosomes. They have several anatomical features which distinguish them from Asian water buffaloes, and it is unlikely that interbreeding could occur between the two genera.

1.2 World population and distribution of buffaloes

The total world population of water buffaloes is about 130 million, of which 124 million are found in Asia, Table 1.2 shows their distribution regions, together with the numbers present in some of the countries which contain significant population.

Domestic water buffaloes have been broadly divided into two types, the swamp type and and the river type. River buffaloes have been subjected to much selective breeding and genetic improvement resulting in the formation of well defined breeds. In contrast, swamp buffaloes have not been developed to any extent and there are no distinct breeds.

TABLE 1.2 — World population of buffaoes (× millions)

ASIA	— 124 India 64, China 20, Pakistan 12, Thailand 6, Nepal 4.5, Philippines 3, Burma, 3, Viet Nam 2.8, Indonesia 2.5, Bangladesh 1.7, Laos 1.2, Sri Lanka 0.9, Malaysia 0.3
MIDDLE-EAST	— 4 Egypt 2, Turkey 1, Iraq 0.3, Iran 0.3
EUROPE	— 0.5 Romania 0.1, Bulgaria 0.1, Italy 0.1
U.S.S.R.	— 0.5
S. AMERICA	— 1.5 Brazil 0.5
CARIBBEAN	— 0.0007
AUSTRALIA	— 0.2

TOTAL Approx. 130 million

(Based on FAO Statistics, 1985)

The swamp buffaloes are generally smaller than river buffaloes. But both types show a wide range of body weights, depending on location, breed and other factors. In general adult swamp type males weigh 325-600 kg, while river type males weigh 400-800kg. The range of weight for females are 300-500 kg for swamp types and 350-700 kg for river types. The swamp buffalo is lighter in colour, being dark grey with a brown tinge to the hair, while the river buffalo is usually black. A characteristic of the former is the presence of two white or lighter grey markings called chevrons on the front of the neck, whereas these do not occur in most river buffaloes except in those of the Surti breed. White animals (called albinoids) occur in swamp buffaloes with different frequencies in different countries (Thailand 10%, Malaysia 5% and Philippines 1%) but albinoids are very rarely seen among river types.

The horns in swamp buffaloes grow outwards, laterally and horizontally and curve upwards, generally remaining in the same plane as the forehead. In river buffaloes, they grow downwards and backwards, then curve upwards with different degrees of twist depending on the breed. The swamp buffalo has a shorter body with a larger belly, a shorter face and thinner legs than the river buffalo.

Swamp buffaloes are distributed throughout Southeast Asia, ranging eastward from Assam, and southwards from the Yangtse valley in China. The largest population is in China (20 million), with Thailand (6 million), the Philippines (3 million) and Burma (3 million) having large populations. The buffaloes of Viet Nam, Indonesia, Bangladesh, Laos, Malaysia and Australia also belong to the swamp type. The indigenous buffaloes of Sri Lanka (called the Lanka buffalo) have been classified as belonging to the swamp type, since they have external (phenotypic) features similar to those of other southeast Asian buffaloes. However, cytogenetic studies have shown that they have 50 chromosomes, which indicates a genotypic simlarity to the river buffaloes of the Indo-Pak subcontinent. It should be noted that swamp buffaloes are also found in certain regions of India, such as Kerala and Orissa. They have been introduced to South America and, together with river buffaloes, constitute significant populations in Brazil, Guyana and Surinam.

The largest populations of river buffaloes are found in India (64 million) and Pakistan (12 million). Although the majority of these animals are unimproved or nondescript (called 'desi' or mongrel buffaloes), several improved breeds of typical dairy-type animals are found in different regions of these countries. The most important Indian breeds are the Murrah of the Haryana region, the Surti, Mehsana and Jafarabadi of the Gujarat region, the Bhadawari of Uttar Pradesh, the Nagpuri of the central region and the Toda of the southern region. Of the Pakistani breeds, the most important are the Nili-Ravi of central Punjab and the Kundi of Sindh province. The Nili-Ravi, Murrah and Kundi are large breeds with black skin and tightly curled horns. In contrast, the Surti is smaller, lighter in colour and has horns which are swept back and curled only at the tip.

The buffaloes of the Middle-East (4 million) and Europe (0.5 million) originated from the river buffaloes of India and Pakistan, although now designated as the Mediterranean type. They are used mainly for milk and meat production, and although there are no distinct breeds, some differences are evident between buffaloes of different countries. In the Middle-East the main populations are located in Egypt, Turkey, Iraq, Iran, Afganistan, and Syria. The majority of buffaloes in the U.S.S.R. are found in the Azerbaidzan region. In Europe, the half-million buffaloes are distributed in Romania, Bulgaria, Italy, Yugoslavia, Greece, Albania and Hungary. River buffaloes are also found in Nepal (4.5 million), Brazil and the Caribbean. Small populations have been introduced into many Southeast Asian and east African countries.

CHAPTER 2

THE SRI LANKA BUFFALO : GENERAL ASPECTS

In Sri Lanka today, buffaloes are found in most parts of the country, associated in activities connected with paddy cultivation. Most buffaloes are owned and used by paddy farmers, usually peasant farmers, in the dry-zone. Several surveys of such farmers have been carried out notably during the period 1978 — 1982. These studies investigated the general patterns of management, breeding, utilisation and disease prevalent on these farms. This chapter summarises the chief findings from these surveys. The chapter opens with an account of the use of buffaloes in historical times based on references to them in the ancient chronicles.

2.1 The historical background

Field preparations is the most costly, and in terms of timing, the most significant in the paddy cultivation calendar. It appears to have been the first agricultural operation in Sri Lanka for which an attempt has been made to relieve the drudgery of human effort by the use of an animal, the buffalo.

It was thought that the Lanka buffalo, *Bubalus bubalis bubalis,* was a descendant of those introduced in the sixth century B.C. by immigrants from North India, and that Lankan wild buffaloes were probably domesticated ones which have become feral. Both these views, however, seem to be incorrect. The occurrence of fossil buffalo teeth in the gem sands of the Ratnapura area at depths of from six to thirty feet below the surface suggests that wild buffaloes were abundantly found in that area in pre-historic times, There are also various fossiliferous deposits in the Dry Zone jungles which indicate that buffaloes and cattle were found in great numbers in the region. It is most likely that the wild buffalo is indigenous to Sri Lanka and was domesticated by the agricultural settlers who migrated from India around the sixth and fifth centuries B.C..

Evidence from the earliest periods of hydraulic civilization in the Dry Zone of Sri Lanka indicates the economic and social significance of cattle, buffaloes and their by-products. The use of draught animals, particularly buffaloes appears to have been the norm in both the cultivation and threshing of paddy from earliest times. Buffaloes were also employed as pack animals and even to draw carts to transport commodities over long distances but, in this respect, pride of place was given to oxen. Both oxen and buffalo were used to power oil extraction and water-lifting equipment. Buffalo hair and bone have long been used in rituals performed in connection with paddy cultivation:

Bonemeal and dung were used as a fertilizer. Ghee, made of cow's milk, besides being consumed had traditionally been used as lamp oil in religious establishments. In addition buffalo horns had been used for making combs and ornamental items.

A remarkable degree of sophistication in animal husbandry was achieved in this early period, much of which appears to have been lost subsequently. The pali commentary, *Papancasudani* written in the fifth century A.D., for instance, describes the duties of a herdsman in rotating grazing sites and in providing the special care perceived as necessary to both the 'herd Leader' and to smaller and weaker animals. Medicinal barks to be used in curing sick animals are also referred to in this text. During the monsoon periods, cattle pens were to be fumigated to rid them of harmful insects.

The ownership distribution of draught animals in ancient Sri Lanka was as wide as their use patterns suggest. The buffaloes and cattle formed an important item of property. There is evidence to suggest that the king, the religious institutions and individuals were the three categories of the owners of cattle. Payments in kind for the use of animal draught were the norm. The services of pack bulls and draught buffaloes were requisitioned by the king from individuals, in return for various privileges. Land was granted as payment for tending the royal herd. Payment in kind (often in the form of a calf) for herding were common place, as was the trading of oxen and buffalo for money. Individuals could therefore build up a small herd of draught animals both through financial outlay and through the supply of their own labour services. Reciprocal arrangements among individuals for the use of animals, traditionally known as *Kaiya* existed and normally involved transactions in kind. The ancient share cropping or *ande* arrangements which has continued to modern times, required the landlord to provide seed and draught inputs if he were to qualify for a half share of the harvest. When the landowner could not supply buffaloes he had to pay the tenant yoke hire *(Viya kuliya)* or forego part of his crop share. Payment for buffalo hire throughout the eighteenth and nineteenth centuries remained on a crop share basis, varying according to the local availability of animals, between one and two bushels of paddy for the ploughing of an acre, payable at harvest. Alternatively, in some circumstances the hirer could pay by working for a specified period on the owners farm.

Thus, until tractors were introduced around 1946, buffaloes played a key role in farm technology in Sri Lanka. Only in areas where the soil is sandy, particularly in the northern peninsula, were buffaloes used for field preparation and threshing. Two-wheeled tractors were introduced at a much later stage-in 1973.

2.2 The population and distribution of buffaloes in Sri Lanka.

The Agricultural Census of 1982 estimated the population of buffaloes in Sri Lanka at 576,360. Of this number 562,289 (98%) are in small holdings where the land area per holding or farm is less than 20 acres. The rest (14,060) are in the Estate Sector. Their distribution in the different districts is shown in Table 2.1.

TABLE 2.1

The population and distribution of buffaloes in Sri Lanka

District	Small holdings	Estates	District	Small holdings	Estates
Colombo	6,680	172	Mullaitivu	2,431	47
Gampaha	21,513	1,224	Batticaloa	13,049	18
Kalutara	13,850	185	Amparai	18,182	—
Kandy	13,592	50	Trincomalee	20,977	316
Matale	28,270	100	Kurunegala	175,341	6,180
N'Eliya	6,750	84	Puttalam	12,229	1,073
Galle	7,381	194	Anuradhapura	61,269	369
Matara	5,837	234	Polonnaruwa	56,670	1,743
Hambantota	28,157	1,263	Badulla	14,310	69
Jaffna	752	14	Moneragala	9,364	310
Mannar	995	—	Ratnapura	11,722	229
Vavuniya	971	—	Kegalle	22,005	186

Total — Small holdings	=	562,297
Estates	=	14,060
		576,357

(*Source:* Department of Census and Statistics, 1982

Kurunegala district has the highest population of buffaloes (175,000), while Anuradhapura and Polonnaruwa districts have over 50,000 animals each. Only two other districts have more than 25,000 animals, these being Hambantota and Matale. The majority of these belong to the indigenous type called the 'Lanka buffalo' and are used by the farmers mainly for work related to agriculture. Exotic or foreign breeds of river type (dairy) buffaloes are found mainly on state farms, and originate from imported breeding stock. The main breeds that have been imported to Sri Lanka are the Murrah and Surti breeds from India and the Nili-Ravi breed from Pakistan. The populations of exotic breeds presently found on state farms are shown in Table 2.2.

TABLE 2.2

Buffalo population on state farms

Agency	Farm	Breed	Number
Dept. of Animal Production and Health	Polonnaruwa	Murrah	747
	Kandakaduwa	Murrah	675
	Ridiyagama	Murrah	1,038
National Livestock Development Board	Melsiripura	Surti	395
Mahaweli Authority (Draught Animal and Diary Development Programme)	Kalankuttiya	Murrah	70
Janatha Estates Development Board	Palugaswewa	Murrah	120

These dairy-type breeds are used mainly for milk production and for obtaining improved breeding stock. The surplus breeding animals from the state farms are given to private farmers for cross-breeding with their indigenous Lanka buffaloes, The cross-bred offspring have milk yields which are intermediate between those of Lanka and exotic breeds and retain their ability for work. They can, therefore, be used as dual-purpose animals, the females being used for milk production and the males for draught power.

Sri Lanka has a small population of wild buffaloes which are found in the jungles of the low-country dry zone. They are now mostly restricted to wildlife parks and nature reserves. There are different views held by scientists regarding the origin and status of the Sri Lanka wild buffalo. Some scientists consider it to be a descendent of the wild arni *(Bubalus arnee,* see chapter 1) of India, while others have classified it as a distinct subspecies which is different from the Indian wild buffalo. A third view point is that they are not truly wild, but are descendents of domesticated animals which have since returned to the wild state. They therefore believe that these animals should be called 'feral' buffaloes rather than 'wild' buffaloes. Although no definite conclusions can be made at present, it is interesting to note that typical wild (or feral?) buffaloes in our National Parks are usually distinguishable from domestic Lanka buffaloes by their darker colour and larger size. It is not known whether these differences are inherited or acquired. The number of such animals living in the jungles of Sri Lanka is not known.

2.3 Herd size and composition

There is a wide variation in the sizes of buffalo herds owned by farmers. Mean herd sizes on a district basis as well as in different agro-ecological zones (AEZ) are given in Table 2.3. Kandy district had the smallest herd size while largest mean herd size was in Hambantota, where individual herds ranged from 14-138 animals per holding. On the basis of different AEZ's, the smallest herd size was in the Wet-Mid country region (mean 5.5 animals) and the largest was in the Dry-Low country 2 region (mean 40.7 animals).

TABLE 2.3

Herd sizes (number of animals per holding) by districts and agro-ecological zones

District	Average herd size	Range
Trincomalee	23	5—75
Batticaloa	46	11—141
Polonnaruwa	23	2—94
Anuradhapura	42	7—152
Hambantota	53	14—138
Ampara	37	4—94
Kegalle	6	1—29
Gampaha	11	2—67
Ratnapura	43	10—129
Kurunegala	17	2—122
Puttalam	23	9—45
Badulla	14	3—49
Matale	12	1—62
Matara	31	5—242
Kalutara	30	5—69
Kandy	5	1—27

*Agro-ecological zone	Average herd size	Range
DL_1	32.7	2—152
DL_2	40.7	4—141
IU & IM	8.0	1—49
IL_1	13.6	2—45
IL_2	24.8	3—89
IL_3	10.9	2—30
WM	5.5	1—29
$WL_{1\ \&\ 2}$	20.1	1—129
$WL_{3\ \&\ 4}$	22.7	2—242

*DL — Dry zone Low country
IU — Intermediate zone Up country
IM — Intermediate zone Mid country
IL — Intermediate zone Low country
WM — Wet zone Mid country
WL — Wet zone Low country

(*Source:* L. N. A. de Silva and others, 1985)

The buffaloes within an area can be categorised according to their sex and age, in order to obtain the 'herd composition'. One method is to categorise them as calves (up to one year of age), juveniles (animals between 1-2 years of age) and adults (over 2 years of age). The adult females can be further divided into heifers (animals which have not yet had a calf) and cows (those which have had at least one calf). The adult males can be categorised as 'entire' (those which are not castrated or sterilized) and '*castrated*' (those which are sterilized by native or western methods). Table 2.4 shows the herd compositon in different districts surveyed. There are more females than males (55.7 vs 44.3%) and more adults (70%) than young stock (30%). Among the total population, heifers comprise 9%, cows 33%, castrated males 15% and entire males 13%.

TABLE 2.4

Percentage composition of buffalo herds (sex and age distribution) in different districts

District	Calves	Juveniles	Heifers	Adults cows	Males
Trincomalee	23.8	10.1	11.1	33.7	21.4
Batticaloa	23.8	14.1	9.9	31.5	20.6
Polonnaruwa	22.2	12.6	7.7	29.7	27.9
Anuradhapura	21.7	11.9	8.1	30.2	28.1
Hambantota	18.5	7.6	10.9	30.1	33.0
Ampara	17.4	15.1	11.6	42.6	13.2
Kegalla	13.1	14.4	9.9	33.8	28.8
Gampaha	13.5	10.4	5.7	32.0	38.4
Ratnapura	12.8	10.8	10.2	27.4	38.9
Kurunegala	21.4	12.1	9.8	32.1	24.5
Puttalam	18.7	18.6	8.7	35.1	18.9
Badulla	12.0	17.9	9.2	35.1	25.7
Matale	16.7	12.0	6.9	40.6	24.2
Matara	12.1	15.2	7.0	26.8	38.9
Kalutara	12.2	13.9	7.5	27.7	38.9
Kandy	13.4	10.9	10.9	36.8	28.0
Overall	17.1	13.0	9.1	32.8	28.0

(*Source:* L. N. A. De Silva and others, 1985)

2.4 — Feeding and management

In the dry-zone buffaloes are allowed to range freely on natural pastures during daylight hours, and are paddocked in the night. Animals from different owners graze together in large communal herds usually around the irrigation tanks. Here, they have the opportunity to graze or wallow as they wish, conditions that are similar to those in the natural or wild state. There is free mating and breeding is uncontrolled. Some straw may be fed in the dry season but no concentrates or minerals are fed.

In more intensive areas of the dry-zone, such as parts of the Kurunegala district and the newly colonised areas under the Mahaweli development schemes, grazing land is limited. Such land is particularly scarce from the time rice is planted until the harvest. During this time, animals may be tethered to prevent them straying into the fields or even driven into the jungle. Some farmers employ professional herdsmen who drive the animals to grazing lands. After the harvest buffaloes are allowed into fallow paddy fields. The grasses, weeds and the paddy rattoon crop in these fallow fields probably contribute the main source of forage to buffaloes in most areas of the Island. None of the surveys conducted have attempted to identify the forages eaten, to characterise their nutritive value or to determine the intake.

In the wet-zone and the mid-country areas, animals are usually managed singly and more intensively. Buffaloes are allowed tethered grazing on roadsides, vacant lots and fallow paddy fields. They are often supplemented with items of household refuse such as banana stems, jak fruit (minus seeds and pericarp) and tree leaves. Normally no concentrates or minerals are fed. The opportunities for wallowing are limited but the climate is milder. If there is no free mating calving rates are low.

The overall picture, therefore, is that buffaloes in Sri Lanka are fed on whatever natural grazing is available with no supplements. The inputs of both time and money expended by farmers on buffaloes is minimal. The nutritional status of the animals can be expectd to vary considerably in relation to rainfall and cultivation patterns. Late pregnant and lactating buffaloes can be expected to be particularly affected under such conditions.

Calves are generally allowed to run with the mother in most areas. In those areas where buffaloes are milked, the calf is usually separated in the night and the cow is milked once in the morning. Alternatively, farmers may leave one or two quarters unmilked. No information is available to judge whether these practices leave sufficient milk for the calf.

2.5 — Breeding patterns and reproductive efficiency

In Sri Lanka, as in many other Asian countries, buffaloes show a seasonal pattern in their breedig activity. In general, the majority of animals show heat signs (oestrus or sexual receptivity) during the period following the main rainy season. They conceive (become pregnant) during these periods of increased breeding activity, and calvings (which occur about 10 months later) also follow a seasonal, pattern. Seasonal patterns have been found to occur both under village conditions as well as in state farms. Several scientists have found that breeding activity and conception were highest about 2.5 months after the peak rainfall period during each year and concluded that the availability of adequate quantities of good quality grass following the rainy season is the main reason for the seasonal breeding activity.

Thus, after the Maha season rains (North-East monsoon) from October-December, breeding activity reaches a peak in February-April. Once again, after the intermonsoonal and Yala season rains (South-West monsoon) in May-July, breeding activity increases though to a smaller extent, in July-August.

This results in a bi-modal pattern of annual calvings, with the main peak in December-February and a smaller peak in May-July. In most regions, however, some calvings do occur during other months of the year as well, while in a few areas only one peak may be seen each year.

In addition to rainfall and nutritional level, other factors also influence the time of conception. If animals are subjected to continuous suckling by their calves, they take longer to exhibit heat signs (see Chapter 4). In some instances the female may show heat signs but there may be no intact bulls available for mating. This could occur in areas where animals are usually kept tethered to trees, or where most of the males are castrated (sterilized) for use as working animals. In such regions the males and females may mix freely only when the rice fields are bare after the harvest and they are let loose to graze. Thus the time of conception may differ from other regions due to climate patterns.

Buffaloes are not strictly 'seasonal breeders' in the way that sheep or horses are. The latter species respond to changes in day length (photoperiod), which changes from season to season in temperate countries. Thus sheep have their breeding season when day length is becoming shorter in the autumn, whereas horses breed when daylength is increasing in the spring. Buffaloes, on the other hand, appear to be influenced by nutritional and other factors related to climatic changes.

Reproductive efficiency or fertility can be assessed by several measures which are called 'indices'. The commonly used indices are age at first calving, calving interval and annual calving rate. Buffalo heifers usually have their first calf when they are 42-48 months old (3.5 to 4 years). Since the duration of pregnancy in buffaloes is about 10 months (310 days in Murrah buffaloes and 317 days in Lanka buffaloes aas explained in Chapter 4), this means that they become pregnant for the first time when they are about 32-38 months old.

The calving interval is the period between two successive calvings. In Lanka buffaloes this varies widely between different locations as well as within locations, and may be as short as 13 months or as long as 24 months. This is due to the fact that many factors influence the calving interval. When an animal calves, it usually undergoes a variable period of sexual rest (called anoestrus or ovarian acyclicity). When this period is over and the ovaries have commenced activity (or cyclicity) once again, the animal will come into heat (or oestrus) and can then conceive (see Chapter 4). However, it must then be mated by a fertile bull at the correct time and the resulting embryo must be normal and healthy so that it can grow to produce a living calf. Hence many factors, including the genetic make-up of the animal, the nutritional state before and after calving, the season of calving, the intensity of suckling by the calf and the presence or absence of fertile bulls will have a bearing on the calving interval. In general, a calving interval of 13—14 months indicates excellent fertility, 16—18 months is average, and anything longer than 20 months denotes poor fertility.

The annual calving rate is a measure of the proportion of breedable female animals which produce a calf during any given year. The calving interval and calving rate are inversely related; if a group of animals have a high mean calving interval they will have a low calving rate, and *vice versa*. In a survey conducted in several districts, it was found that the districts of Anuradhapura, Batticaloa, Trincomalee and Kalutara had the lowest calving intervals (13—14 months) and the highest calving rates (66-75%) showing them to be the districts with best fertility. On the other hand, Kandy and Kegalle districts had the lowest fertility, with calving intervals of 23—24 months and calving rates of only 42—43%.

A buffalo cow usually lives upto an age of about 20 years and produces on an average 6—9 calves. Some animals, of course, die much earlier due to various causes while a few may live up to an age of 25—30 years.

2.6 — Utilisation of buffaloes

The ancient chronicles record references dating back to the 4th century BC, on the use of buffaloes for draught power and milk. It is clear that these animals played an important role in the rural economy of Sri Lanka from ancient times.

Surveys conducted in the recent past have shown that buffaloes are used in most parts of Sri Lanka for draught, milk and dung. In addition, although buffalo slaughter is officially banned, there is little doubt that significant numbers are slaughtered for meat.

TABLE 2.5

Patterns of utilisation of buffaloes in Sri Lanka

District	Percentage of farmers who used buffaloes for:			
	land preparation	threshing	milk	clay mixing
Anuradhapura	100	98	81	—
Polonnaruwa	100	81	71	—
Puttalam	100	100	21	—
Matale	100	100	15	04
Kegalle	100	100	—	02
Kurunegala	99	92	10	—
Matara	96	32	100	—
Hambantota	100	27	96	—
Kalutara	100	77	91	—

(*Source:* L. N. A. de Silva and others)

All farmers use buffaloes for work, almost exclusively for activities connected with paddy cultivation. Although the use of these animals for clay mixing prior to baking of bricks is prevalent in a few areas of the country, they are not used for other work such as oil extraction or road haulage. These practices were apparently prevalent in the ancient days and are still seen in some other countries in the region. In contrast to the widespread use for paddy cultivation, indigenous buffaloes are milked in only a few parts of Sri Lanka, mainly, the Matara/Hambantota and Polonnaruwa/Batticaloa areas. In the mid-country, Kurunegala and several other areas, they are rarely milked. These differences appear to be purely a matter of tradition. General patterns of utilisation of buffaloes in Sri Lanka, adapted form an islandwide survey, are shown in Table 2.5.

TABLE 2.6

Details of the utilisation of buffaloes in Polonnaruwa and Matara districts

Objective	Percentage of farmers surveyed in:		
	Matara	Polonnaruwa	Both districts
Milk only	16	35	24
Draught only	6	35	20
Milk & draught	43	17	30
Milk & manure	14	—	8
Milk, manure & draught	23	13	18
Total milk objective	94	65	80
Total draught objective	72	65	69

(*Source:* J. A. de S. Siriwardana, U. G. L. Wickramasuriya and S. S. Balachandran, 1982, **Management practices of the buffalo in small farms.**In, SAREC report R3: 1982 Page 13, SAREC: Stockholm)

In Polonnaruwa and Matara districts, buffaloes are milked in addition to their use for draught. Table 2.6 shows the pattern of utilisation in these two districts.

Use of buffaloes for paddy cultivation:

From ancient times, buffaloes have been used as draught animals in paddy cultivation. Indeed, the techniques used in ploughing, puddling, levelling and threshing with buffaloes remain largely unchanged upto modern times. It is only with the recent large scale imports of tractors, particularly since 1970, that the role of buffaloes in paddy cultivation has declined. At present, the use of tractors is high, particularly in the dry-zone, where it is estimated that 45% of paddy land is tilled by tractor.

There is general agreement between the different surveys on the work capacity of the indigenous buffalo. There are some differences, however, in the type of land preparation in different parts of the island, probably related to the soil types. For example, there was less ploughing and levelling in the Kalutara district and less puddling in Kurunegala and Kegalle, when compared to other districts.

Buffaloes worked on average 6.9 (± 0.9) hours per day for 52.3 (± 13.6) days/year on land preparation. The working season lasted about 8 weeks and each buffalo was rested for about 30% of the time during this period. Average values for working capacity are given in Table 2.7.

TABLE 2.7

Average working capacity of buffaloes in paddy cultivation

Activity	Buffalo-days required		Area worked/buffalo/day	
	per acre	per hectare	acres	hectares
Ploughing	4.7	11.8	0.21	0.09
Puddling	13.2	33.1	0.08	0.03
Levelling	2.7	6.8	0.37	0.15
Threshing	8.8	22.1	0.11	0.05

(*Source:* L. N. A. de Silva and others, 1985)

It can be seen from the table that a buffalo can plough about 0.2 ac/d and that more than twice the number are needed for puddling. In contrast to swamp buffaloes in other South East Asian countries, our farmers use two animals per plough whilst in these countries only one is used. This probably reflects differences in size or strength.

For threshing paddy, buffaloes were used for 10 hrs., usually at night, for about 29 days in the year.

From these figures, it can be calculated that 3.3 animals are needed per ha of paddy land if buffaloes are to be used for all activities connected with paddy cultivation. No district in the island has the required concentration of animals; Kurunegala (2.2/ha) and Kegalle (1.9/ha) were closest. As part of a survey of overall farm power patterns in Sri Lanka, a study was made recently of the use of buffaloes for draught in four dry-zone colonisation schemes. It was found that the cost of using buffaloes was very much less than using tractors, if the farmer used his own animals. Buffalo hire charges were close to that of tractors so that buffalo owners who hired out their animals made large profits. Under these conditions, farmers prefer to hire a tractor than a buffalo since it was quicker and since even dry land could be ploughed. It was noted in the survey that the level of mechanisation in Sri Lanka was relatively high when compared to other developing countries. The existence of regional imbalances in buffalo numbers when compared to acreage of paddy land was also pointed out.

It can be seen that the choice between a buffalo and a tractor depends on the relative costs to the farmer. The cost of tractor operations can change abruptly with fluctuating foreign exchange rates and changes in cost of fuel. Certain policy changes appear to be needed to reduce the extent of mechanization, and to stabilise the situation.

Use of buffaloes for milk production:

The surveys conducted revealed that there was a wide disparity between districts in the numbers of buffalo herds that were milked. Animals in Kandy, Kegalle and Gampaha were rarely, if ever, milked. In contrast, all farmers in Matara and Batticaloa milked their herds. Other districts fell between these extremes with an overall average of 40% for the island.

In those areas that milking was practised, the general pattern was to separate the calf in the evening and milk the cow once in the morning. The calf thus had *ad libitum* suckling during the day. The quantity of milk taken by the farmer ranged from 1—1.5 l/d and it was estimated that the calf drank an equivalent quantity. But, as the amount drunk by the calf was not estimated, an accurate value for the total milk yield of the indigenous buffalo is not available. The production per herd (farmer) ranged form 2-19 l/d.

The milk was either consumed, sold or more commonly, made into curd; the different practices varied in different areas. In one survey, it was estimated that 50% farmers made curd whilst 30% consumed all the milk themselves. There is no information on the techniques and cultures used in preparation of curd.

Results of these surveys suggest that the milk potential of the indigenous buffalo is under exploited. The wide disparity between regions is milking frequency can only be explained on the basis of tradition.

2.7 — Diseases and mortality

The major diseases of buffaloes in Sri Lanka can be categorised as being due to parasites, bacteria or viruses. Detailed accounts of these diseases are given in Chapters 6 and 7. Only a brief description of their main effects and prevention will be given here.

The most important parasitic disease is round-worm infestation of buffalo calves. The organism is called *Toxocara vitulorum*, and causes serious disease and high moratlity (10-40%) in very young animals of 2—6 weeks age. The calf gets infected from its mother through larvae of the worm which are passed in the milk. The disease and resultant mortality can be readily prevented by treating all buffalo calves between 2—3 weeks of age with an effective anthelmintic drug (see Chapter 6). Other parasites which could occasionally cause problems are *Coccidia* in young calves and Babesia in adults.

Of the bacterial diseases, the most important one is Haemorrhagic Septicaemia, due to the organism *Pasteurella multocide.* This disease affects mainly juveniles and adults, and is prevalent mostly in the dry and intermediate zones of the country. It can cause high mortality ranging from 5—20% in an area, but can be prevented by vaccinating animals against the disease once a year. Other bacterial diseases which may sometimes cause problems are *Salmonella* and *Escherichia coli* infections in young animals (which causes diarrhoea) and *Brucella abortus* infection in adult cows (which cause abortion when the cow is in the later stages of pregnancy).

Foot and Mouth disease is the most important viral disease in buffaloes. It is highly infectious and can spread rapidly throughout a large area. It does not cause mortality except in young debilitated animals, but the effects of the disease may be quite severe on the growth and body weight of the animal. When it occurs during the cultivation season animals cannot be used for draught purposes. This disease can also be prevented by animal vaccination. Recent studies indicate that a group of viruses called rotaviruses may be responsible for diarrhoea in very young buffalo calves. The incidence and severity of this disease are still not known.

TABLE 2.8

Annual mortality rates in different age groups of Lanka Buffaloes

Age group	Mean mortality (%)	Range in different districts (%)
Calves (< 1 yr)	25.4	10.5 — 46.1
Juveniles (1-2 yr)	21.5	2.4 — 44.1
Adults (> 2 yr)	8.0	2.7 — 14.0

(*Source:* L. N. A. de Silva and co-workers, 1985)

Results from several different surveys on mortality rates in buffaloes have given figures which are basically similar. However, wide variations have been noted between different regions and districts. Table 2.8 gives the overall mortality figures for different age groups of buffaloes, and the variation seen between different districts.

CHAPTER 3

PHYSIOLOGY AND NUTRITION OF INDIGENOUS BUFFALOES

The information available on the physiology and nutrition of domestic buffaloes is less than for cattle. Both species being ruminants and of comparable size, it can be expected that buffaloes are basically similar to cattle in this respect. In some characteristics, however, buffaloes differ obviously from cattle. Examples of such differences include the colour and texture of the skin and the shape and size of the horns and hooves. Buffaloes, unlike cattle, also need to wallow in water or mud for a period of the day.

Recent studies carried out in Sri Lanka, have probed several aspects of the physiology, behaviour and nutrition of indigenous buffaloes. The main findings in these studies are described in this chapter.

3.1 — Physiology

Indigenous domestic buffaloes are relatively small in size when compared to the native animals of neighbouring countries such as Thailand, Malaysia and the Philippines, Calves weigh 20—25 kg at birth;adult females are 250—350 kg in weight, whilst adult males are heavier. The skin is grey/black in colour and is lighter than in Indian buffalo breeds. The horns curve outwards from the head and the poll is not prominent. Calves are covered with coarse hair but these are lost with age and adults are virtually hairless. In common with buffaloes in other Asian countries, they show a marked affinity for water and spend much of their time wallowing in water or mud.

3.1.1 — Blood values

TABLE 3.1

Values for constituents in the blood of indigenous buffaloes
(n =250)

	Average	Range
Blood		
Haemoglobin (g/l)	132	90 — 193
Packed cell volume (ml/l)	334	220 — 450
Red cells (10^{12}/l)	5.8	2.9 — 8.8
Mean corpuscular volume (fl)	61	29 — 115
Mean corpuscular haemoglobin concentration (g/l)	389	290 — 570
Plasma		
Total protein (g/l)	81	59 — 102
Albumin (g/l)	55	41 — 79
Sodium (m eqt/l)	125	110 — 173
Potassium (m eqt/l)	4.2	1.9 — 7.9
Calcium (mg/l)	93	69 — 122
Magnesium (mg/l)	26	14 — 53
Inorganic phosphorus (mg/1)	56	25 — 95

(*Source:* S. S. E. Ranawana, 1987, Proceedings of the SAREC buffalo project, Interim Review Seminar — not published, only mimeographed)

Values for some common blood parameters are shown in Table 3.1. These values are, in general, similar to those reported in cattle. Haemoglobin content and packed cell volume are somewhat higher than in cattle, and the red cells are larger. Unlike in cattle, the erythrocytic sedimentation rate is rapid. Values for total protein, albumin, calcium and magnesium appear to be higher, and thyroxine concentrations lower in buffaloes when compared to cattle.

3.1.2 - Respiration and pulse

TABLE 3.2

Average values for some physiological indices in adult buffaloes and Zebu cattle measured during the dry season in the wet-zone of Sri Lanka

	Buffaloes			Zebu cattle		
Time of measurement (hr)	**07.00**	**12.00**	**Increase**	**07.00**	**12.00**	**increase**
Respiration rate (breaths/min)	22	80	58	19	30	11
Heart rate (pulses/min)	53	58	5	59	65	6
Rectal temperature (°C)	37.8	40.0	2.2	38.7	39.3	0.6
Skin temperature (°C)	31.1	37.5	/.4	30.7	36.6	5.9
Cutaneous evaporation rate (g water/m^2/minute)	300	420	120	240	440	440200

(*Source:* A. A. J. Rajaratne, M. Phil. thesis, University of Peradeniya, Peradeniya.)

Average values for respiration and pulse rates measured during the dry season in the dry and wet zones of Sri Lanka are shown in Table 3.2. For purposes of comparison, values for Zebu cattle are also shown in the Table. Early morning (resting) respiration rates were similar in cattle and buffaloes. After a few hours grazing in the sun, respiration rate in buffaloes increased sharply; the increase was less marked in Zebu cattle. Pulse rates were lower in buffaloes and showed little change during the day. In the monsoon, with overcast skies and/or rain, there was no change in respiration or pulse rates from early morning values.

3.1.3 - Rectal and skin temperature

Rectal temperatures of buffaloes was lower than in cattle, when measured early morning. After a few hours grazing in the sun, there was a marked increase in rectal temperatures in buffaloes whilst that of cattle showed only a small increase. Studies carried out in India have given similar results. It appears, therefore, that a relatively labile body temperature is a characteristic of buffaloes as a species. When measurements were made at Polonnaruwa, values as high as 42° C (107° F) were recorded in animals that had grazed for a few hours in the sun. During the monsoon, the rectal temperature did not increase as much and remained at more-or-less the early morning values.

Due to their black hairless skin, buffaloes grazing in the sun absorb large amounts of heat from solar radiation. This is in contrast to Zebu cattle who have a short, smooth and shiny hair coat with a high reflectivity. The temperature of the top surface skin in buffaloes can reach, therefore, very high values. This seems to be a reason for buffaloes to cover themselves with mud. Indeed, measurements showed that buffaloes covered with mud have a lower rectal temperature than cleaner animals.

3.1.4 - Skin evaporation

Measurements of the rate of skin evaporation in buffaloes gave values comparable to those in Zebu cattle. The rates were higher in buffaloes early morning and similar in both species at mid-day. The increases in Zebu cattle, which are known to sweat efficiently, were greater than in buffaloes. The sweat gland density in buffaloes is known to be much less than in Zebu cattle. These results suggest, therefore, that the rapid rate of cutaneous evaporation observed in buffaloes is due largely to passive diffusion of water rather than to true sweating. It is likely that the structure of buffalo skin does not allow for efficient conservation of water. A covering of mud could help to reduce this evaporation.

3.1.5 - Grazing — watering behaviour

The most striking feature in which buffaloes differ from cattle is their need to wallow in water or mud. Studies of behaviour have shown that buffaloes wallow frequently if water is available and graze in the sun in between. In one study in the dry-zone during the dry season, buffaloes wallowed 8—9 times a day for about 15 minutes each time. In a separate study in the wet-zone, during the dry season, they wallowed 3 to 4 times for somewhat longer periods. Wallowing was confined to the hotter parts of the day, usually between 09.00 and 16.00 hours. In contrast, the most intensive grazing periods, were 06.00 to 09.00 hours and after 16.00 hours. During the monsoon with overcast skies and constant rain, they did not go to water, either to wallow or to drink, and grazed continuously.

Buffaloes as a species are also characterised by a strong herd instinct, which is more marked than in the case of cattle. Whatever activity they indulged in, grazing, wallowing or idling they did as a group and close together.

3.1.6 - Water requirements

The affinity that buffaloes show for water indicates a higher requirement. The water requirement can be determined by measuring the daily turnover of water through their bodies. Table 3.3 shows the water turnover for different classes of buffaloes in Sri Lanka. The turnover is also expressed in terms of body weight to compensate for differences in sizes. It can be seen that the turnover, and therefore the requirement, is much greater in buffaloes than in Zebu cattle. It is also evident that pregnancy and lactation increases water needs. Water requirements were also higher in the dry-zone than in the wet-zones.

TABLE 3.3

The daily turnover of body water in adult buffaloes measured in different parts of Sri Lanka. Values for Zebu cattle also given for comparison

Agroecological Zone/season	Physiological status	Water turnover litres/day	Water turnover litres/kg/day
Buffaloes			
1. Intermediate zone under coconut	late-pregnant Lacatating	64 64	164 187
2. Wet-zone in the dry season	not pregnant or lactating	36	140
3. Wet-zone in the intermonsoon	not pregnant or lactating	41	161
4. Dry-zone in the dry season	not pregnant or lactating	41	190
Zebu cattle			
Wet-zone in the dry season	not pregnant or lactating	28	120

(*Source:* S. S. E. Ranawana, et al, 1984, Utilisation of water by buffaloes in adapting to a wet-tropical environment. In **The use of nuclear techniques to improve domestic buffalo production in Asia,** page 171)

It could be estimated from these data that the drinking water required by an adult buffalo given fresh grass would range from 15—35 l/day. The corresponding values for animals on dry forages (rice straw) would be 45—65 l/day.

3.1.7 - Environmental physiology

Ruminants in the tropics are faced with the problem of losing heat in order to maintain their body temperature. Tropical cattle lose heat mainly by evaporation of water either in the skin (sweating) or in the respiratory tract (panting). Both sweating and respiration rates increase in response to a heat load. Although buffaloes lose water through the skin, they seem unable to control this loss in a manner that makes it efficient or effective. The rise in rate of respiration with heat load indicates that panting is an important aspect of temperature control. The heat load experienced by buffaloes grazzing in the sun would be far greater than in cattle due to their black, hairless skin surface.

Figure 1: WALLOWING: Wallowing is a major route of heat loss in buffaloes. Aliable body temperature enables them to 'store' body heat which is dissipated during a short immersion in water. (Section 3.1.7)

Buffaloes, however, have developed an additional method of losing heat, namely, wallowing. A labile body temperature allows them to store heat which can then be dissipated by a short immersion in water. The heat loss has been estimated under dry-zone conditions by measuring the total body water in the animal and the reduction in rectal temperature during wallowing. It was found that the rectal temperature falls by upto 2°C during a 15 minute immersion and it was estimated that an adult buffalo could lose about 200 k cal of heat in the wallow. Over a whole day, in the dry-zone, upto 40% of the basal heat production could be lost in this manner, showing that wallowing is a major route of heat loss in buffaloes.

Wallowing as a means of losing heat has certian advantages particularly under conditions of high humidity. Sweating and panting, evaporating methods, are less efficient under humid conditions since the air already contains water. These methods, particularly panting, needs energy unlike for wallowing. Wallowing, however, needs a ready supply of water. This together with the high rate of water turnover makes buffaloes more dependant on water than other domestic ruminants. If adequate water is available, however, buffaloes are well adapted to withstand hot and humid conditions.

3.1.8 - Lactation

The indigenous buffalo cow has a low milk yield and a short lactation length (6 months) when compared to dairy buffalo breeds such as Murrah, Surti and Nili-Ravi. Earlier estimates of milk yield in the indigenous buffalo have ranged form 2—3 l/d. These estimates however, did not take into account the milk drunk by the calf. More recent estimates in suckled cows have given an average value of 3.5 l/d with a range of 3—5 l/d, for cows in early lactation. There is no doubt however, that the yield is low. Calculations based on growth of calves indicate that intakes of 1.5—2 l/d is sufficient for the calf. It seems 1—1.5 l/d may be taken from a local buffalo cow without affecting the calf.

TABLE 3.4

Composition of indigenous buffalo milk

Total solids	—	166	±	29 g/l
Fat	—	73	±	24 g/l
Protein	—	41	±	9 g/l
Lactose	—	42	±	4 g/l
Phosphorus	—	825	±	158 mg/l
Sodium	—	534	±	137 mg/l
Potassium	—	713	±	108 mg/l
Specific gravity	—	1.0238	±	0.003

(*Source:* A. Horadagoda, et al, 1987 Proceedings of the Annual Sessions of the Sri Lanka Veterinary Association, 1987)

Analysis of local buffalo milk has revealed that its composition is similar to that reported for dairy buffaloes. Average values based on a preliminary analysis are given in Table 3.4. It can be seen that the fat content and total solids are high. Protein is also higher than in cows milk.

3.2 — Nutrition

3.2.1 - Digestive physiology

Buffaloes, similar to other animals, require energy, proteins, vitamins and inorganic mineral elements as nutrients. Being ruminants like cattle, sheep & goats, buffaloes have the ability to digest cellulosic material such as grasses, straws and tree fodders and obtain the necessary nutrients from them. This ability is due to the presence of a greatly enlarged fore-stomach, called the rumen, in which they play host to a specialised group of anaerobic and thermophilic bacteria, protozoa and fungi. These organisms are able to break down the complex structural carbohydrates-cellulose, hemi-cellulose and pectin — present in the cell walls of plants and constitute plant fiber. The end-products of this fermentation, mainly short-chain fatty acids such as acetate and propionate, are absorbed and used by the ruminant to meet its energy needs. During the course of rumen fermentation, the micro-organisms grow and multiply and in this process, synthesise their own proteins. Moreover, they are able to synthesise amino acids and proteins from ammonia. Urea, normally an excretory product, diffuses across the rumen wall, is hydrolysed to ammonia and incorporated into microbial proteins. The protein of micro-organisms can be digested in the ruminant intestines when the microbes die and get washed down.

During fermentation, vitamins of the B group and vitamin K are synthesised. These become available to the host animal as the microbes pass into the intestine. Ruminants are therefore, independant of a dietary supply of vitamins other than vitamins A and E. These latter vitamins are normally present in green forages.

The ruminant system is thus able to provide the host with energy, proteins and most vitamins even when they are fed with poor quality roughages. The mineral requirements of ruminants must also be met form the forages eaten. Since the mineral composition of forages often does not match the animal needs, one or more minerals may be inadequate even when forage is abundant. Young, growing animals and lactating cows, because of their greater need for minerals, are particularly susceptible to inadequacies.

The ability to digest and utilise roughages, particularly the poorer quality ones, is developed to a greater extent in some ruminants. If the ability is low, animals need to be more selective and are classed as browsers. Those with a greater ability are known as grazing ruminants. Of the domestic ruminants in Sri Lanka, buffaloes appear to have the best developed ability to digest poor quality roughages. This ability is thought to be related to a larger and stronger rumen and to a slower rate of passage. Buffaloes can therefore, eat more, mix it better, keep it for longer and thus digest these materials more efficiently.

Although no direct measurements have been made on the indigenous buffalo, there is no doubt that it has similar characteristics and explains how they can thrive by grazing poor quality forage without any supplementation.

3.2.1 - Nutrition of indigenous buffaloes

Recent studies, which surveyed feeding practices on small buffalo farms, found that the animals are generally grazed either tethered or free. The forage was usually of the unimproved or natural variety. Apart form some cut grass and/or tree leaves in some areas and straw in others, no supplements were fed. There is little information available on the varieties of natural forages eaten, the intake or the nutritive value of these roughage.

The supply of nutrients to a ruminant from forages is judged by the nutrient content, availability and the intake. The content and availability of energy and protein are expressed as digestible energy (DE as Mcal/kg dry matter) and digestible crude protein (DCP as g/kg dry matters) respectively. The content of vitamins and minerals are expressed as units, mg or g per kg dry matter. Values for some Sri Lankan forages are shown in Table 3.5

TABLE 3.5

The nutritive value of some common Sri Lanka forages

	Digestible energy (Mcal/kg Dm)	Digestible Crude Protein (g/kg Dm)	Ca (g/kg Dm)	P (g/kg Dm)
Grasses				
Guinea A (young) (Panicum Maximum)	2.35	50	3.5	2.0
Guinea A (mature)	2.10	35	3.5	1.6
Carpet Grass *(Axonopus sp)*	2.60	90	4.0	1.2
Balathana *(Eleusine indica)*	2.40	100	8.5	1.4
Atora *(Panicum repens)*	2.30	50	2.2	2.0
Tree leaves				
Glyricidia maculata	2.50	170	17	1.9
Jak *(Artocarpus sp)*	2.30	105	12	1.7
Rice straw	1.50	10	3	0.3

(*Source:* S. S. E. Ranawana — misscellaneous sources)

It can be seen that some of the natural grasses such as carpet grass are quite satisfactory in their nutritive value. Guinea A is a common tall grass found in most parts of Sri Lanka. It has an average nutritive value when young and is a poor quality material when mature. Tree leaves are higher in protein and calcium than grasses, but the energy values are similar. Rice straw, a very poor feed, is low in all nutrients.

Since information on the types of forage grazed and the intake are not available, it is not possible to comment on the adequacy or otherwise of the nutrient intake under natural grazing conditions.

3.2.2 - Rates of growth

Some studies have been made of the rates of growth of buffaloes under grazing conditions in Sri Lanka. These indicate the adequacy of nutrition in these animals. In one such study, two-year old buffalo heifers were allowed to graze in a jungle tract at Polonnaruwa, with constant access to water, and body weights were measured over a period of 12 months. The buffaloes wallowed several times during the day and grazed in between. These conditions are similar to those observed among buffaloes in the dry-zone. The buffaloes in this study grew at an overall rate of 0.36 kg/d over the 12 months. Growth was least (0.208 kg/d) during the dry period and highest (0.64 kg/d) following the rains when forage was abundant.

Several other studies in which growth rates were measured have been carried out on large government farms in the dry-zone. In one study, young 16 month old buffaloes were grazed on an improved pasture. Grazing area was restricted to 4½ animals/hectare and animals were wallowed only once a day. Under these conditions, the best growth rate. following rains, was 0.34 kg/d. During the dry season from July to October, there was no growth and animals actually lost weight. In another study. under similar conditions, Lanka buffaloes grew at the rate of 0.39 kg/d over 12 months. In this study, it was also found that buffaloes grew faster than cattle when raised under identical conditions.

From these data, although limited, it could be concluded that indigenous buffaloes, provided they are given sufficient area and time to graze and have access to water for wallowing, are able to derive adequate nutrients from natural forages. During the height of the dry period or if grazing area is limited, the nutrient intake is inadequate. They appear able. however, to compensate during the season when forage is available.

3.2.3 - Intensive systems of feeding.

With the advent of large irrigation and settlement schemes in the dry-zone of the country, the patterns of land use have changed rapidly. No longer are unlimited grazing lands available for buffaloes and cattle. As a consequence of these changes it has become necessary to develop more intensive feeding systems. Such systems will depend heavily on the feeding of agro industrial by-products. The main roughage in these feeding sytems will be rice straw, which will be supplemented with tree fodders, legume straws and a limited quantity of grass. Several studies carried out in the recent past on feeding of rice straw to buffaloes have provided some of the initial information needed to develop such systems.

3.2.4 - Rice straw

Rice straw, although abundantly available, is a very poor quality feed. It has a poor digestibility (low available energy) and is deficient in protein, vitamins and most minerals. The low digestibility and the consequent poor intake, are due to the extensive lignification of the cell walls which make the cellulose and hemicellulose unavailable to rumen microorganisms.

More than a hundred years ago, it was shown in Europe that treatment of such materials with alkali can increase the digestibility. Alkalies such as NaOH, $Ca(OH)_2$ and NH_3 have been used for this purpose. A method that has been tried out in Sri Lanka is to ensile rice straw after spraying with a solution of urea. The urea is broken down to ammonia which acts on the straw. Unlike with other alkalies, urea has the added advantage that it increases the nitrogen content of the straw.

In a series of studies, it has been shown that ensiling rice straw with urea in this manner for 21 days, dramatically increased both the digestibility and the intake. It was also found that the process can be hastened by incorporating natural sources of the enzyme urease such as Glyricidia leaves. In field trials under large farm conditions, feeding urea-treated straw increased growth rates and milk production in cattle and buffaloes when compared to untreated straw. Although there is little doubt of the efficacy of this treatment methods, they involve a certain amount of capital outlay. For this reason, the methods available are uneconomic under small-farmer conditions in the dry-zone and these methods are feasible only for relatively high rates of production.

Simpler methods such as spraying straw with urea immediately before feeding have also been studied. In one study, it was found that rice straw sprayed with 2% urea and fed free choice together with tree legume leaves, rice bran and a mineral supplement could support low levels of milk production over a short period. Such systems can be recommended immediately, particularly to tide over periods when forage is in short supply.

It is evident that changing patterns of land use in Sri Lanka, will lead inevitably to more intensive systems of feeding buffaloes. These systems will be essentially straw-based and supplemented with tree fodders, rice bran and other such agro-industrial by-products available in the area. Such systems will be feasible only if farmers can obtain an additional income by way of milk (and meat) from their animals, as it will not be worthwhile, on their part, to rear buffaloes intensively and only use them twice a year for paddy field work. Keeping a cross-bred (Lanka × Murrah or Surti) buffalo cow, for instance, can provide a farmer with both milk and work. More sophisticated systems such as feeding urea-treated straw may become feasible under these conditions.

3.2.5 - Vitamin and mineral nutrition

Vitamins: Buffaloes require the same vitamins, at the level of their tissues, as any other mammal. Since all the B complex vitamins and vitamin K are synthesised in the rumen, they are independent of a dietery requirement for these vitamins. A *trace of the* metal cobalt is needed in the diet for the rumen microorganisms to synthesise cyanacobalamin (vitamin B_{12}). Vitamins C and D are synthesised in the body, the latter in the skin by the action of ultraviolet light from solar radiation. Buffaloes are, therefore, dependant on the diet only for the vitamins A and E. These two are present in green forages in apparently adequate quantities. When ruminants are fed over a period of time with dry roughage, such as hay or straw, with no green supplements, deficiencies of these two vitamins may arise.

The vitamin A and E status of buffaloes has not been studied in Sri Lanka. A condition that responds to vitamin E occurs among buffaloes at the height of the dry season in North East Thailand. It is likely that inadequacies of these two vitamins are present, at least seasonally, in Sri Lanka. Yellow maize is a good source of vitamin A whilst rice bran contains significant amounts of vitamin E. Feeding these materials could compensate for deficiencies in the dry season. There is also limited evidence that cobalt concentrations in Sri Lankan forages are low. This could lead to inadequacies of vitamin B_{12} among buffaloes and other ruminants. Further research on the situation with regard to these 3 vitamins is needed.

Minerals: The mineral elements required as nutrients by buffaloes are listed in table 3.6. They are divided into a major and a minor (or trace) groups based on the requirements. Cobalt and nickel are needed for the metabolism of the rumen microorganisms and so, are peculiar to buffaloes and other ruminants. All these minerals must be present in the diet in adequate quantities and in the correct balance. An excess of one mineral can interfere with one or more of others, even though the latter are present in adequate amounts.

TABLE 3.6

The mineral elements that are essential for buffaloes

Major elements	Trace elements
Calcium Magnesium Phosphorus Sodium Potassium Chlorine Sulphur	Copper Zinc Iron Magnesium Molybdenum Cobolt Iodine Selenium Nickel

Grazing buffaloes must depend on the forages they eat to supply their mineral needs. The content of essential minerals in forages however, is known to vary widely and depends on the amounts of the minerals present in soil, and their availability to the plant. The amounts present will in turn vary from area to area depending on the soil type. Availability depends on factors such as the moisture and organic matter concentration in the soil. The mineral content of grasses, particularly Na, P and Cu decline markedly with maturity of the plant. It is clear therefore, that although animals requirements are constant, the mineral supply from herbage can be highly variable. As a result, in grazing ruminants, inadequacies and deficiencies of minerals can occur in some areas of the country.

TABLE 3.7

The average content of mineral elements in some common Sri Lankan roughages (on a dry matter basis)

	Rice straw	Guinea grass	Foxtail grass	Glyricidia leaves	Jak leaves	'Adequate' level
g/kg DM						
Calcium	3.5	5.0	2.6	17.0	12.0	3.5
Magnesium	1.0	3.2	3.1	4.8	1.6	1.0
Phosphorus	0.7	1.9	1.0	1.9	1.7	2.4
Sodium	0.3	1.0	0.6	0.3	0.3	1.6
Potassium	12.0	13.0	12.0	14.0	12.0	4.0
Sulphur	1.0	2.0	1.5	2.5	2.4	2.0
mg/kg DM						
Copper	2	8	3	9	8	10
Zinc	32	30	6	20	16	40
Iron	290	170	225	210	400	50
Manganese	100	200	150	83	250	30

(*Source:* S. S. E. Ranawana, 1986, Mineral supplementation of rice straw-based diets. In Rice straw and related feeds in ruminant rations (Eds. M. N. M. Ibrahim and J. B. Schiere) Straw Utilization Project; Peradeniya, Page 218)

Typical values for the content of minerals in some common Sri Lankan forages are shown in Table 3.7. These values can be compared with those accepted as 'adequate', given in the last column. Glyricidia is a common tree legume while Foxtail and Guinea grass are typical examples of a wild and improved variety respectively. In general, forages are high or even excessive in K, Fe and Mn. Others such as Ca and Mg are often marginal whereas P, Na, Cu and Zn are invariably low. In a survey of 60 Sri Lankan grasses, it was found that 58% were low in P and over 80% had inadequate concentrations of Na, Cu and Zn. Tree leaves and shrubs had very high Ca levels but were similar to grasses with respect to other minerals. In general, shrubs and herbs had a higher mineral content than tree leaves and grasses. Rice straw is deficient in all minerals except K, Fe and Mn; levels of Na and P are particularly low. Among the concentrates that may be fed to buffaloes, rice bran has a very high P content.

Mineral concentrations in forage indicate those that are likely to be inadequate for grazing buffaloes. It is also possible to assess the actual status of animals for the different minerals by analysing blood, other body fluids or tissues. For example, the Cu status can be assessed by measuring Cu concentrations in plasma, liver or hair, and by measruing the enzyme ceruloplasmin in blood.

TABLE 3.8

Average mineral concentration in the blood plasma of 265 indigenous buffaloes

Mineral element	Mean Concentration (mg/l)	Proportion with subnormal values
Calcium	93	9%
Magnesium	26	1%
Phosphorus	56	27%
Copper	0.73	22%
Zinc	0.88	18%
Iron	1.50	1%
Selenium	0.10	8%

(*Source:* S. S. E. Ranawana, 1987, Proceedings of the 4th AAAP Congress, Hamilton, New Zealand, page 184)

Using such methods, the mineral status of indigenous buffaloes on Sri Lankan small farms has been studied. This survey included 265 animals from 33 herds in both the dry and wet zones of Sri Lanka. The results shown in Table 3.8 indicate that a significant proportion had an inadequate status for P, Cu, Zn and selenium. Although not measured here, other studies have shown that Co and Na are also deficient. It can be seen that these inadequacies tally with the mineral concentrations found in forages. In a 12 month, separate study at Polonnaruwa, it was found that season (rainfall) has significant effects on the mineral status,with the period just before and just after the rainy season being most critical. Further evidence for mineral inadequacies have been supplied by supplementation studies. In one such experiment, buffalo calves supplemented with P, Na, Cu, Zn and Co doubled their growth rates.

It is clear from these results that indigenous buffaloes need to be supplemented with minerals, particularly Na, P, Cu, Zn, Co & Se. These minerls can be mixed with the concentrates in the case of intensively—reared animals. Those managed under range conditions will have to be supplemented by using either long acting injectable preparations or the use of mineral blocks. These blocks contain common salt which induce them to lick the blocks. Other minerals are included in a ratio with the salt, so that when an animal obtains its salt requirement, it will also injest others. A mineral/salt block containing cement as a hardener, has been tested with promising results, in Sri Lanka.

CHAPTER 4

REPRODUCTION IN INDIGENOUS BUFFALOES

Much of our current knowledge on reproduction is based on studies conducted in cattle. Most of these findings have proved to be highly relevant to the buffalo. Until the 1980's, there were not many studies on the physiology and endocrinology of the indigenous buffaloes in Sri Lanka.

4.1 — Puberty

Puberty in the bovine female is marked by the appearance of the first 'heat' or 'oestrus period'. The 'heat' period in bovines is defined as the interval during which a female cow can be successfully mated with a bull in order to obtain a calf. Normal signs during this period are (I) restlessness (II) bellowing (III) frequent attempts to urinate (IV) clear, glassy, mucus discharge from vulva (V) attempts to mount other animals in the vicinity and (VI) standing to be mounted by other animals.

These signs although common and well known to farmers in the case of cattle are not so well marked in female buffaloes. Neither the presence of clear mucus nor standing to be mounted by other animals were seen in female buffaloes maintained under experimental conditions. Attraction of the intact male and its attempts to mount are often the only demonstrable sings of 'heat' in this species.

In a majority of the animals, oestrus period was detected during late evenings and early mornings. During these periods the intensity of the heat signs were more marked. Therefore under experimental conditions in which the bull is maintained with the females, the frequency of matings recorded were high during late evenings and early mornings. Although matings have been recorded during other times of the day the number was relatively low. Matings are rare during periods of the day when the ambient temperature is high and when animals were commonly found to wallow.

The age at puberty in the Lankan buffalo is now accepted to be between 26-31 months. This is commonly calculated by obtaining the age at 1st calving and subsequently subtracting the length of gestation from it. In this calculation, we assume that the animal became pregnant on the 1st oestrous period itself. Examination of the records of a buffalo experimental station (at the university), clearly indicated that the indigenous female buffalo, maintained under good nutritional status, attained puberty as early as 24-26 months of age.

The determination of the age at puberty in the male is more difficult since there is no marked physiological event such as the 'heat' period in the female. Puberty in the male has been defined as the age at which the mature spermatazoa first appear in the seminiferous tubules. Assuming this criterion studies conducted on local male buffaloes showed that the first mature spermatazoa appear around 19 months of age. Further studies are required, however to determine the age at which the 1st ejaculation containing 1×10^9 sperms/ml is obtained. Studies carried out so far indicate that the time interval between puberty and sexual maturity in indigenous male buffalo is greater than in cattle.

4.2 — Oestrus in the indigenous buffalo

The oestrus cycle in buffaloes is 17-21 days long. Shorter cycles have also been recorded in buffaloes and these were subsequently confirmed by hormone measurements. Although the duration of 'heat' has not been studied as extensively as cattle it appears to last 12 to 21 hrs after the onset.

Synchronisation of heat is an advantage in an organised breeding programme. Several studies have been carried out using drugs such as prostaglandin (PGF_2) and progesterone releasing devices (PRID) for synchronisation of dairy (river) type buffaloes. However subsequent fertility rates have invariably been poor with fixed time insemination. These studies were carried out in breeds such as Murrah and Surti, and this technique has not been investigated in indigenous animals. If it is found that fixed time insemination is not suitable, the use of a bull following synchronisation could be more successful.

4.3 — Pregnancy and gestation length

Gestation period of the water buffalo is known to be longer than that of cattle; most reports indicate that it is more than 300 days in comparison to 275± 10 days in cattle. There are only two estimates of gestation period in the indigenous buffalo of Sri Lanka. In one, by analysing the records obtained from state farms a gestation period of 301 ± 2 days was computed. This estimate however,was much shorter than a value of 316 ± 10 days obtained in a recent study. The latter estimate agrees closely with reports for river and swamp types from neighbouring countries and seems more reliable.

Figure 2: In most of the animals heat was detected during mornings and evenings using an intact bull.

Figure 3: Bull mounting a buffaloe cow in heat.

4.4 — Detection of pregnancy

Early detection of pregnancy can be made by measuring the hormone progesterone in plasma or in fat-free milk. Elevations above 0.5 ng/ml of progesterone either in the plasma or in fat free milk is considered to be a satisfactory criterion for detecting pregnancy at 21—23 days post-service.

Since the gestation period is longer, the criteria used for diagnosing and particularly for estimating the stage of pregnancy differs from those used in cattle. Studies on indigenous animals clearly indicated that the descent of the pregnant uterus into the abdomen, appearence of fremitus and the final ascent of the foetus prior to parturition occurs much later than in cattle.

4.5 — Development of the mammary gland

Mammary gland development occurs slowly during pregnancy and is only marked during the last four months of the gestation. Swelling or enlargement of the base of the gland, depigmentation and reddening are the common features observed. Secretion of honey like material from the teat is seen from the 8th month of gestation.

4.6 — Parturition

Duration of parturition seems to be much shorter than in cattle and lasts only 6-8 hrs. Dystocias or difficulties at birth are uncommon in indigenous buffalo cows when compared to cattle. Signs of approaching parturition are similar to those shown by cattle. Liquefaction of the mucus plug occurs from the 9th month of gestation. Relaxation of pelvic ligaments is noticeable only 2 to 3 days prior to parturition.

4.7 — Uterine involution

This is the time period taken for the uterus to revert to its original size and consistency after parturition as detected clinically by rectal palpation. Reports indicate that it takes about 28-39 days for the uterus to involute in local buffaloes. It is not known whether regeneration of the endometrium is complete and within this period.

4.8 — Calving interval

The period of time between two successive calvings is known as the calving interval. This period includes an 'open-period' — the interval from calving to conception — and the subsequent gestation. Since the latter is constant it is the time taken to conceive that determines the length of the calving interval.

A long 'open period' is recognised as the major factor in the poor breeding efficiency of indigenous buffaloes. A calving interval of 432 days has been recorded in a herd of local buffaloes raised on a state farm. In field studies done by several workers later indicated much longer calving intervals ranging form 547 to 617 days. It has also been reported that the calving interval of buffaloes that were milked were shorter than those that were not milked on a regular basis.

The factors that are likely to affect the calving to conception time can be intrinsic, environmental or due to management practices. Intrinsic factors are related to the genetic potential of the animal. These factors are difficult to control and often take a long period to improve. Selective breeding or upgrading may be the only methods available for manipulation.

Environmental factors are mainly due to climatic effects and include the photoperiod, rain, humidity and ambient temperature. Since differences in photoperiod (ratio of light: dark) throughout the year under our conditions do not exceed 30 minutes, their effects can be assumed to be minimal. Rainfall may affect reproduction in two ways; it can affect the availability of good pasture (nutrition) or the availability of water for wallowing. Unavailability of water to wallow can cause heat stress to the animal which, in turn, may effect reproduction through endocrine mechanisms or by lowering the feed intake.

The factors therefore which could be manipulated to increase reproductive efficiency fall under the third category (management practices). Preliminary investigations of the effects of restricted suckling on post-partum ovarian activity indicates that this practice is beneficial at least under experimental conditions. The effect of other management practices such as the frequency of milking, length of the suckling period and the effects of work (draught) on post-partum conception need to be investigated.

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CHAPTER 5

PRODUCTION OF MILK AND MEAT FROM BUFFALOES IN SRI LANKA

The national buffalo population is made up of about 95% indigenous or swamp buffaloes and the other 5% of imported Indian 'river' type breeds and their crosses. The majority of imported animals belong to the Murrah and Surti breeds. These animals are located mainly in large government and private sector farms (see Table 2.2).

Field surveys have shown that more than 90% of buffalo owners use their animals for preparation of land in connection with paddy cultivation. The main emphasis on the utility value of the local buffalo seems to be therefore on its draught ability; other uses such as milk, meat and manure play a lesser role. The surveys also showed that only about 40% of buffalo farmers milked their cows. Of these only 14% milked their cows throughout the year while the other 26% milked them for shorter periods, generally 2 to 3 months after calving.

In Trincomalee, Batticaloa, Polonnaruwa, Hambantota, Amparai, Matara and Kalutara districts, 60 to 100% of buffalo farmers milked their cows. The reason for these high rates appear to be traditional demand for curd in these areas and the streamlined systems of milk collection and marketing. In contrast, in districts such as Gampaha and Kegalle farmers often did not milk their cows at all.

Over 50% of the farmers who milked their animals, prepared curd. Manufacture of curd involved additional work but the returns are much higher than earnings by selling liquid milk. The conversion of milk to curd also had the advantage of enabling the handling of a perishable commodity like milk and in overcoming the difficulties of transport.

Indeed, if not for the conversion to curd and the relative ease of transport to existing markets, the proportion of buffaloes exploited for milk would be less than at present. Consumer preference of milk by-products such as curd should be borne in mind in planning for the future exploitation of the buffalo as a milk animal.

The reason given by the farmers when questioned as to why they were not miling their cows were, (a) insufficient milk in the dam for the alf, (b) it will interfere with their cultivation programme, (c) fears about cows losing condition.

5.1 — The genetic potential of the local buffalo for milk production.

Records show that the indigenous buffalo in Sri Lanka has been kept mainly to help in rice cultivation work from the early period of its domestication. This breed therefore, has not undergone any selective breeding for milk production over the years. Studies with the indigenous buffalo carried out in a government farm under superior management and better levels of nutrition have shown the average milk yield to be 381 litres over a lactation length of 250 days (Table 5.1). This level of production could not be improved further with improved management and feeding. It is evident therefore, that the low milk yield of the local buffalo is due to a low genetic potential.

TABLE 5.1

Milk yield and lactation length in the different breeds and crosses

Breed Group	1st Location		All lacations		
	Number of observations	Milk yield (litres)	Number of observa-tions	Milk yield (litr-es)	Lactation length (days)
Lanka (L)	49	353	148	381	250
Murrah (M)	112	1427	724	1454	332
M X L (F_1) (50% Murrah)	68	829	546	999	283
M X F_1 (B_1) (75% Murrah)	48	1096	262	1103	318

(*Source:* N. Tilakaratne and E. F.A. Jalatge, 1983, Lactation and reproduction performance of river and swamp-type crossbred buffaloes, Proceedings of the 5th World Conference on Animal Production, Tokyo, Japan.)

Due to its low production indigenous buffaloes are usually milked only once a day. The calves are separated from their mothers late in the evening and in the morning they are suckled to initiate the let down of milk. They are then hand milked leaving a fair amount of milk to the calf. Some farmers are in the habit of leaving one entire quarter for the calf.

5.2 — Meat production from the indigenous buffalo

In countries where buffaloes are bred for meat they are considered to be a good meat animal. In Sri Lanka however, due to the importance of the local buffalo as a source of power in paddy cultivation, successive governments brought in laws to restrict the slaughter of buffaloes. Until recently only buffaloes over twelve years of age and those that were unfit for the plough were allowed to be slaughtered.

At present the slaughter of buffaloes is completely prohibited by law as a measure to prevent the dwindling of the herd. In addition, there are regulations to restrict the transport of buffaloes from one administrative district to another. Despite these stringent measures illicit transport and slaughter of buffaloes takes place to meet the growing demand for meat in urban areas.

Colombo municipal slaughter house authorities estimate the number of illicitly slaughtered buffaloes, during the years 1963—1967 to be 409500. This is about 6½ times the recorded slaughter figures of 63500 for the same period. The same sources gives the average adult weight buffalo to be 650 — 700 lbs (295.4—318.1 kg) and the carcase weight to be 300 lbs (136.3 kg).

One drawback of the existing laws is that buffalo farmers are unable to get a reasonable price for the aged animals or for those that are unfit for work or milk. Genuine buffalo breeders are prevented by these regulations from fattening animals for meat.

Due to this policy of not slaughtering buffloes, little research work has been done to assess the meat potential of local buffaloes.

In a study comparing two breeds of buffaloes (Murrah and Local) and three breeds of cattle (Friesian, Red Sindhi and Sinhala) in the dry zone of Sri Lanka, the growth rate from 8th to 22nd months of age was found to be higher in buffaloes. It was also found that the local buffalo and Sinhala cattle gave a higher dressing percentage and a higher muscle to bone ratio than the Murrah or the other breeds of cattle.

TABLE 5.2

Mature weight and average chest girth in female buffaloes of different breeds (n = 246)

Breed	Approximate age (years)	Average mature weight (kg)	Average chest girth (cm)
Murrah	5 to 6	433	130
Surti	5 to 6	405	122
Local	5 to 6	314	119

(*Source:* Katada, Ozawa, Buvanendran and Gurusinghe, 1977, Changes in the composition of body size with age in buffaloes, Unpublished report, Animal Breeding Division, VRI)

In a spearate study involving three breeds of buffalo Murrah, Surti and local — it was found that maturity was reached in 5 to 6 years. The adult weights for Murrah, Surti and local were 433, 405 and 314 kg respectively (Table 5.2).

Experiments in other South East Asian countries show indigenous buffaloes to be better converters of poor quality forages than neat cattle. Even with poor grazing and sub-optimal conditions,buffaloes are able to reach 300 to 350 kg live weight in 12 to 18 months. In an experiment where buffaloes and two other breeds of cattle were grazed on poor and moderate quality pastures the daily weight gain recorded by buffaloes was far in excess to that shown by neat cattle (Table 5.3)

TABLE 5.3

Comparative weight gain of cattle and buffaloes on poor-quality pastures and average-quality pastures

(g/day)

Class of animal	Weight gain on poor pastures	Weight gain on average pastures
Jamaica Red cattle	0	477
Buffaloes	213	617
Brahaman cattle	0	295

* Animals were kept on poor pastures for 10 weeks and on average pastures for another 10 weeks

(*Source:* Shute, 1966 as cited by Cockrill, 1974)

The buffalo, therefore, is a good source of meat and the cost of production is less than that for meat of neat cattle. This fact is being exploited in countries such as Malaysia and Pakistan where fattering of buffaloes for meat is a common practice.

5.3 — Improving the productivity of the local buffalo

Due to their low productivity, it is not an economic proposition to maintain a herd of local buffaloes purely as a dairy enterprise. Moreover, the absence of a meat market for the uneconomical animals create problems for scientific dairying. One way of improving the genetic potential for milk in the local buffalo is by breeding it to more productive breeds. Indian breeds of buffalo are superior to the local buffalo in respect of milk yield and body weight. They are also used in India for draught purposes.

These breeds of buffalo have been developed in different parts of India primarily for milk production, and today they are reputed milk breeds. The place of origin of each breed is shown below.

State	*Buffalo breed*
Punjab	Murrah, Nili-Ravi
Gujarat	Surti, Jafferbadi
Uttar Pradesh	Bhadavari
South India	Toda
Central India	Nagpuri-Manda

The average milk production of the different breeds of buffaloes are shown in Table 5.4.

Murrah and Surti are the two Indian breeds that have been used widely in other countries for the purpose of upgrading their indigenous buffaloes. In Sri Lanka the Murrah buffalo has been used in the upgrading of local buffaloes for 30 to 40 years. The Surti breed has also been introduced to Sri Lanka recently and is being used for the same purpose. Some of the state farms carry herds of Murrah and Surti buffaleos. Excess stock from these farms are being issued to farmers.

TABLE 5.4

Reproductive parameters and milk yield of buffalo breeds

Breed	Average age at first calving (months)	Average calving interval (days)	Average milk production (kg/lactation)	Average lactation length (days)
Bhadwari	50.7	453.6	1,110.0	276.0
Marathwada	55.2	429.9	960.0	270.0
Murrah	41.3	495.1	1,744.0	279.0
Murrah	42.4	479.5	1,597.3	295.9
Nili	53.2	461.6	1,855.2	316.0
Surti	44.5	461.1	1,722.0	350.1
Non - descript	49.5	481.0	541.0	272.3

(*Source:* Animal Genetic Resources in India, NDRI 1981, as cited by Lensch, 1987)

Problems and prospects of cattle and buffalo husbandary, in India with special reference to the concept of the sacred cow. Hamburg.

The Murrah, heavier of the two breeds, is known to increase the milk potential (Table 1) and give a higher adult weight in their crossbred progeny. Crossbred Surti buffalo cows (Surti × local) give a milk yield comparable to the Murrah cross (Murrah × local) and has the advantage of being more acceptable to farmers for ploughing and puddling work in paddy fields because of its smaller size and easy manoeverability.

5.4 — Future prospects for the indigenous buffalo as a milk and meat producer.

At present, the main deman for buffaloes is for draught. There is little doubt however, that the future of the indigenous buffalo in Sri Lanka will depend on a successful transition from a purely draught animal towards a dual-purpose (milk & draught) or even a triple purpose (meat, milk & draught) animal.

In the new settlement schemes under the Mahaweli Development programmes, use of land is much more intensive than in the past. Due to a resulting scarcity of grazing land, farmers find that they can keep fewer animals and that these animals need to be reared more intensively. The farmer, therefore, has to devote more time (and money) on a fewer number of animals.

Other factors prevailing in these areas could reduce the use of buffaloes for draught. Water is usually released over a short period of time and the farmer has to complete land preparation quickly. He may therefore, be compelled to use tractors which are considerably quicker than animals. Shortages of labour will also lead to increased mechanisation. Although the increased use of tractors and a concurrant reduction in the acreage tilled by buffaloes is undesireable — due to expenditure on tractors, fuel and spare parts — this situation may be inevitable given the changing patterns of land use and the need to optimise production.

It is also not practical for a farmer to rear buffaloes intensively and use them for only 2-3 months of the year. Keeping buffaloes then becomes feasible only if he is able to obtain a return by way of milk production. Selling of milk or curd can also give the farmer a steady income throughout the year, in contrast to his earnings from crops which are usually seasonal.

Large herds of buffaloes can still be seen in many parts of Kurunegala, Matale, Anuradhapura and Hambantota districts. It is evident however, that buffaloes will have to be adapted to more intensive forms of land use. In order to provide milk in addition to draught, they will need to be upgraded to dairy buffalo breeds such as Murrah, Surti and Nili-Ravi.

5.5 — Upgrading of the indigenous buffalo

The ultimate aim of upgrading is to improve the productivity of local buffaloes by crossbreeding with breeds such as Murrah and Surti. The first cross of a local female to a Murrah bull termed F_1 will have 50% Murrah blood and 50% indigenous blood. When the F_1 is mated back to a Murrah bull the resulting progeny has 75% Murrah blood and 25% indigenous blood. By repeated mating to Murrah bulls, the local animal can be upgraded to the level of the Murrah in a few generations.

Murrah and Surti breeds appear to be well adapted to conditions found in Sri Lanka. When local buffaloes are crossed to these two breeds the crossbreds carrying varying levels of Murrah and Surti blood, appear in no way inferior to local animals in their draught ability. Milk production of the crossess is increased (see Table 5.1).

At present a buffalo crossbreeding programme is being carried out in parts of the Kurunegala District. In this programme, buffalo bulls, mainly of the Murrah breed, have been given on loan to farmers to be mated to the breedable females in their herds. Local bulls and bull calves are castrated to prevent them breeding. The scheme started in 1984, has today a promising population of crossbred calves accustomed to local conditions. This scheme can be implemented in other areas as well. Where dairy co-operatives have been established and farmers derive the benefit of a higher income from buffalo milk (due to the higher fat content when compared to cows milk), there is a growing interest to upgrade their local buffaloes using Murrah or Surti bulls.

The programme to upgrade the indigenous buffalo should include the development of improved feeding and disease control systems. The use of treated straw (see chapter III) together with the fodders such as Ipil Ipil, Glyricidea and Erythrine should be encouraged. Prevention of avoidable deaths, particularly in young stock, by regular worming and vaccination should be practiced.

CHAPTER 6

PARASITIC DISEASES OF BUFFALOES

Domestic animals are afflicted by a large number of parasites, both internal and external. The internal parasites include unicellular (protozoan) organisms such as coccidia and trypanosomes as well as multicellular helminths that can inhabit several parts of the body. External parasites include flies, ticks, mites and lice. Some of these parasites complete their entire life cycle on the animal (permanent), while only some stages of others (temporary) parasite animals.

In general, buffaloes are less affected by parasites than cattle. Neverthless, they can cause considerable harm and the need to control them is accepted. Buffaloes, like cattle and other domestic animals are affected by both internal and external parasites.

6.1 — Diseases caused by protozoa

6.1.1 — Coccidiosis

This protozoal disease is known to affect many species of animals. Coccidia belong to the family Eimeridae and most species inhabit the intestinal tract of animals. The stage of the organism that is expelled in faeces of affected animals is called the oocyst. It is not visible to the naked eye and when examined under a microscope measures about 5 - 10 u by 1.5 u in size. The shapes of coccidial oocysts (spherical, sub-spherical, ovoid or ellipsoidal) and sizes vary according to species.

Recent studies have revealed that coccidia belonging to nine species occur among buffaloes in Sri Lanka. These are, *Eimeria subspherica, E. ellipsoidalis, E. zuernii, E. cylindrica, E. bovis, E. bareillyi, E. canadensis, E. auburnensis* and *E. ankarensis*. Buffalo calves become infected very early in life, and heavy infections producing severe diarrhoea could result in dehydration and even death. Most natural infections are due to several species. Some coccidial species are highly pathogenic while others are not. The disease can be severe in calves up to about two months of age and death usually ensues in untreated calves.

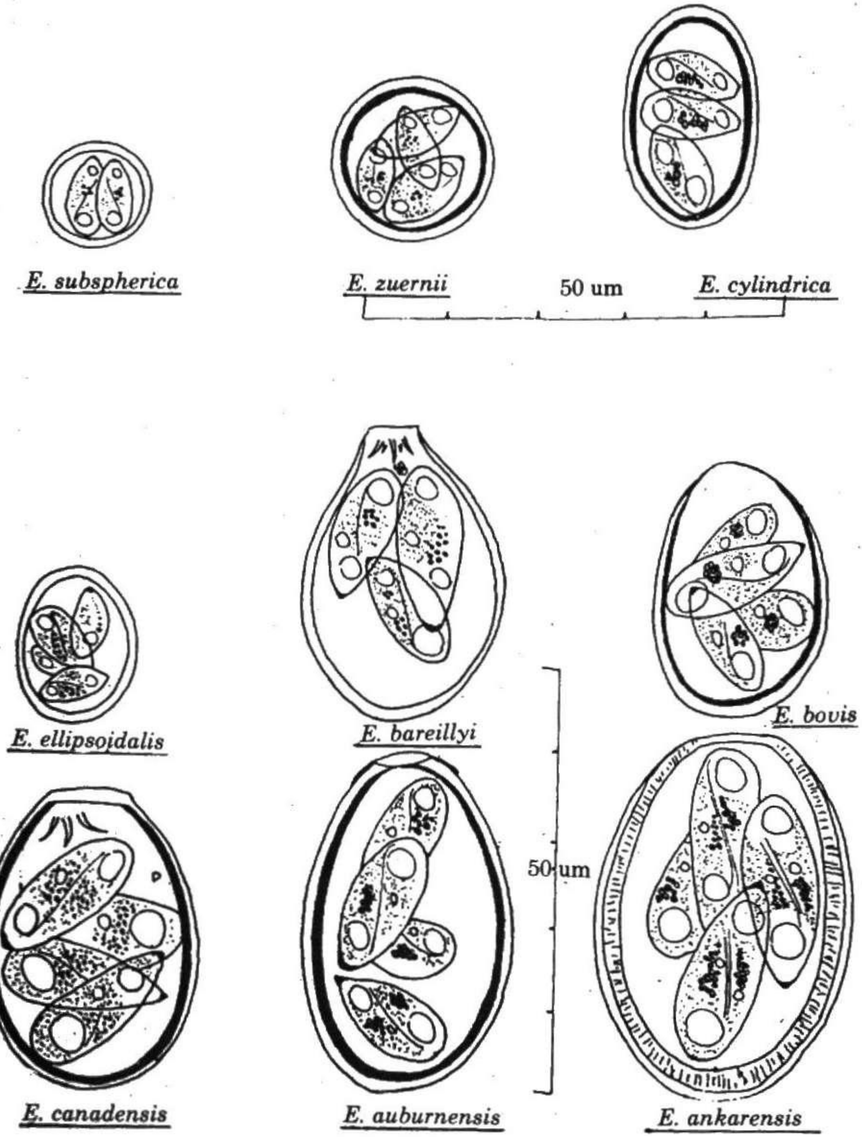
Life cycle:

The single celled oocyst that passes out in the faeces of infected animals develops under suitable conditions by a process called sporogony into the infective stage. The calves become infected by eating or drinking contaminated material containing this stage. In the intestines the oocyst wall breaks liberating sporozoites which enter the cells of the intestine and begin development. Each sporozoite develops into a schizont which by a process of asexual multiple fission produce merozoites. These merozoites later become male and female gametocytes and undergo sexual reproduction to produce oocysts which finally pass out in the faeces.

Diagnosis:

Affected calves develop diarrhoea and some may show elevation of temperature. Depending on the species of coccidia, the diarrhoea may be greenish in colour or blood-tinged. The disease can be confirmed by examination of faecal material which would reveal coccidial oocysts (Fig. 6.1).

Figure 6.1 — This Figure shows sporulated oocysts of coccidia (Eimeria sp.) in buffaloes. Since each oocyst has different characteristics, it is possible to identify the species of coccidia infecting animals by examining the faeces under a microscope. Of these species, E. bareillyi can be highly pathogenic to calves less than 2 months old, causing severe diarrhoea and even death.



Control:

Buffalo calves should be reared preferably in individual pens up to about 2 months of age. If however, calves are to be rared together due to lack of space, young calves should be separated from older calves. The pens should be cleaned daily and strict hygienic conditions maintained to prevent reinfection.

6.1.2 — Theileriosis

Theileriosis is a disease that affects cattle, buffaloes, sheep, goats and wild ruminants. It is caused by protozoan parasites belonging to the genus Theileria that infect the lymphocytes, erythorocytes and histiocytes of mammals.

Six species of Theileria namely *T. parva, T. lawrencei, T. annulata, T. mutans, T. sergenti* and *T. orientalis,* have been recognised in cattle and buffaloes. *T. parva* and *T. lawrencei* are found only in Africa. *T. parva* causes a fatal disease called East Coast Fever. *T. lawrencei,* though not very pathogenic to the buffalo, could cause mortality in cattle when transmitted to them from buffaloes. *T. annulata* is an important parasite in India causing serious illness among European breeds of cattle. It also affects the Indian Water buffalo (Bubalus bubalis)In Sri Lanka.*T. annulata* has been detected among cattle and buffaloes,and in one instance has been incriminated as the cause of mortality among Murrah buffaloes.

Apart from *T. annulata* another species, tentatively identified as *T. mutans,* has been detected in Sri Lanka. This organism appears closely related to *T. orientalis* or *T. buffeli* reported from Australia. Infection of buffaloes both local and imported with this parasite is common in Sri Lanka. In the dry-zone, 50—100% of both young and adults have been found to carry this infection.

Transmission:

The disease is transmitted by ticks and by contaminated syringe needles. Ticks of the genera *Rhipicephalus, Hyalomma, Amblyomma* and *Haemaphysalis* are known to transmit Theilerial parasites. In Sri Lanka *Haemaphysalis bispinosa* has been shown to be the transmitter of *Theileria sp.* Transmission is by stage to stage and the disease is not transmitted from one generation of ticks to another through eggs.

Life cycle:

The life cycles of different Theileria species in the tick are probably similar. When a larve or nymph feeds on a Theileria infected animal inges ts the parasites along with the blood meal. When the engorged tick drops to the ground these parasites multiply in the intestines of the ticks by sexual reproduction and finally make their way into the salivary glands. In the newly moulted nymph or adult, as the case may be, the parasite multiplies asexually to produce sporozoites. The sporozoites enter the next host when the newly moulted tick begins to feed. In the host animal, Theileria sporozoites develop in the lymphocytes initially to produce schizonts. These schizonts produce merozoites which then enter the red blood cells.

Infected animals develop high fever and become anorectic. They may also be listless with diarrhoea and swollen lymph nodes. As the disease progress, the animals become anaemic and some develop red-coloured urine.

Diagnosis and control:

Theileriosis can be easily diagnosed by examination of stained blood smears in the laboratory. The disease is prevented mostly by controlling the transmitting ticks. Vaccines against *T. parva* and *T. annulata* are available in some countries but have not proved to be very effective.

6.2 — Helminth parasites of buffaloes

Information on the helminth parasites infecting buffaleos is not extensive. Nevertheless, from the available literature it is evident that some helminths are important pathogens in buffaloes particularly in the Middle and Far East. The important helminth species belonging to the common classes, Trematoda, Cestoda and Nematoda the sites in the body where they occur and their pathogenicity are summarized in Table 6.1. Under these classes the common genera and the species which are important are listed.

TABLE 6.1

Common helminth parasites of buffaloes

	Site	Pathogenicity
Trematodes :		
1. *Fasciola hepatica*)	Bile ducts	(Cause liver rot and responsible for considerable (mortality in Malaysia & Thailand
2. *Fasciola gigantica*)		
3. *Gigantocotyle explanatum*)		(Has a wide distribution in India and Sri Lanka. (Infection detected mostly after slaughter, Responsible (for considerable economic loss.
Cestodes : *Moniezia species*	Small intestine	Pathogenicity is not known but heavy infection can be responsible partly for poor growth.
Nematodes :		
1. *Strongyloides species*	Small intestine	
2. *Toxocara vitulorum*		Effect on the host is not well documented. But we have noted intermittent diarrhoea when the infection is heavy as shown bylarge numbers of eggs per gramme of faeces. Eggs are found in faeces as early as six days after birth. Severe diarrhoea is seen.
3. *Mecistocirrus digitatus*)	Abomasum	Effects on the host not well known but may cause gastritis
4. *Haemonchus similis*)		
5. *Haemonchus* sp.)		
6. *Cooperia mc masteri*	Small intestine	Effects on the host not well known but may cause enteritis
7. *Cooperia* sp.		

6.2.1 — Trematoda (Flukes)

Liver flukes: *Fasciola hepatica* and *Fasciola gigantica* commonly occur in the bile duct of buffaloes in Thailand, Malaysia and some parts of India. Upto now *Fasciola* species have not been recorded in cattle, buffaloes or goats in Sri Lanka. The writer had met with three cases of *F. gigantica* in goats in the slaughter house, Kandy but all these animals had been imported from India. It appears that *Fasciola* species have not established in ruminants (cattle, goats and buffaloes) in Sri Lanka. It is not known if the appropriate vector *Limnoea acuminata*,a tropical mud snail which is common in South India occurs in this country.

Gigantocotyle explanatum is a very important conical fluke (paramphistomatid) which occurs in the bile ducts of buffaloes in the Dry-Zone of Sri Lanka. The infestation is rare in cattle, goats and sheep. The infestation does not appear to be fatal and little or no data is available on the clinical manifestation of this infestation in the hosts. However, the infestation affects the liver and makes it unfit for human consumption. On *post mortem* examination the infected liver will show cirrhosis, hardening of the parenchyma and thickening of the bile ducts. The condition is easily diagnosed on *post mortem examination* but the diagnosis of the infection from faecal examination for eggs of *Gigantocotyle explanatum* is difficult as the presence of eggs of other species of conical flukes which occur in the rumen and reticulam of buffaloes will make differential diagnosis difficult.

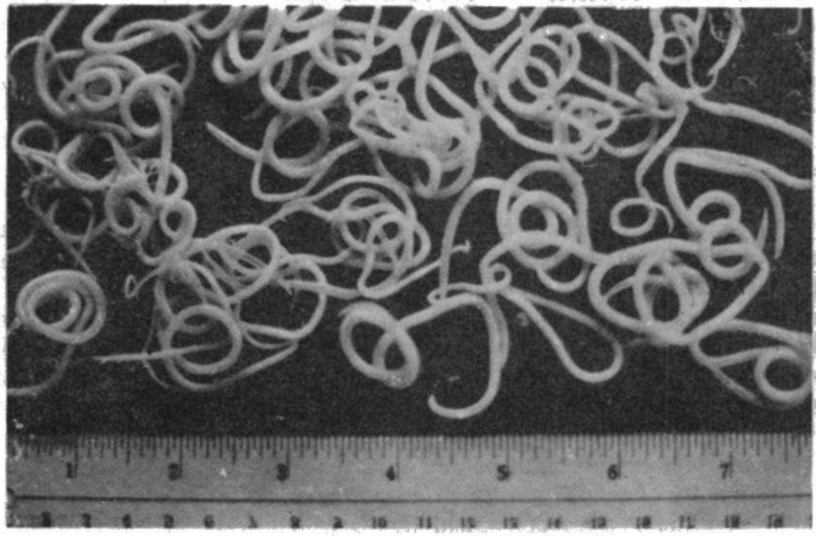
Other conical flukes: Several species of conical flukes (paramphistomatids) are always seen in the rumen and reticulam on *post mortem*. These are blood red in colour when fresh and conical in shape. On fixation the flukes turn white. The effect of the mature flukes on the host is not known, but the immature stages, in the course of their migration through the mucosa, can cause severe diarrhoea and even death. This condition is commonly known as immature paramphistomiasis. Clinical paramphistomiasis is often precipated by overwork and stress. Thickening and haemmorhages of the intestinal mucosa along with the presence of immature flukes embedded in the mucosal tissue are of diagnostic importance in this disease.

Some of the common species of conical flukes which occur in the rumen and reticulam of buffaloes and cattle are listed below.

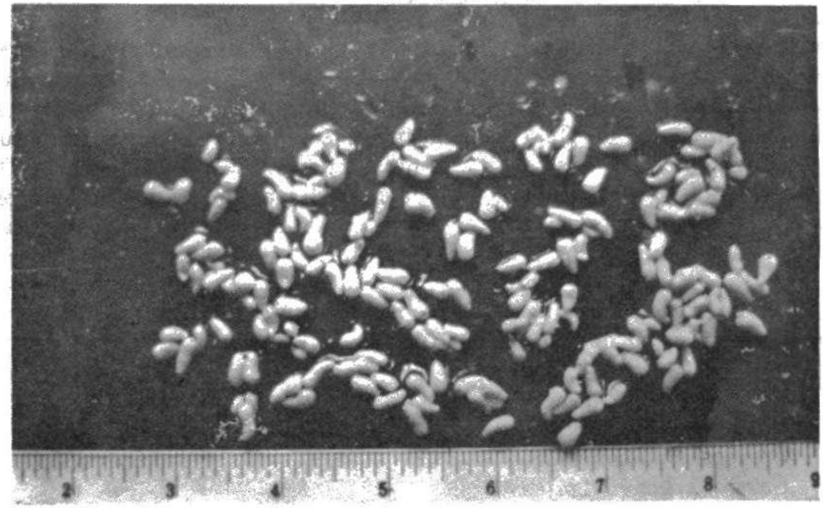
Paramphistomum cervi
Gastrothylax cruminifer
Gastrothylax cobboldi
Gastrothylax elongatus
Galicophoron species
Coylonocotyle streptocoeluim
and other species.

The macroscopic appeareance of the conical flukes after preservation in hot formal saline is shown in Figure 6.2

Figure 6.2 — Helminths from buffaloes. This Figure shows examples of a roundworm and a fluke found in Sri Lanka buffaloes



Toxocara vitulorum (round worms of buffalo calves) recovered at a *post-mortem* examination of a buffalo calf that died at 28 days of birth.



Paramphistome (conical flukes) from the rumen of a buffalo.

Schistosoma nasalis is a blood fluke responsible for nasal granuloma in cattle, buffalo, horse and other species. These flukes are slender 5-11 mm long and about 0.5 mm wide. In cattle they cause coryza and snoring but buffaloes often harbour the infection without clinical signs. Thus buffaloes may act as carriers of the infection. The flukes infest the veins of the nasal mucosa of the host. Presence of granulomatous lesions and abscesses in the mucosa are diagnostic. Microscopic examination of the nasal discharge may reveal typical boomerang shaped eggs.

The incidence of this infection in buffaloes in Sri Lanka is not known. The writer has seen *S. nasalis* eggs beign shed with the nasal discharge by four buffaloes in Kandy without any concomitant clinical signs.

Life-cycle of the trematodes:

In general, the conical and blood flukes are transmitted by different species of aquatic snails. Thus ponds and tanks with the infected snails can pose a serious danger to buffaloes, cattle and goats. Transmission of *Fasciola* species (the flat worm) occurs through the mud snail and thus flooding of pastures accelerate the emergence of cercaria from the snails. The cercaria are the preinfective stages of this trematode. The cercaria in turn encyst on vegetation and form the metacercaria, the infective stage. The metacercaria are highly resistant to dessication and remain infective for several months even after the flood subsides. Likewise, the cercaria of conical flukes encyst on the vegetation in the ponds and streams in a very short time after emergence from the snail. For example the cercaria of *Gigantocotyle explanatum* encyst in two hours after emergence. Animals become infected when they injest the cysts.

The cercaria of *Schistosoma nasale,* however, do not encyst but swim about in the water and enter the body of the host either through the skin or through the mouth. The cercaria can also enter the skin of man but do not migrate extensively through the body, as they do in the natural host, nor reach the adult stage. The migrating larval stages of *Schistosoma cercaria* can cause a type of itch in man commonly called bathers' itch.

6.2.2 — Nemotodes (round worm)

Nematode infections in buffaloes, with particular reference to the species and their prevalence in animals of different age groups are not fully documented in the literature. Among the helminths which parasitize buffaloes *Toxocara vitulorum* has been studied extensively by parasitologists and veterinary clinicians. The other common helminths which occur in buffaloes are *Strongyloides* species, *Mecistocirrus digitatus, Cooperia Mcmasteri, Haemonchus* species and the other Trichostrongyloid species.

Strongyloides species:

This is a very common species which infects buffaloes of all ages. A mature *Strongyloides* infection may occur from about the seventh day of birth. At this time, on microscopic examination, varying numbers of eggs of *Strongyloides* can be seen in the faeces. Thus the prepatent period of *Strongyloides* in buffaloes is about seven days. The eggs are small and about 50 microns long and 15 microns wide. They are embryonated when passed in the faeces.

The life-cycle is direct in that embroyonated eggs are passed with the faeces and these eggs hatch within a few hours. Some of the larvae hatched from the eggs develop directly to the infective stage while others develop into free living males and females which in turn produce eggs capable of developing into the infective stage. The infective larva enter the host either through the skin or through the mouth. The larvae migrate to the lungs, bronchioles, bronchi trachea and pharynx and are thereafter coughed up and swallowed by the host. The larvae thus reach the intestines and mature in about 14 days after infection. Some of the larvae are passed in the milk in their third-stage of development, and are responsible for the lactogenic infection in calves. In Sri Lankan buffalo calves the infection acquired through the milk-reaches maturity and patency in about seven days of birth. This early patency indicates the occurrence of a prenatal of a perinatal lactogenic infection. Many third-stage larvae of *Strongyloides* have been observed in the milk of lactating cows.

In general, the clinical signs in a calf with an apparently heavy infection, as indicated by a large *T. vitulorum* egg-count per gramme of faeces, consists of diarrhoea with foul-smelling yellowish faeces with an acid odour. In an animal with a toxocariosis these signs are noted in 28-56 days of age. The diarrhoea is followed in three to four days by constipation. Sometimes rectal examination may reveal fresh blood and mucus. The mortality in calves due to this infection ranges form 25-50 percent and is particularly high in poorly nourished cavles. The mortality, therefore can vary from one area to another in Sri Lanka with the differences in calf rearing practices.

The life-cycle of *T. virulorum* is complex. Infection with adult nematodes occurs in the small intestine of calves aged three to eight weeks. At this time, large numbers of eggs are passed with the faeces of the calves. The eggs embroyonate and after one larval moult reach the infective stage. The infective eggs can remain viable for long periods outside the body under humid and moist conditions.

On ingestion by animals, the larvae hatch in the intestine and migrate to the lungs and other tissues, and finally encyst. In buffalo cows about the time of parturition the encysted larvae are mobilized and some are transported to the mammary glands and are passed in the milk. In general, most calves are infected from the milk of the dams. Calves which are separated at birth from dams do not acquire a patent infection. On the other hand, foster calves which suckle the cows reared in an infected area acquire the infection. Larvae have been observed in milk continually from days one to twenty-four after parturition but most larvae are present during the period of four to ten days after parturition. Since the infection reaches patency in calves as early as 3 weeks of age it can be assumed that the infection is acquired within a day or two of birth. The larvae grow rapidly after they enter the intestines of calves and it appears that factors present in the milk or secreted by the intestines of the calf stimulate their development.

Other nematodes of buffalo calves:

In the case of *Mecistocirrus digitatus*, *Haemonchus* species, *Bunostomum phlebotamum* and other trichotrongyloid species the life-cycle is direct. The eggs are passed with the faeces and the first-stage larvae, which hatch from the eggs, reach the infective stage after two moultings. The third-stage (infective) larvae are ensheathed. Infection of the host occurs through the mouth with all species except with *B. phlebotomum*. The infective larvae of *B. phlebotomum* enter the host through the skin and after a sojourn through the lungs, bronchi and trachea reach the intestines and develop to the adult stage. The infective larvae of *M. digitatus*, *Haemonchus* and *Trichostrongylus* species develop directly in the intestine.

The prepatent period of *B. phlebotomum* and *M. digitatus* is long, about 55-60 days. Infection with fully mature worms, therfore, are seen about the third month of age.

TABLE 6.2

Efficacy of anthelmintics against nematodes

Anthelmintic Drug	Dosage mg/kg BW	Species of Nematodes
Peperazine compounds	200	*T. vitulorum* (immature) formspassed with the faces from 36 hours — 72 hours of medication. Worms alive when passed & remain alive in phosphate buffer for about 72 hours. but preparation less expensive and within the reach of farmers.
Benzimidazoles:		
Oxfendazole (Sytamex, Wellcome Laboratories)	7.5	*T. vitulorum* (100% effective against adults). *Strongyloides (effective)*
Febantel ('Rintal', Bayer)	7.5	*M. digitatus*, *Haemonchus* spp., *Trichstrongyus* spp *Bunostomum* spp. Highly effective against mature and immature stages.

Treatment and control of nematode infections

Nematodes can be controlled by a combination of proper hygiene and the use of anthelmintic drugs. Some of the common anthelmintics used in the control of nematode infections are listed in Table 6.2. These modern drugs are very effective but should be used strategically with a proper understanding of the life-cycle of the worms. The objectives of controlling worm infestation should be twofold; to keep animals relatively free from worms but at the same time to allow the development of natural immunity of further infection.

6.3 — External parasites of buffaloes

6.3.1 — Ticks

Ticks are a group of ectoparasites comprising nearly 800 species worldwide that attack most species of animals and man. They can be divided broadly into soft ticks and hard ticks. Soft ticks lack a hard outer covering or scutum and are found on birds. The hard ticks in contrast possess a scutum or hard exoskeleton and parasitise mammals and reptiles. The life cycle of a tick consists of four stages; the egg, larva, nymph and adult. The sexes cannot be differentiated in larval or nymphal stages and the features become conspicuous only in the adult. The adult female feeds on blood and drops to the ground when fully engorged, to commence egg laying. The eggs, under suitable conditions develop into larvae. The larva attaches itself onto a passing (host) animal to begin its parasitic life.

In some species, like the common cattle tick, the larva develops into an adult whilst remaining on the same host. Such species are known as one-hosts ticks. Other species of ticks require two or three hosts to complete their life cycle. In the case of two-host ticks, the larva feeds and moults into the nymphal stage on the same host. The young nymphs that emerge feed and drop to the ground where they moult into adults. The adults attach onto a second host and the females drop to the ground, when fully engorged, lay eggs and complete the cycle. In the case of three-host ticks, the larval, nymphal and adult stages feed on three different hosts. Each stage drops to the ground after feeding.

When present in large numbers ticks can cause unthriftiness and even death due to blood loss. The value of hides is often reduced by tick infestation. Most important, however, is their ability to harbour and transmit bacteria, viruses, parasites and fungi, that cause several diseases in domestic animals.

In Sri Lanka ticks belonging to nearly 34 species have been identified. In recent surveys ticks have been collected from buffaloes in different areas of Sri Lanka. Ticks belonging to several species, namely, *Rhipicephalus haemaphysaloides, R. sanguineus, Hyalomma marginatum isaaci, Hy. brevipunctata, Amblyomma integrum, Haemaphysalis bispinosa* and *Boophilus annulatus* (Sensu lato) were encountered on buffaloes. Ticks of the genera *Hyalomma* and *Amblyomma* are present only in the dry zone. The infestations can vary from moderate to high depending on age of the animals and the type of management.

In general buffalo calves harbour more ticks than adults. In large herds, buffalo calves harbour moderate to heavy infestations whilst in smaller herds the infestations are lighter. These infestations are invariably of the one-host type ticks of the genus *Boophilus*. In adult buffaloes, ticks are found mostly on the ears, under the base of the tail and the switch. *Hyalomma* ticks are usually seen under the base of the tail with *Rhiphicephalus* and *Amblyomma* on the tail. The long mouth parts of *Hyalomma* and *Amblyomma* ticks cause bleeding wounds on the tail which often become infected.

In Sri Lanka the only disease of economic importance that is transmitted by ticks is theileriosis. The tick *H. bispinosa* has been experimentally shown to transmit theileria.

Control:

Ticks can be controlled by the use of several acaricides (chemicals) that are available commercially. These are best used as a spray or as pour-on applications. In heavy infestations, it is advisable to treat the animals at least once every three weeks.

6.3.2 – Lice

In warm countries including Sri Lanka, lice are very common parasites on buffaloes. These arthropod parasites are small and wingless and have dorso-ventrally flatened bodies. The entire life cycle of a louse is passed on the host. Adults lay eggs that are operculated and cemented to the hairs of the host. Eggs develop in about 17 days to produce the first nymph which resembles the adult. There are three more moults through the first, second and third nymph at stages to the adult. The body of a louse is composed of a head, thorax and a large abdomen.

The lice can be divided into two sub-orders, namely, Anoplura nad Mallophaga. Those that belong to Anoplura have their mouth parts adapted to sucking tissue fluids and blood of the host and are known as sucking lice. Mallophaga are termed biting lice and possess mouth parts adapted for chewing epithelial debris on the skin of the host. The species of sucking lice reported from buffaloes are *Haemotopinus eurysteruus*, *H. quadripertusus* and *Linognathus vituli*. The biting louse found on cattle and buffaloes is known as *Damalinia bovis*. Buffaloes usually become infected by close contact with other animals but lice can also be spread by farm equipment and people. Both calves and adults harbour lice on their body. Control is by application of insecticides.

6.3.3 — Flies:

No systamatic studies have been carried out in the flies that afflict buffaloes in Sri Lanka. Casual observations however, have shown that flies of the families *Simuliidae* and *Tabanidae* do affect the buffaloes.

Simuliidae:

The Simuliids are found in most parts of the world, particularly in warm countries. They cause great annoyance and irritation to animals. The smaller species of this family are called black flies or buffalo gnats. The body is composed of a head, thorax and abdomen. The thorax is humped over the head and sprouts two broad wings. The fly possesses a short piercing proboscis with which it bites the legs, abdomen, head and ears of the host. The flies are active in the morning and evening and rest during the hotter parts of the day under leaves on the ground. Swarms of these flies can prevent cattle from grazing and even cause them to stampede.

The flies lay eggs on stones or plants just below the water surface in running streams. The female inserts its ovipositor into the water to deposit several eggs at a time. They hatch in 4—12 days depending on the water temperature.

Tabanidae:

These flies are large and robust with powerful wings and large eyes. Flies that are of importance in Sri Lanka belong to the genera Tabanus and Haematopota. Eggs are laid in the vicinity of water usually on leaves of plants. They lay between 300—600 eggs which hatch in 4—7 days into larvae that drop into the water or disappear into the mud. The larvae feed on small curstacean and change into a pupa which in turn become an adult. The entire life cycle is completed in about 4—5 months.

The flies usually attack large animals and feed on the skin of the abdomen, legs, neck and withers. The bites of Tabanidae are painful and irritating. Each fly may bite several times in different places before it is replete. The bite wounds often bleed and can get infected.

Tabanidae are known to be mechanical transmitters of the parasites *Trypanosoma evansi* in cattle and buffaloes. They could also transmit *Trypanosoma theileri* cyclically. Both species of Trypanosomes are present in Sri Lanka. Control of flies is difficult. Efforts to destroy breeding places of the insects and application of insecticides to animals can be useful.

CHAPTER 7

BACTERIAL AND VIRAL DISEASES OF BUFFALOES

Water buffaloes are affected by the same bacterial and viral diseases as cattle, although there are differences in the degree of susceptibility. It is not certain whether these apparent differences in susceptibility are related to differences in habitat, behaviour, management, nutrition and other environmental factors, or due to a two species difference.

7.1 — Haemorrhagic Septicaemia

This disease is caused by a bacterium, *Pasteurella multocida*, and is the most serious of all buffalo diseases. It is prevalent in Asia and Africa where it causes heavy economic losses. In Sri Lanka it has been estimated that haemorrhagic septicaemia (HS) accounts for two thirds of all deaths in young buffaloes. Although it is a condition that affects both buffaloes and cattle, buffaloes are more susceptible to the disease.

The disease is endemic in the dry-zone of Sri Lanka and outbreaks occur every year. The animals most affected are those in the 6 months to 2 years group. A seasonal incidence is evident, due to the fact that rain and moist conditions prolong the survival of the bacterium outside the animal body and thereby help in the spread of the disease. Most outbreaks, therefore, occur in the rainy season. In regions where the disease is endemic most animals have naturally acquired immunity by the time they reach adulthood. In other areas, where only occasional out-breaks of disease usually occur, losses can be very heavy if the disease breaks out and all age groups including adult animals are affected. The disease is most common among large nomadic herds that graze in communal pasture lands and drink from the same water sources. It is less prevalent in small, isolated herds. The lowest incidence of the disease is in the hill country. In endemic areas, a large proportion of animals are clinically normal, but harbour the bacterium in their tonsils. From time to time, when subjected to stress, they shed the bacterium in their nasal secretions. Such animals are infective to others, but are themselves immune to the disease and are known as carriers. Other animals pick up the infection by inhalation or by the oral route.

Depending on the number of bacteria inhaled or ingested, the animal will either develop a mild sub-clinical infection and become immune or will develop clinical signs after an incubation period of 2—3 days. The first sign will be a rise in temperature, which may go up to 105—106^{0} F. This early stage of the disease often escapes unnoticed. Later, a swelling may develop under the jaw and in the throat region which sometimes spreads to the chest down the forelimbs. Respiratory distress, evidenced by laboured breathing will follow and finally, the animal will become recumbent and die. In some animals, the visible symptoms may not to be observed for more than 24 hours, while in others it may linger on for 2—3 days, before death. The disease is diagnosed by a consideration of the history, the observed clinical signs and a postmortem examination. As to how distinct these changes are, will depend on the course of the disease. Where the animal has shown clinical signs for a few days post-mortem changes will be marked and easily recognisable, but in acute cases, where death sets in early, these changes will be less marked.

The diagnosis can be confirmed by cultural examination of the blood in a laboratory. The bacterium is present in the blood after death and can be cultured in a suitable medium and identified. Inoculation of mice with the blood of the dead buffalo is a more reliable test. If the carcass is old and decomposed, instead of blood, bone marrow is a suitable material for laboratory examination and a long bone from a limb, cleared of all muscle tissue, is suitable for this purpose.

Once the disease is reported, all movement of animals in and out of the area, village or herd must be stopped. Persons looking after sick animals should take great care not to carry infective material on their person. All animals in the neighbourhood must be immediately vaccinated, irrespective of their previous vaccination history.

Treatment with antibiotic drugs is effective only if carried out in the very early stages. When one case of HS has been recorded, the only practical methods of saving others is to check the rectal temperature of all in-contact animals regularly, and treat if a temperature rise is observed.

The disease can be controlled by preventive vaccination. First vaccination is recommended during calf-hood at 4—6 months of age, followed by a booster vaccination 3 months later. Thereafter, the animals need to be vaccinated annually. The vaccine is manufactured in Sri Lanka at the Veterinary Vaccine Production Laboratories at Gannoruwa and a free vaccination service is provided by the Department of Animal Production and Health through the Government Veterinary Surgeons.

7.2 — Foot and mouth disease

This disease affects cattle, buffaloes, sheep, goats and pigs and is caused by a virus. Of the several types of this virus only two types, designated as type 'O' and type 'C' are present in Sri Lanka with type 'O' being more common. Type 'C' was introduced in the late nineteen sixties, and has accounted for a few isolated and sporadic outbreaks of foot and mouth disease.

In Foot and Mouth disease morbidity (% animals affected) is high, but the incidence of mortality (death) is very low, particularly in adult buffaloes. When the disease breaks out in a herd, it spreads rapidly within a few days and may affect the entire herd. Deaths usually occur among calves. Buffaloes are, in general, less severely affected than cattle, and indigenous buffaloes are more resistant than imported breeds. Economic losses due to F.M.D. occur not in the form of deaths but in the incapacitation of animals during an outbreak and a permanent drop in the productivity of the animals, thereafter. The loss can be very significant if an outbreak occurs during a cultivation season, when the animals cannot be used for draught purposs. The longer term effect is an insidious loss which is often not obvious; it has been reported that the milk yield of animals recovered from Foot and Mouth disease drops permanently by about 30% on the average.

Symptoms and lesions are very similar to that in cattle. Initially, there will be profuse salivation, with a characteristic drooling of saliva. Upon closer examination of the mouth, vesicles will be evident on the tongue, lips and the buccal mucosa. Later, the vesicles will open, and ulcerations will be seen. In the latter stages secondary bacterial infection can occur resulting in lameness. As a result of the mouth lesions, the animals will stop eating and become debilitated. For the purpose of confirming the diagnosis and to determine the type of virus, laboratory tests must be done. The material required for laboratory tests are portions of epithelium from the affected animals mouth, collected in the early stages of the disease and despatched to the laboratory in a preservative (Buffered glycerol saline).

There is no specific treatment for the disease and is normally directed towards minimising secondary bacterial infection, which often delays the healing of the mouth and hoof lesions. Copper sulphate or alum solution is applied to the mouth lesions and Stockholm Tar to foot lesions. The disease can be prevented by vaccination which confers immunity for 6 months. Hence, twice yearly vaccination must be carried out in endemic areas. In the event of an outbreak, the animals in the immediate vicinity must be vaccinated. Since type 'O' is the common type in Sri Lanka, normal vaccination programs as well as emergency vaccination when outbreaks occur use the type 'O' vaccine. Confirmation of the identity of virus type must be done in the laboratory with every outbreak.

7.3 — Rinderpest

Rinderpest is an acute, highly contagious disease of cattle, buffaloes, sheep, goats and pigs. It is caused by a virus belonging to the Myxovirus group and related to the viruses of distemper in dogs and human measles. The disease was once introduced to Sri Lanka in the early nineteen fourties through cattle imported from India during the world war II, but was soon eradicated. The disease has once again been introduced in 1987 and has broken out in the Eastern Province, presumably by goats imported form India.

When the disease breaks out in virgin areas, with a highly susceptible population, morbidity rates may approximate 100%. Mortality rates however, are variable and range from 25% to 90%. This is presumably due to the existence of strains with considerable variations in virulence. The incubation period in field cases is around 6—9 days. In the first stage of the disease which lasts 3—5 days, there is high fever, (105°F—107°F). There is profuse, clear nasal and lacrimal discharges and bubbly clear blood stained saliva initially, which becomes mucopurulent later. Discrete necrotic lesions 1—5 mm in diameter develop in the mouth and tongue, which join up and form extensive, reddened ulcerative lesions. After 5—6 days of illness, the temperature drops but profuse diarrhoea develops as the lesions extend to the gastro-intestinal tract. They may last up to 10—12 days. Necrotic lesions will also be observed at post-mortem in the oesophagus and the abomasum but not in the forestomacks. Lesions may also be seen in the small and large intestines, where haemorrhagic bands running transversely give a characteristic striped appearance.

The Rinderpest virus is very fragile, and does not survive outside the animal body for very long. Thus direct contact is required between animals for transmission. The disease is controlled by preventive vaccination. In areas where the disease is introduced for the first time, eradication is possible if all infected and in-contact animals are slaughtered, and by intensive vaccination in surrounding areas. Vaccines in use are live-virus vaccines. The vaccine virus is also extremely fragile and should be stored at -20° C or 4° C. After reconstitution in the diluent, it has to be maintained at 4° C during use and must be administered in single doses using cold syringes. Vaccination gives lifelong immunity.

7.4 — Ephemeral Fever

Ephemeral fever, also known as 3-day fever is reported to occur among buffaloes in Sri Lanka. It is caused by a virus. In highly susceptible populations, nearly 100% animals may be affected in outbreaks, but in endemic areas, morbidity may be in the region of 5—10%. There is usually spontaneous recovery after a transient illness and only occasional animals will die of intercurrent infection or prolonged recumbency. The disease is believed to be spread by insects.

The disease usually affects animals over 6 months of age. There is a sudden onset of fever (106—107° F), with muscular signs such as shivering, stiffness, clonic muscle movements and constant shaking of the head. The animals may adopt a peculiar posture, with all four legs bunched together. Some animals may become recumbent with the legs sticking out and the head turned towards the flank, a posture similar to that seen in parturient pareis. The temperature becomes normal in 3 days and in most cases recovery is spontaneous. Treatment with Salicylates or Butazolidine will help to relieve muscle stiffness. Care must be exercised in drenching to avoid aspiration pneumonia. In the recumbent animal, proper nursing is important.

7.5 — Mastitis

The term Mastitis is used to describe inflammation of the udder. The most common cause of mastitis is bacterial infection and in the dairy buffaloe, it is a disease of considerable economic importance. If not treated promptly and correctly, permanent damage can be caused to the milk producing glandular tissue in the udder, and after recovery from infection, the milk production can be permanently reduced in such dairy buffaloes. Surveys carried out in Sri Lanka has shown that the buffalo is less susceptible to mastitis than dairy cattle.

Unlike other bacterial diseases which are caused by specific organisms, mastitis is caused by a variety of bacteria. The most common bacteria are those belonging to the genus Streptococcus — *Streptococcus agalactiae, S. dysgalactiae* and *S. uberis*. Other bacteria incriminated are *Staphylococcus aureus, Escherichia coli* and *Corynebacterium pyogenes*. The nature and severity of the infection depends on the type of bacterium involved. Mastitis occurs in a sub-clinical form and in a clinical form. In the former, no visible changes occur, but the causative bacterium is present. Such animals are a potential source of infection to others. Their milk yield may be reduced. They can also, under certain circumstances, become clinical cases. In clinical mastitis, visible changes occur in the milk and in the udder. The changes in the milk include discolouration, presence of clots or blood and rapid spoilage. Changes in the udder include swelling, hardness evidence of pain when touched at milking time. Rarely in very acute forms, in addition to these changes, the animal may develop generalised signs of illness and fever.

Clinical Mastitis must be promptly treated with antibiotic preparations that are infused into the udder through the teat canal. The most commonly used antibiotic is Penicillin. It is useful to consult a Veterinarian and culture a sample of milk to determine the causal bacterium and its sensitivity to antibiotics, before treatment is commenced. This is particularly helpful in problem animals or herds, where the response to penicillin is poor. Treatment must be continued regularly until recovery. The response to treatment must be closely monitored and changes made accordingly. Sub-clinical mastitis can be detected by a simple test called the 'California Mastitis Test' which can be carried out in the dairy itself.

Mastitis is better prevented than treated. Mastitis causing bacteria are found in the udders and milk of clinically and sub-clinically infected animals and in the environment of a dairy. Infection occurs by entry of the bacterium into the udder through the teat canal which occurs most commonly immediately after milking, when the teat canal is open. Preventive measures are therefore directed towards minimising the causal organisms present in the dairy environment and the chances of their transmission between animals and entry into the udder. Some of the methods used to prevent the occurence of mastitis in cows are given below.

a) Good dairy hygiene — the dairy must be regularly washed and maintained free of puddles of stagnant water. Cows must be washed well before bringing into the milking area, particularly if their under surface is smeared with dung etc. First, the milker must wash his hands with soap and water. The udder must then be washed with soap and water but not wiped. Milk gently, quickly and completely and not change milkers often. Immediately after milking, dip all four teats in a recommended teat dipping solution.

b) Milking order: In a dairy, animals should be regularly tested by the CMT. The order in which animals are milked should be decided on the results of this test — first the mastitis free animals, then recovered animals, next the suspected or sub-clinical animals, and finally the known infected cows. Dry Cow therapy — At the end of the lactation, all sub-clinically affected quarters must be treated with a long-acting 'dry cow' antibiotic udder infusion.

c) Controlled culling — In dairy herds, animals that get mastitis repeatedly should be culled. Some of these animals may be genetically predisposed to mastitis. The shape of the teat, teat canal, nature of the sphincter are all important factors, in susceptibility to mastitis.

7.6 — Anthrax

Anthrax is an acute, infectious disease of all species of livestock, including buffaloes and is communicable to man. The disease is caused by a bacterium *Bacillus anthracis.* The disease lasts only a few hours, and often animals are found dead without displaying any signs of illness. Upon close observation, animals will show a high fever (106—107° F), with blood shot eyes, muscle tremor, dyspnoea, terminal convulsions and die within a few hours. After death, discharges of dark, tarry blood (that will not clot) will be seen at all natural orfices — mouth, nostrils, anus and genital organs. There is a striking absence of rigor mortis, and there will be rapid putrefaction and bloating of the carcass.

In a case of sudden death with any of the above signs, no attempt must be made to open the carcass for examination. Samples of peripheral blood, smears and swabs, collected by needle puncture should be despatched to the laboratory for confirmation of diagnosis. When discharged from the body, the anthrax bacillus forms spores which are resistant to heat, cold and chemical disinfectants, and can remain viable in the soil for several years.

Treatment is only effective if carried out in the very early stages, Penicillin in large doses must be administered for at least 5 days. Broad-spectrum antibiotics have also been used with success. The carcass of an animal that has died of anthrax must be buried in a deep pit, of at least 2 meters covered with a layer of lime. Anthrax bacilli have been found in soils in many parts of Sri Lanka, particularly in the North. The disease itself however, is relatively uncommon, and most reports have been from Jaffna. Prevention is by vaccination of all animals in premises where the disease is endemic. Two vaccinations at 6 monthly intervals followed by annual — re-vaccination is recommended.

7.7 — Brucellosis

Brucellosis is a disease caused by a bacterium, *Brucella abortus,* characterised by abortions in late pregnancy and infertility. It is prevalent among buffaloes particularly in the dry-zone areas of the Eastern and North-Central provinces. The disease is of public health importance, causing undulant fever in man. The commonest method of human infection is by the consumption of milk without heat treatment. Pasteurisation kills the organism.

Surveys carried out in Sri Lanka has shown that the mid and hill country areas are free of Brucellosis, whereas in the EP and NCP certain herds, including buffaloes may have as high an infection rate as 30—40%. Infected herds have also been found elsewhere, particularly in the North Western, Western and Southern Provinces, but the infection rate is lower. When first introduced, Brucellosis causes a storm of abortions in a herd. Thereafter, the disease leads to infertility, retained placenta or the birth of weak calves. Infected bulls may show orchitis, or often no signs at all, but could infect cows if used for stud purposes.

Prevention is by a two-pronged approach. Since the disease manifests itself only during pregnancy, many non-pregnant animals could be harbouring the disease without any signs of disease. The disease can be detected by examination of blood, or milk. Routine testing must be carried out, and reactors detected for the first time in an area or herd should be culled. In areas and herds where the disease is endemic, vaccination is advocated. The vaccine used is a live vaccine containing an attenuated strain (S 19) of the organism. One injection given at 3—6 months of age provides lifelong immunity. In endemic areas, where animals are vaccinated for the first time, a low-dose vaccintion scheme is used for adult animals.

7.8 — Common bacterial and viral conditions of young buffalo calves

7.8.1 — Navel ill or Joint ill

As in cattle, the young buffalo calf, born in unhygienic surrounding is prone to infection through the umbilical cord. These organisms enter the blood stream and localise in certain specific sites, notably the joints which become swollen. The common bacterium involved is *streptococcus sp.* Antibiotics are used in treatment.

7.8.2 — Infections of the Gastro-intestinal tract

Gastro-intestinal infections caused by bacteria and viruses may range from simple to acute diarrhoeic disease leading to dehydration and death. Septicaemia could occur in weak colostrum-deprived calves. A number of specific viruses (eg. rotaviruses) have now been incriminated with diarrhoeal disease in buffalo calves. Among the bacteria infecting the gastro-intestinal tract are *E. coli* and *Salmonella sp.*

Treatment is usually symptomatic and is directed towards preventing dehydration and death. In bacterial infections, antibiotics have proved useful. It is important to eliminate other causes of diarrhoea such as coccidiosis and helminth infestation, as these could predispose to or aggravate the condition.

7.8.3 — Pneumonia

Pneumonia is a common disease condition among young buffalo calves reared under intensive conditions on large farms. One survey carried out in such a farm showed that Pneumonia accounted for a more than one half of all deaths among buffalo calves under 6 months of age.

The disease is initiated by a variety of viruses. Virus pneumonia however, is a mild, transient disease and spontaneous recovery occurs in most cases. Signs include high temperature, clear discharge from the eyes and nostrils, heavy breathing and a cough. In some cases, the primary viral infection is complicated by secondary bacterial infection, often by bacteria normally present in the upper respiratory tract. This leads to acute pneumonia with respiratory distress, purulent nasal discharge and death.

Prevention is effected by proper housing, adequate ventilation, prevention of sudden chilling, good, clean, dry bedding in calf pens and by a high level of nutrition. The onset of the bacterial phase of pneumonia can be detected if close observation is made of the calves. Those showing signs of virus pneumonia are isolated and subjected to a course of antibiotic treatment to prevent the secondary bacterial stage.As there are a mutiplicity of organisms involved, the use of vaccines is not practical. In individual outbreaks, where specific bacteria are involved, auto-vaccines prepared from organisms isolated from the particular outbreak have been of some value.

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