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FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

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FOREWORD

by W. Ross Cockrill

In 1974 *The husbandry and health of the domestic buffalo* was published by the Food and Agriculture Organization of the United Nations (FAO) under the sponsorship of the Australian Freedom from Hunger Campaign (FFHC). It was the result of some ten years of study, travel and research. The study was a project of the Australian FFHC.

A postscript to the above volume, *The buffaloes of China*, was published in 1976, again with the sponsorship of the Australian FFHC.

The husbandry and health of the domestic buffalo was favourably received. It achieved one of its principal aims in stimulating interest in the water buffalo and focusing attention on the need for field investigation and trials, observations and research in many disciplines, in order to close the gaps in knowledge of this neglected domestic animal.

The book consisted of two parts, the first of which dealt with specialized studies. These included material supplied by over 20 scientists and writers who recognized the importance of the water buffalo in the countries of Asia and the Far East as well as in certain countries of the Near East, Europe and Latin America.

The following major contributions were included:

Species, types and breeds Genetics Environmental physiology	I.L. Mason
Blood groups and protein polymorphisms	Jan Rendel
Reproduction	P. Bhattacharya
Observations on the physiology of reproduction	A. Roy
Nutrition	Margaret I. Chalmers
Parasites and parasitic diseases	R.B. Griffiths
Observations on skin colour and hair patterns Aspects of disease Management, conservation and use The working buffalo	W. Ross Cockrill

Milk and milk production ..... H.D. Kay
Meat and meat production ..... A. Ognjanović

Other contributions, which were incorporated into the appropriate chapters, were forthcoming from R.V.S. Bain (Haemorrhagic septicaemia); J.R. Hudson, Saw Brown E Maung and U Maung Maung Gyyi (Skin ulceration); S.P. Bennett, E.M. Kidner, B. Rumich, D. St. Polikhronov, G. de Franciscis, S.B. Dhanapala, P. Bhattacharya and B.P. Joshi (Bloat); J.M. Riddell-Swan (Fascioliasis); H.H. Groenewald (Management); H. Roth (Immobilization); D.H.L. Rollinson (Calculating age); Y. Nayudamma (Hides and leather); R. Cochrane (Work); and D.D. Charles and E.R. Johnson (Carcass characteristics).

The second part of the book dealt with the world distribution and potential of the water buffalo. Geographical chapters, many of which incorporated the results of original research and observations, were written by:

D.G. Tulloch	The feral Swamp buffaloes of Australia's Northern Territory
David H. Wilkin	The buffaloes of New Guinea
R.O. White and M.A. Mathur ..	The buffalo in India
C. Shoho	The buffaloes of Okinawa
M.Z. Khan	The buffaloes of Pakistan
A.B. Coronel	The buffaloes of the Philippines
A.A. El-Itriby	The buffalo in the Arab Republic of Egypt
P. Mahadevan	The buffaloes of Trinidad and Tobago
D. St. Polikhronov	The buffaloes of Bulgaria
A. Salerno	The buffaloes of Italy
W. Ross Cockrill	The buffaloes of selected countries in Asia, the Far East, Africa, Latin America and Europe

Information on other areas was supplied by:

C.A. Walker (Lao and former Portuguese African territories); Tim Bhannasiri (Thailand); W. Schulthess (Madagascar); João Limpo Serva (Mozambique); D.J. Brand, D. Simms and R.C. Bigalke (South Africa); H.E. Hornby and K. Kuneman (Tanzania); E.P.S. Rogers (Uganda); A. Jazierski (Zaire and Congo); O. Miranda (Bolivia); S.P. Bennett (Colombia); J. Leclerc (French Guiana); A. Chacón Díaz (Peru); H.G. Byron (Surinam); Abelardo Ferrer D. (Venezuela); T. Szmodits (Hungary) and N. Muntiu (Romania).

The list of contributors is by no means complete. In the final chapter of *The husbandry and health of the domestic buffalo* the present writer listed the names of over 170 individuals who had supplied information, statistics, photographs and other material and, while expressing gratitude, offered his apologies for any inadvertent omissions in recording the sources of much valuable cooperation. H.S. Caldwell who, as consultant and assistant editor made a material contribution to structure, bibliography and index, deserved special mention.

Dame Phyllis Frost, who at the time was heading the Freedom from Hunger Campaign in Australia, provided the resolute support and confidence which helped the project through difficult times and ensured the eventual publication of the study. Australia's FFHC wished to give emphasis to projects which would be educational in character and of particular value to the people of the Far East region and especially of southeast Asia. While the project met these requirements, the cost of the publication, notwithstanding heavy subsidization, put it beyond the reach of some groups who would benefit from the knowledge gathered between its covers. These included many university students, smallholders, and village-level buffalo owners. Dame Phyllis urged that an abridged condensed paperback version of *The husbandry and health of the domestic buffalo* be produced to meet their needs and be sold at a price which would be within reach. In view of the growing interest in the water buffalo as expressed by expanding research and the publication of an increasing number of valuable papers in national and international journals, it was proposed that the study should be updated by appropriate reference to work published subsequent to the printing of *The husbandry and health of the domestic buffalo* early in 1974.

Abridgement has of necessity entailed the exclusion of many tables, graphs and illustrations. The text has been simplified and the content reduced to essentials without, it is hoped, detracting from the contributions of those whose names are listed above. In the interest of clarity, and in order to avoid repetitious references to specific chapters in the parent publication, such references have been reduced to a minimum. The extensive bibliography, which included over 4 000 references, is augmented in the present work by a list of selected papers published since 1972.

Special mention is made of three recent publications which are of particular interest and value. They are *The Asiatic water buffalo,* a compilation by the Food and Fertilizer Technology Centre, of the Asian South Pacific Council, published in Taiwan, China, in 1975; *Domestic water buffalo* by M. Fahimuddin, published in New Delhi in the same year; and the *Proceedings of the First International Convention of Buffalo*

Production, held at Caserta, Italy, in 1974, compiled and edited by G. de Franciscis.

The work of abridgement, condensation, rewriting and updating has been done by H.S. Caldwell, who also compiled the reference list and prepared the index. Both FAO and the Australian FFHC are indebted to him.

The three publications by FAO under the sponsorship of the Australian FFHC, *The husbandry and health of the domestic buffalo*, *The buffaloes of China*, and *The water buffalo*, should not be regarded as the final word on the subject. There are still some world areas where buffaloes exist in significant numbers and where they make an effective contribution to the agricultural economy, but where little has yet been published concerning them. Such areas include the U.S.S.R., with almost 500 000 buffaloes. Brazil also is making notable advances in buffalo production and a detailed review of the present situation would provide information of value to other countries as well as to the many enterprises, especially in the Amazon valley, where the increase in the buffalo population has been spectacular.

A considerable number of countries, for example in Africa and Latin America, which have not previously had buffalo populations, are now interested in securing nucleus breeding stocks. A development of very recent times has been the export by air of batches of up to 200 Swamp buffaloes from Australia's Northern Territory to a surprising number of countries in both hemispheres. This trade could, it is believed, grow to some 5 000 animals annually and be maintained at that level for some years without deprivation of the stocks in the territory. It is stimulated by Australia's highly satisfactory livestock disease situation, for neither rinderpest nor foot-and-mouth disease has been observed in the continent for many years, while contagious bovine pleuropneumonia, which had never been recorded as occurring naturally in the feral Swamp buffaloes of the Northern Territory, has been eradicated by use of the complement fixation test, vaccination, and a limited stamping-out policy. No case has occurred in cattle since 1968, and during the entire control programme no naturally occurring case was seen in buffaloes. There would seem to be no reason for any country to refuse imports of buffaloes from Australia on the grounds of the risk of introducing pleuropneumonia.

It is unfortunate that some countries which have plentiful stocks of the excellent River breeds have not yet eradicated or brought under control a variety of infectious and contagious diseases affecting livestock. Consequently there is a reluctance on the part of potential importing countries to accept the risk of introducing exotic disease, even where

satisfactory quarantine arrangements can be made and the risk can be classified as a calculated one.

Within recent years, however, there have been indications that the importance of movements of blood lines about the world may override the hazards of disease introduction, and that some countries are prepared to accept these risks under conditions of efficient quarantine. So far as buffaloes are concerned, the following representative importations have taken place within the last decade, without any subsequent recorded disease transfer:

To:	*From:*
Brazil	India, Italy and Trinidad
Bolivia	Brazil
Bulgaria	India and Pakistan
China	India and Pakistan
Colombia	Trinidad
Costa Rica	Australia
Mozambique	Italy
Nigeria	Australia
Papua New Guinea	Australia
Tanzania	Egypt
Uganda	India
U.S.S.R.	India
Venezuela	Trinidad, Italy, Bulgaria and Australia

The buffalo exists in greatest numbers in many areas of the world where the shortage of protein, and especially of animal protein, is most acute. It is an animal not of the past but for the future, and an important part of that future lies in the potential of the buffalo as a source of quality meat.

If the buffalo is reared and fed for meat production, the meat is tender, palatable, of high quality and acceptable to the consumer. It can be obtained at less expense and with fewer inputs than that from cattle and, in tropical countries particularly, at a much earlier age.

It has been repeatedly emphasized that there are many gaps in knowledge of the biology of the buffalo and that these gaps must be closed if the full potential of the animal is to be realized. An Expert Consultation on International Buffalo Research Needs, organized by FAO, and sponsored by the Technical Advisory Committee of the Consultative Group

on International Agricultural Research, was held in Singapore in March 1976. It brought together a representative gathering of scientists and administrators who reviewed and identified needs in the research field.

The consultation noted that the domestic water buffalo population of the world constitutes a major source of farm power, milk and meat; that in spite of its importance to the overall economy of many Asian, Far Eastern and Near Eastern countries no major effort has yet been made to increase farm level output from the buffalo through programmes of improved feeding, management and the conservation and use of selected superior germ plasm. It considered that many of the biological and socioeconomic problems limiting the efficiency of production and utilization of the buffalo require careful and intensive research. It therefore recommended that an international buffalo research project be established to assist in the development and strengthening of national research capabilities, coordination of research, exchange of information, training of research workers and the optimal use of existing research staff and consultants.

This is a part of the growing appreciation of the fact that, in the hitherto neglected water buffalo, there is an animal of outstanding potential which, in terms of productivity may, in tropical and subtropical countries, equal and possibly outstrip other domestic livestock. This potential may also be realized in the temperate zones of the world.

Floreat Bubalus!

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part I - the water buffalo: specialized studies

1. SPECIES, TYPES AND BREEDS

Classification of buffaloes

When reference is made to buffaloes, it may be to several different animal species, all of which are called buffaloes. The big-game hunter, for example, may be describing experiences with the ferocious African buffalo; or a North American may be talking of the days of Buffalo Bill and of the vast herds of American bison; but a traveller from the Far East would, undoubtedly, be praising the virtues of the Asian water buffaloes.

To arrange these species, very briefly, in zoological order, one may start with the families of the ruminants: the camels, giraffes, deer and the Bovidae. This last family comprises the tribes of sheep and goats, antelopes, and the Bovini. The tribe of Bovini is, in its turn, divided into three groups: Bovina, cattle; Syncerina, the African buffaloes; and Bubalina, the Asian buffaloes.

The Bovina group embraces *Bos*, domestic cattle; *Poëphagus*, the yak; *Bibos*, the banteng, the gaur and the kouprey; *Bison*, the American bison, *Bison bison*, and the European bison, *Bison bonasus*. The Syncerina group comprises the Cape buffalo, *Syncerus caffer caffer*, and the Congo buffalo and, possibly, an intermediate species.

The Bubalina group is the one that concerns us in the present study. The species existing at the present time are *Bubalus arnee*, the arni and its domestic descendant, the water buffalo, *Bubalus bubalis;* the anoa, *Bubalus depressicornis*; and the tamarao, *Bubalus mindorensis*.

The arni is a very large animal that lives in big herds in thick reeds, rushes or grass jungle in northern India. It may also exist in Sri Lanka and other areas. It is always closely associated with water and spends much of the daytime in wallows. The range of the arni is being remorselessly reduced by the extension of agriculture. Several varieties have been described, varying in colour and in the shape of the horns. Some wild buffaloes may be descendants of domestic buffaloes which have become feral. In the forest areas of Sri Lanka, Democratic Kampuchea, Lao and Viet Nam, there is frequent interbreeding between wild and domestic buffaloes and, as a result, there is very little difference in the

appearance of the two types. The domestic buffaloes have been developed over the centuries from the original wild ancestor, the arni.

Linnaeus gave the domestic buffalo its specific name, *bubalis*.

The anoa is the smallest wild buffalo. It is confined to the island of Sulawesi (Celebes) in Indonesia, where it lives in mountain or lowland forests. There are two, possibly three subspecies, and they are in danger of extinction.

The tamarao is found only in the island of Mindoro in the Philippines and hence is also known as the Mindoro buffalo. Tamaraos live in thick bamboo jungle in small herds or family groups. In many ways they are intermediate between arni and anoa. And they also are becoming rare.

Domestication and early distribution

It is certain that the buffalo was domesticated very long ago, but when and where are not known. Representations of apparently tame buffaloes appear on seals of the third millennium B.C. found at Mohenjo-Daro in the Indus valley and at Ur in Iraq. Domestic buffaloes were known in China in the second millennium B.C. It is said that they first appeared in Egypt after the Arab conquest in the ninth century A.D. In the Jordan valley they are first recorded in 723 A.D., presumably taken there by the Arabs. There is a traditional belief that they were introduced into Europe by the Mongol invaders, but it seems to be more probable that they were brought by returning crusaders. By the thirteenth century large numbers were kept in Thrace, in the Danubian region and in the Pontine marshes of Italy. Attempts were made to maintain buffaloes in France, England and in Tunisia, but they did not long survive.

Notes on the history of introductions into the various regions wherein they flourish at the present time are to be found in the sections on individual countries (see part II of the present study).

World population of domestic buffaloes

Until very recently it was thought that there were about 70 to 80 million domestic buffaloes in the world, but it now emerges that this is a grave underestimate. There are several contributary factors in the low assessment: in the census returns of some countries buffaloes are included with cattle as bovines; in other areas owners tend to give low numbers for fiscal reasons, or they disregard the annual increase of stocks; in some regions large herds live in a semiwild state and it is impossible to determine

how many there may be at any time. From studies in the "buffalo countries" it seems certain that there must be at least 140 million domestic buffaloes in the world today.

FAO estimates for 1974 for buffaloes were 130 million. Those made over the last ten years show an annual increase in the world population of water buffaloes of about 2 million. Estimates for individual countries are given in the various chapters in part II of the present study.

The two types of water buffaloes

Nearly 40 years ago Macgregor described the two groups which he termed Swamp and River types. The Swamp buffalo is primarily the work animal of the rice-growing countries of the Far East. River buffaloes have been developed by selection in India and Pakistan into many dairy breeds of dairy animals, some of very high performance. The skin of the Swamp buffalo is grey at birth but becomes slate blue later. The skin of River buffaloes is black, but some specimens may have dark slate-coloured skin. Other brown or fawn-grey calves are born in herds of black breeds. There are striking differences between the two types in appearance, behaviour and genetic factors.

Swamp buffaloes are heavy-bodied and stockily built, the body is short and the belly large. The forehead is flat, the eyes prominent, the face short and the muzzle wide. The neck is comparatively long, the withers and croup are prominent. A dorsal ridge extends backward and ends abruptly just before the end of the chest.

River breeds, on the other hand, have comparatively longer faces, smaller girth and bigger limbs. The dorsal ridge extends further back and tapers off more gradually.

The differences between males and females are more marked in River breeds than in Swamp buffaloes.

The horns of the young Swamp buffalo grow outward, and curve in a semicircle, but always remain more or less on the plane of the forehead. The horns of River buffaloes grow downward and backward, then curve upward in a spiral. Even in longhorn breeds like the Nagpuri, the horns sweep backward, not outward, and are twisted, even if only slightly. Great variations are seen in various varieties and breeds, but the basic form of each type can usually be recognized.

All buffaloes love to wallow and, if they are permitted, they will spend the hottest hours of the day almost completely submerged. The Swamp buffalo prefers to wallow in a mudhole that it makes with its horns. Its objective is to acquire a thick coating of mud. River buffaloes, however, prefer deep water. The Swamp buffalo's plaintive cry is the

origin of the Thai name for the animal, *kwai*. The River buffalo generally has a deeper voice.

Crossbreeding between the two types is discussed in the chapter on genetics (see p. 23).

Swamp buffaloes

Apart from recent introductions of River breeds into some areas, the domestic buffaloes of southeast Asia are of the Swamp type. They are widely distributed from southeast China, as far northward as the Yangtse (Yangtze) * river, westward in Viet Nam, Lao, Democratic Kampuchea, Thailand, Burma, Assam, northern Nepal and Sri Lanka; to the south in Malaysia, Indonesia, and the Philippines. It is estimated that there are more than 54 million Swamp buffaloes in these countries. They have been successfully introduced into Australia and into several other areas of Oceania, Brazil and Trinidad. In some countries, for example in the state of Madras, India, both types are maintained.

TABLE 1. — ESTIMATE OF BUFFALO POPULATIONS (IN THOUSANDS) IN COUNTRIES WHERE THE SWAMP TYPE PREDOMINATES

Brunei	17	Philippines	5 000
Burma	1 800	Singapore	3
China	29 929	Sri Lanka	716
Democratic Kampuchea	840	Thailand	5 700
Hong Kong	1	East Timor (former Portuguese Timor)	128
Indonesia	2 870	Viet Nam	2 265
Lao	1 040		
Nepal	3 831		

Malaysia: Sabah, 80; Sarawak, 8; Peninsular Malaysia, 205

SOURCE: FAO. *Production yearbook 1974*.

CONFORMATION

The shoulders of the Swamp buffalo are strong but the hindquarters are generally poorly developed. The tail is short, reaching only to the hocks.

* The spelling of place names is the "pinyin" spelling which has been officially adopted for transliteration by the Chinese authorities.

The udder is small and set far back. The calf often sucks from behind. In the male the penis is closely bound to the belly except for a short free extremity. The purse is short and has no neck, so that the testicles are carried well out of harm's way.

There is a general tendency to underestimate the weight of buffaloes. Estimates of average liveweight of adult Swamp buffaloes range from 300 to 350 kg for Burmese to 500 to 600 kg for those of Lao. Although Thailand is noted for the size of its buffaloes there is a noteworthy variation within the country: the large strains average 450 to 550 kg, while the small varieties only range from 300 to 450 kg. Weights of over 1 000 kg have been observed. The big buffaloes of the island of Sumba average 500 kg against an average of 350 to 400 kg for all Indonesia. Many varieties in China are quite small, and when full-grown may be only 250 kg in weight, but there are some herds of improved families of good size and conformation.

Records of measurements of height at withers show a remarkable uniformity. Of all the measurements commonly recorded, the height at withers is the least affected by nutritional levels and errors of technique. An overall average is 129 to 133 cm for males, and 120 to 127 cm for females. The big buffaloes of Viet Nam attain 150 cm for males and 140 for females.

Typical colour

The characteristic colour of Swamp buffaloes is dark grey or slate grey and the distinctive colour markings are the chevrons, the stockings and head marks. There are, typically, two chevrons: the upper one crosses the underside of the neck just below the throat; the lower one crosses just above the brisket. The skin of the chevron is pale and the hair is white or light grey. Chevrons are distinct in the foetus at about the ninth month of gestation, before the hair grows. Variations in the chevrons are seen in different types and in individual animals. The upper chevron may be ill-defined or missing altogether and the lower one may have forked ends. Many superstitions are associated with chevron patterns.

The arni, the wild buffalo of India, has well-marked chevrons. The Surti is the only River breed that has the marking, but among the buffaloes of Egypt, Iraq and Turkey, some specimens are to be seen, possibly indicating an ancestry including Surti or Swamp progenitors.

The stockings on all four limbs are light grey. In many animals there is also a brown garter just below the knee and hock.

The head markings of the typical Swamp buffalo are also characteristic.

There is a light grey patch near the inner corner of each eye, two white or light grey flecks on each side of the face, and a white "moustache" on the upper lip.

Colour variations

In China, the tan or "reed-flowered" buffalo is seen quite frequently. Piebald and skewbald buffaloes have been noted in several countries. The Toradja people of Sulawesi breed a spotted buffalo of outstanding size, the *tedong bonga,* for fighting and for ritual sacrifice. White spots on a black background, and white with blue-roan patches, are highly prized colours. In Indonesia, there is a "red-pied" variant, and in Australia some light red feral buffaloes are seen. They are said to be less amenable to domestication than typically coloured specimens, and are referred to as "ginger" buffaloes. Tapir-like markings are reported in some areas.

White Swamp buffaloes are present in buffalo populations of many lands. They are quite common in some districts, in others they are rare. Although sometimes referred to as albinos, it is more correct to call them albinoids. Pigment is present in the skin in the form of spots or freckles. The eyes, horns and hoofs are also pigmented and there may be pigment in the skin of the muzzle and in the membranes of the nostrils and mouth. Pigmentation tends to become more widespread as the animal grows older. The skin over most areas is faintly pink or may have a yellowish tinge. On the belly and on the inner surfaces of the legs it may be bright pink, especially in young animals and in those that have been housed for some time. The people of some countries avoid the meat of albinoid buffaloes in the belief that it is associated with leprosy. Many other superstitious beliefs are held regarding these animals in other countries. And in some areas albinoids are not considered eligible for sacrifice, whereas large numbers of dark animals may be taken for that purpose, with the result that the albinoids become relatively more numerous.

There are few reliable reports of albino buffaloes; the occurrence of true albinism is rare.

Hair coat and hair patterns

The amount of hair varies with breed, age, season, altitude and housing; it is always less dense than that of cattle. Buffaloes kept at an altitude of 2 000 m in Nepal, and those in countries with cold winter weather, grow heavy hair coats. Newborn calves have long, dense hair, the number of hairs is fixed before birth and, as the skin grows to cover the extending

area, the density of hair is decreased. The hair coat becomes less dense with age, pregnancy and lactation. Buffaloes have the habit of licking and rubbing each other and this, too, reduces the hair covering.

A distinct beard under the jaw is characteristic of some types and is common in the *desi* buffaloes of India.

Hair whorls are seen in all buffalo breeds; they are most distinctive in Swamp buffaloes. There is a high degree of individuality in the whorls, in their position, size, shape and number. They have been recognized as aids to identification of individual animals for centuries. They are of particular value in those areas where there are religious or other objections to branding and tattooing.

It is generally possible to distinguish hair whorls in the foetus at 60 to 30 days before gestation is complete. They may be situated almost anywhere on the body; the commonest sites are on the head, shoulders and flanks, and they may be of clockwise or anticlockwise pattern.

They are called cowlicks in Malaysia, *kwan* in Thailand, and épis in Lao, Viet Nam and Democratic Kampuchea.

Many superstitions are associated with the hair whorls of buffaloes; there are auspicious types and unfavourable types. The location and type may affect the market value of the animal. Some patterns are considered to be lucky in one country but not in another. One kind is held to presage a short life. There are many other similar beliefs. However, these local prejudices should not be lightly disregarded, for they may exert profound influence on the livestock husbandry of rural peoples.

Some of the names given to Swamp buffalo varieties

The Malay word for buffalo may be represented phonetically as *krbau*. This was modified, in Spanish form, in the Philippines to *carabao*, with the female *caraballa*. In Indonesia, the Dutch variant is *karbouw*. There are many other derivations from the Malay word.

In the Malay language the Swamp buffalo is *kerbau-sawah*, and the River buffalo is *kerbau-sungei* or *kerbau-sapi* for the milch animal. In China buffaloes are *shui niu*.

In the Philippines the word carabao is now used for the imported River breeds as well as for the local Swamp buffaloes. A large type of carabao is referred to as the Cambodian carabao while the mature animal is often called the Shanghai carabao.

The Swamp buffalo of Brazil is considered to be a distinct breed called the *Rosilho*, meaning roan colour.

In several countries numerous varieties or breeds are described and referred to after the names of the districts in which they are bred. Most of them differ only in minor characteristics from the typical Swamp type and it is misleading to call them breeds or even varieties. Considerable variation in colour, size and horn shape may be seen, but representatives of all types may be found in most buffalo populations in southeast Asia. Only the more important varieties are listed here.

In Democratic Kampuchea, the *krabei beng* is a longhorn type of the high forest districts, the *krabei leu* is a shorthorn of the plains; there is also the smaller *moi* variety.

There are said to be many varieties in China: the Haitzŭ of Jiangsu (Kiangsu) province; the Wuchü and the Tangyang of Hubei (Hupeh) province; the Round-barrel type of Jiangsu province; the Yuantung of Fujian (Fukien) province; and also the buffaloes of Gwangxi (Kwangsi), Ping hu and Taiwan.

In Sulawesi, Indonesia, the *tedong bonga* is bred for fighting and ritual sacrifice. It is an animal of outstanding size and spotted colour.

The *bahnar* is a powerful working buffalo of the Mekong valley in Lao.

Many local varieties are described in Thailand. They include the *kwai chan*, a fighting strain, the *kwai jawn*, a small animal of the south, the *kwai kam* of the uplands, the *kwai pra* near the Burma border, and the *kwai glapp*, *kwai marid*, and *kwai tui* of the central plain.

Performance

Although Swamp buffaloes are the most efficient work animals for the cultivation of land in the rice-growing areas, they are also employed in a wide range of tasks, many of which are described in the chapter on the working buffalo (see p. 114).

The potentials for meat and milk production are discussed in the chapters on milk and milk production (p. 121), and on meat and meat production (p. 137).

River buffaloes

Distribution

River buffaloes have been carefully selected and bred for many generations in India and Pakistan, and improved dairy breeds have evolved. In addition to their outstanding contribution to the welfare and economy of their native states, they have been used with great success in several

TABLE 2. — ESTIMATED POPULATIONS (IN THOUSANDS) OF WATER BUFFALOES IN COUNTRIES WHERE THE RIVER TYPE PREDOMINATES

Africa, Egypt	2 150	Europe, Albania	2
Asia, Afghanisan	33	Bulgaria	67
India	60 000	Greece	8
Iran	460	Italy	80
Iraq	309	Romania	218
Pakistan	10 199	Yugoslavia	62
Syria	1	U.S.S.R.	433
Turkey	1 023		

SOURCE: FAO. *Production yearbook 1974.*

other lands to improve local stocks and to provide milk supplies to many cities. They have also been introduced effectively into countries where domestic buffaloes were previously unknown.

Distinctive breeds have evolved in different regions. Some have been fortified by recent introductions of selected sires from India and Pakistan, and others have been crossbred with many types.

The River breeds will be considered in the following order: those of northwest India and Pakistan; the Gujarat breeds; the Uttar Pradesh breeds; the breeds of central India; the south Indian breeds; the buffaloes of the Near East, the U.S.S.R. and Europe; and finally the recently introduced buffaloes in other regions of the world.

NORTHWEST INDIA AND PAKISTAN

The Murrah group comprises the Murrah, Nili-Ravi and Kundi breeds. Buffaloes have long been selected in this part of the subcontinent for high milk yields and for curled or Murrah horns. The Murrah breed is also known as the Delhi from the centre of origin, whence it spread due to its capacity for milk production to the valleys of the Ravi and Sutlej rivers, to the north of Sind and to western Uttar Pradesh. Consignments have been exported to other parts of India and to many other countries.

Varieties developed in the various areas into distinct breeds: the Ravi, Nili, and the Kundi. With partition, in 1947, the breeding areas of the

Ravi and the Kundi and most of that of the Nili were included in Pakistan, thus giving political support to the recognition of separate breeds. The Nili and the Ravi are, however, so similar that they are no longer considered to be separate breeds and are generally referred to as the Nili-Ravi breed. Many consignments of buffaloes exported as Murrahs prior to the second world war may have included any of these breeds.

The animals are all massive, sturdy, with deep, wide frames, short limbs and heavy bones. The horns are short and tightly curled. They have well-developed udders, conspicuous milk veins and squarely placed teats. They are tractable, easily handled and the milk is readily let down.

The Murrah

Jet black skin and hair is the most popular colour, a white tail switch is preferred, and a whole black tail is considered unlucky. White markings on the head and legs are undesirable. Some brown or fawn-grey, *bhurra*, specimens are seen, even in herds long bred for black colouring. White buffaloes are extremely rare and are not eligible for registration in the Murrah herdbook.

Adult males weigh 450 to 800 kg, but unusual specimens may attain 1 000 kg. Females weigh 350 to 700 kg, exceptionally up to 900 kg. Reports from other sources give rather lower figures. The average height at withers of adult males is about 142 cm, and of females 133 cm.

Murrah buffaloes, in spite of their size, are not suitable for draught work, being slow and not heat-tolerant. They are, however, used for haulage work in many places in northern India.

High average milk yields are recorded for many lactations at military dairy farms (see p. 123). The minimum yield for herdbook registration is 1 360 kg in 300 days, with at least 7 percent butterfat.

The Nili-Ravi

The name Nili means blue and refers to the river Sutlej. The Ravi is also called the Sandal Bar breed, from that part of the Ravi valley where it is most abundant.

Black is the usual colour of skin and hair but there may be up to 15 percent of brown animals in some herds. Walleyes, which lack pigment in the iris, are often seen. White markings on the forehead, face, muzzle, legs and a white tail switch are typical and desirable characteristics of the breed. Pink markings on the udder and brisket are sometimes present in Ravi buffaloes but rarely in Nili. Extension of white patches above the knee or hock and over the neck and body preclude registration. The horns are short, broad at the base and closely curled. Loose, hanging horns, called *deli* or *dheli*, may be seen in up to 2 percent of Nili-Ravi

buffaloes. The udder is well developed, extending well forward and behind. The teats are long and evenly placed.

The average weight of the adult male is nearly 600 kg, that of the female about 450 kg.

At the Bahadurnagar farm, 538 Nili-Ravi females averaged 2 000 kg in lactation records for 300 days.

The Kundi

Kundi buffaloes are distributed over a wide area of rice-growing tracts along the river Indus in the north of Sind.

The name is derived from *kundhi*, meaning fishhook, applied to the shape of the horns which are thick at the base, inclined backward and upward, and ending in a moderately tight curl. Some may have several coils.

The typical colour is jet black but up to 15 percent of light brown specimens may be seen in some districts. White Kundi buffaloes have been reported but they are very rare. Appreciated points are a white star on the forehead, white tail switch, four white hoofs, and walleyes, called *maniki* eyes.

Kundi buffaloes are smaller than the other breeds of the group. Liveweights range from 320 to 450 kg.

Milk yields average 9 kg daily, with good specimens giving up to 18 kg. Ten at Sukkur farm averaged 2 120 kg in an average total lactation of 316 days, or more than 11 kg per day over the first five lactations.

Buffaloes in Sind are rarely worked or fattened. Most of the male calves are slaughtered or allowed to die.

The Gujarat breeds

The Surti, Mehsana and Jafarabadi breeds are found in separate districts of northern Gujarat.

The Surti

Also called the Surati, derived from the town of Surat. Although they are bred well to the north of the town, it is the port through which they were exported. Alternative names indicate distribution: Charotar, Deccani, Deshi, Gujarati, Nadiadi and Talabda.

The general colour is black or brown. The skin is black or reddish, the hair silver grey to rusty brown. Typical specimens have two white chevrons. The hair below the knees and hocks is usually whitish grey and there is often a streak of white above the eyes. The lower border

of the ear may be fringed with white hairs. Animals with white markings on the forehead, legs and tail switch are preferred. The horns are of medium length and sickle-shaped, curving downward and backward and upward, ending in a hook at the tip.

The Surti is well shaped, of medium size, with a straight back. It is quite low on the legs.

The udder is well shaped and well set on the body, the skin is pinkish and the teats are squarely placed.

Typical mature males weigh 640 to 730 kg, and females 550 to 650 kg. The average height at withers of males is 131 cm, and of females 124 cm.

The average of 335 lactations at the Poona Agricultural College was 2 090 kg, with 7.9 percent butterfat. The average length of lactation was 350 days and of dry periods 111 days.

The Mehsana

The centre of this breed is around the town of Mehsana. They are also bred around other towns in northern Gujarat. They are kept for milk production in the cities of Ahmadabad and Bombay. The breed may have been developed from Surti and Murrah crosses. Murrah males are frequently used.

Colour and conformation are very variable. Jet black skin and hair are preferred. Undesirable characteristics are light brown, fawn-grey and white specimens; white markings on the face, body, legs, hoofs and horns; and a white tail switch. Horn shape is variable, typically sickle-shaped, with more curve than the Surti and less than the Murrah.

Compared with the Murrah, the Mehsana has a longer body, lighter legs and longer, heavier head. It is about the same size as the Surti. The udder is well developed and carried well behind. The hindquarters are more capacious than the forequarters, and the teats are fairly long, thick and pliable. The Mehsana is docile, easy to handle, and has a reputation for regular breeding and persistent lactation. Bombay milk producers consider them to be more profitable than Murrahs.

The height at withers of the typical adult male is 132 cm; the female is about the same.

These buffaloes are not used for work. Calves are neglected and many die of starvation.

The Jafarabadi

The name is derived from the town of Jafarabad. Other names are Bhavanagri and Gir, from the Gir forest of Kathiawar (Saurashtra) in Gujarat.

The typical Jafarabadi is black. Compared with the Murrah, the body

is longer, the frame more loosely knit, the head and neck more massive and there is a well-developed dewlap. The forehead is very prominent. The horns are heavy and broad and inclined to droop, sometimes covering the eyes, and curving up at the point in an incomplete coil.

The average liveweight of adult males is about 590 kg, and of females 454 kg. The height of the male is 142 cm, and of the female 140 cm.

The milk yield of a good specimen is up to 18 kg daily, or 1 800 to 2 700 kg in a lactation. The butterfat percentage is high and the milk is valued for the preparation of ghee. Jafarabadi buffaloes have been introduced with great success into Brazil, Trinidad and other countries.

The Uttar Pradesh breeds

The Bhadawari

The home of the breed is the Bhadawari estate, in Agra, and the adjoining areas of Gwalior state. An alternative name is the Etawah from the district of that name; another is the Badavan. They are kept in scattered areas in the valleys of the Jamuna and Chambal rivers.

The Etawah may be a local type improved by crossing with Murrahs, giving higher milk yields with a lower fat content.

The typical Bhadawari is copper-coloured, with scanty hair which is black at the roots and reddish brown at the tips. Crosses with the Murrah are black. The horns are compact, flat, growing backward, upward and inward.

The legs below the knees and hocks are usually brownish white and the tail switch is white or black and white.

The udder is not so well developed as in the Murrah. The teats are of medium size but not of uniform length.

The average milk yield is only about 3 kg per day, but the butterfat content may be as high as 13 percent. Ghee-making is the common village industry. At a state livestock farm the average yield of 80 females in 246 lactations was 1 250 kg in 276 days.

Bhadawari males are often worked. They stand the heat better than other breeds and they are more suited to the needs of the villagers.

The Tarai

This is a local breed of the hills of northern Uttar Pradesh and has not been subjected to systematic improvement by selection. It is frequently crossed with the Murrah. A similar type is found in the Terai area of Nepal.

The colour varies from black to brown. There is a white blaze on the forehead of some specimens. The tail switch is white. Typical horns

are long and flat, curving backward and upward. The Tarai is not very massive. The legs are short but strong, and the tail reaches to below the hocks.

Milk yields are low, 2 to 3 kg daily or 450 kg in a lactation of about 250 days.

Tarai buffaloes are, however, well adapted to the difficult climate and nutritional conditions of the environment.

Central Indian breeds

Six breeds are described in central India: the Nagpuri, the Pandharpuri, Manda, Jerangi, Kalahandi and Sambalpur. There are also many local strains.

The Nagpuri

The alternative names of these buffaloes indicate their wide distribution: Berari, Ellichpuri, Gaulani, Gauli, Marathwada, Durna-Thali or Varadi.

The Nagpuri are usually black. Some animals have white markings on the face, legs and tail switch. The horns are long and flat, curving back nearly to the shoulder. They are more lightly built than the breeds of northern India and Pakistan.

Adult males may attain about 522 kg body weight, while the females only average 408 kg. The height at withers of the male is 142 cm, and that of the females 132 cm.

Although the milk yields are lower than those of the northern breeds, from 5 to 7 kg daily, the Nagpuri is the chief milk producer of Madhya Pradesh and Hyderabad. At the government farm at Aurangabad, 22 females, in 69 lactations, averaged 960 kg.

The males are used for heavy draught, but they are slow. However, they are reputed to require less water for sluicing or spraying than other breeds.

The Pandharpuri

This local breed of southeast Maharashtra is similar to the Nagpuri. It is hardy and well suited to the arid region. In Mysore it is called Dharwari.

Pandharpuri buffaloes are medium-sized, compact and fairly good milkers. Their horns are even longer than those of the Nagpuri.

The Manda

These buffaloes are bred in the hills on the borders of Orissa and Andhra Pradesh, reared in areas of thick forest and brought down to the

plains for sale in large numbers. They are referred to as Manda (meaning herd), Parlakimedi or Ganjam buffaloes.

The general colour is brown or grey. There are yellowish tufts of hair on the knees and fetlocks and the tail switch is yellowish white. The horns are broad and semicircular.

The Manda is medium-sized, smaller than the other breeds of the region. The height of mature males is about 132 cm.

As a work animal the Manda is hardy and able to draw a load of 0.5 ton, but at a slow pace. It can work in the hot sun like a bullock. It is economical to feed and thrives well under varied conditions.

The Jerangi

These small buffaloes are bred in the hills of Orissa. Because of their small size and rapid pace, they are sometimes referred to as "deer buffaloes."

They have thin, black skin and black hair. The body and head are short. The small horns curve backward. The tail is thin and short. Height at withers is from 107 to 114 cm.

Jerangi buffaloes are very useful for working wet lands with light soils, more suitable for ploughing than for carting, yet they can pull useful loads. They are nervous in traffic but trainable, hardy but not very heat-resistant.

The Kalahandi

Named after its habitat in the Kalahandi Samasthanam of Orissa, the breed is also called Peddakimedi, after the people of that name who take them for sale into the plains.

The Kalahandi is a large, short-barrelled animal, grey or ash grey, with a white tail switch. The horns are broad, long and curve backward, then turn forward slightly at the tip. The eyes are large and prominent and have a narrow red rim around the lids.

The chest is well developed and the skeleton is very strong.

Kalahandi buffaloes are reputed to be better milkers than local non-descript animals. They are hardy and withstand heat and sun better than other local breeds. They are simple to feed and require less water for bathing. Docile and good workers, they are used for cultivating padi land, for haulage and sugarcane crushing.

The Sambalpur

Calves are taken from Madhya Pradesh to Sambalpur, Orissa, for rearing and later sold in other districts. Alternative names are Gowdoo (meaning cowherds) and Kimedi.

Typical specimens have black skin and hair but brown and ash grey individuals are occasionally seen. The tail is long and the switch is white. The horns are short, narrow and curved backward, then upward and forward at the tip.

The Sambalpur is big and powerful, with a long, narrow body. The animals require more careful management and better feeding than other local varieties. Given these, they breed regularly and produce more milk than the Kalahandi, Manda or Jerangi buffaloes; 12 selected females gave 2 270 to 2 720 kg in 340 to 370 days, with a daily average of 7 kg.

These buffaloes are exceptionally docile, yet active and quick-moving. They are good, heavy draught animals, although they cannot work in the sun for more than short periods.

South Indian breeds

Many local names are given to local types of nondescript buffaloes in southern India. They are being replaced gradually by more productive breeds from central India. Two south Indian breeds are described here, the Toda and the South Kanara.

The Toda

The Toda tribe of the Nilgiri hills of Madras breed this special type of animal that has some of the characteristics of the Swamp buffalo of Sri Lanka. Their numbers are declining as the urban area of Ootacamund extends into the Nilgiris.

The typical Toda buffalo is of exceedingly powerful build, with a very long body, and short, sturdy legs.

Horns are variable in shape, usually set wide apart, with points recurved inward and forward. Along the crest of the neck and back there is a thick mane.

The Toda is a good milker, giving yields of 4.4 to 8.8 litres daily of rich, well-flavoured milk.

These animals are very important in such tribal ceremonies as those associated with birth, betrothal and funerals, but they are not used for agricultural work or meat.

The South Kanara

These buffaloes have also been called the Malabar breed. A Hindu sect, the Jain Bants, own these fine, hardy animals. Some of the best specimens may be seen around Mangalore on the west coast. They are used for agriculture and for racing, one of the great amusements of these people.

Desi *buffaloes*

Most of the buffaloes of the Indian subcontinent are nondescript, *desi* mongrels. In Bangladesh, for example, there is no defined breed and virtually all are *desi* buffaloes.

Different varieties are described in various countries, generally given local names but, as a result of uncontrolled breeding, their characteristics are very variable.

In Trinidad, they are called "bison" or "hog cattle."

Specimens with chevrons and white stockings may be seen occasionally, even in areas where River breeds predominate.

Many *desi* buffaloes are very small and of poor quality. Commercial movements constitute a danger to the type of animal of the receiving districts.

On the other hand, the production potential of some varieties, for example some of those of southern India, might be worthy of investigation.

Notes on the buffaloes of Bangladesh, Nepal and Sri Lanka are to be found in the chapter on the buffaloes of the Indian subcontinent (see p. 163).

The buffaloes of the Near East and Europe

In Asia, west of Pakistan, River buffaloes are kept in many parts of Afghanistan, Iran, Iraq, Jordan, Syria, Turkey and the U.S.S.R. They also constitute an important sector in the livestock of Egypt, of Italy and the Balkan countries. They are similar to the buffaloes of India and Pakistan.

Iraq

Most of the buffaloes are found in the marshes of the southeast. Some herds are kept for milk production in the principal towns.

FAO estimates for 1974 for buffaloes were 309 000. Figures show a recent annual increase of about 10 000.

Most of the Iraqi buffaloes are slate black in colour but many are grey and some are reddish or dun at the extremities. White markings on the head, legs, body and tail are very common, and walleyes also often occur. Occasionally an individual may be seen that might be described as white with black patches.

The horns are of the open-sickle shape; those of the buffaloes kept in the north are more acutely curved. Around Basra whole herds may have horns that slope halfway along the neck and curve upward only in the last quarter.

All Iraqi buffaloes are robust but lack the fine qualities of the better Indian breeds. The withers are high and the croup and haunch bones

are prominent. The body is rather elongated and the legs are long but not coarse. The udder is seldom big or fleshy. It is carried well back and has good-sized and well-placed teats.

Marsh buffaloes look taller and more leggy than those kept in other parts of the country. This is attributed to the rough conditions of their environment rather than to genetic differences. The average height at withers of mature females is 143 cm.

Milk yields in well-managed herds are from 12 to 14 litres daily at the height of lactation, or 1 600 to 1 800 litres in a lactation of about eight months. Marsh buffaloes give about 5 litres a day in a lactation period of about four or five months.

Iran

Buffaloes are bred in Khuzestan, Iran, contiguous with the marshes of Iraq, and it is presumed that they belong to the same population as the Iraqi marsh buffaloes. They are of a uniform type, dark grey in colour, more than 140 cm in height and weighing about 400 kg. There is another population in the northeastern provinces between the Elburz mountains and the Caspian sea. Milk yields of up to 2 500 litres in a 200-day lactation are reported. The males are used as draught animals.

Some Murrahs have been imported.

FAO 1974 estimates for buffaloes are 460 000, and the numbers appear to be increasing steadily.

Afghanistan

It is estimated that there are about 33 000 buffaloes in Afghanistan; their numbers and popularity are increasing. They are kept in a few well-defined areas such as Baghlan in the north, around Kabul and Jalalabad in the east, and along the northeast frontier with Pakistan.

The great majority are *desi* nondescripts, with some of the characteristics of the Murrah, Kundi or Nili-Ravi breeds. Some are used for work and a few for milk.

Syria

The buffalo population of Syria is declining, and it is believed that there are now no more than 1 000. They are black in colour, with medium-sized horns, directed backward. They are rather large animals with broad, sharply sloping rumps. Milk yield is 400 to 600 litres per year, with 6 to 9 percent butterfat. They are also used for draught purposes.

Jordan

There is one herd of a few hundred buffaloes in a swamp area of Jordan.

U.S.S.R.

Caucasian buffaloes are bred in north Caucasus, particularly Dagestan, and in the Transcaucasian republics. They are most numerous in the Kura river valley and along the coast of the Caspian sea in Azerbaidzhan, and in Georgia.

According to FAO estimates, the number of buffaloes in the U.S.S.R. in 1974 was 433 000.

The skin of the Caucasian buffalo is dark grey and the hair is black; in some animals it may be dark brown. A white star on the forehead and a white tail switch are common. The horns are of medium size, curving backward; the points turn upward and inward. The face is long and narrow, the withers are high, the back short and wide and the hindquarters wide and sloping. The legs are long, thick and heavy-boned.

Average liveweight varies in different districts; that of adult males ranges from 416 to 560 kg, females from 390 to 618 kg. Height at withers of mature females in various districts ranges from 124 to 135 cm. The buffaloes of the lowlands are bigger than those of the highlands.

The Caucasian buffalo is a triple-purpose animal but milk is the most important product. The average yield on ordinary farms is in the range of 750 to 1 000 kg per lactation. Where feeding conditions are good it may reach 1 500 kg. Females registered in the state and regional herd-books have averages of 1 360 to 1 724 kg.

These buffaloes are rarely slaughtered for meat until they are at least 3 or 4 years old, and often not until they are at the end of their milking or working usefulness. Adult males gained 1 kg per day during a feeding trial, and dressed out at 48 percent. The corresponding figures for females were 0.7 kg and 49 percent.

Turkey

The Anatolian buffalo is bred in the northwestern half of Turkey, including Thrace. The most important populations are along the coasts of the sea of Marmora and of the Black sea. In some areas they are kept intensively; a few are kept near the coast of the Aegean sea.

FAO estimates of the number of buffaloes in Turkey in 1974 were just over 1 million, and tending to decline.

The skin is dark grey to black with black muzzle, horns and hoofs. The hair is usually black to black-brown. There are often white markings on the forehead and tail switch, less commonly on the legs. White and pied animals are extremely rare. The horns are of medium length, sickle-shaped or semicircular, directed backward and slightly upward.

The body is coarse and angular, the belly rounded and voluminous. The legs are strong and heavy-boned.

Average liveweight ranges from 350 to 900 kg, but that of buffaloes sold in the market at Istanbul during a four-year period was only 404 kg. The height at withers varied in different districts from 124 to 139 cm. The biggest buffaloes were those kept at the government stud farm, then those in the vicinity of the sea and in the west.

Milk production at the Karacabey stud farm averaged 1 066 kg in 145 lactations of 218 days. Butterfat average was 8 percent. The national average lactation yield is estimated at 770 kg.

Egypt

About 63 percent of the Egyptian buffaloes are in lower Egypt, 20 percent in middle Egypt, and the remainder in upper Egypt. FAO estimates for the number of buffaloes in 1974 were just over 2 million, and tending to increase.

Two varieties are described: the Beheri of lower Egypt, and the Saidi of upper Egypt. The Beheri is large, slate grey, with a smooth skin. It is a good milker. The Saidi is smaller, almost black, more hairy, a poor milker and primarily a working animal.

The buffaloes of lower Egypt have been further divided into the Menoufi of the south of the delta, the Beheri of the province of Beheira, and the Baledi. They are distinguishable in general appearance but there is little difference in measurements. The Menoufi may have a shorter body but nearly the same height as the Beheri. It is probably sufficient to refer to the Egyptian buffalo without attempting to define varieties.

Some Egyptian buffaloes have pale chevrons, typical of the Surti and Swamp breeds, but less distinct. Walleyes and white spotting on the head and elsewhere are disliked. The horn shape varies from lyre- to sword-shaped. The "Egyptian horns" are preferred: comparatively short, curved backward alongside the head and upward at the tip. The head is long and the ears are long and drooping.

The body weight ranges from 360 to 800 kg. The average of 200 adult Menoufi females was 617 kg. Average height at withers varied between 134 and 142 cm. Menoufi females may be shorter, lower and wider in the body than average Egyptian buffaloes.

The average lactation yield in farmers' herds is estimated at about 680 kg but, on farms of the Ministry of Agriculture and of university departments, herd averages range from 1 300 to 2 000 kg, with a mean of 1 700 kg. Ministry of Agriculture statistics give an average for mature buffaloes of 1 168 kg and for younger animals of 898 kg.

Egyptian buffaloes have been exported to several countries in Africa and South America.

THE DOMESTIC BUFFALOES OF EUROPE

Buffaloes are kept in all the countries of the Balkan peninsula from Thrace in the east to Albania in the west and from central Greece in the south to Transylvania in the north. There are about 100 000 in Italy. The total population for Europe may be around 456 000.

They are all of the same general type and differ chiefly in size. The buffaloes of Greece, Yugoslavia and Albania are considerably smaller than those of Bulgaria, Romania and Italy. They have been given the names of Balkan and Mediterranean buffaloes. The Anatolian buffaloes of Turkey form part of the same general population and are of a similar type. Further observations on the buffaloes in all these countries are to be found in the chapter on the domestic buffaloes of Europe (see p. 223).

The common colours are black, dark grey, grey-black, black-brown, dark brown and slate black. White markings are sometimes seen, but in Italy they preclude registration in the herdbook of the province of Caserta.

Partial depigmentation of the iris of the eyes is sometimes seen and is termed blue eyes.

Horns are of medium length; those of the female are longer and thinner than those of the male, and those of the castrate are longer still. They are directed backward and sideward with the tips curving upward and inward to form a crescent or lyre shape.

The face is long and narrow and there are long sparse hairs on the lower border of the jaws. The body is thickset and the legs are short and sturdy. The withers are prominent and higher than the sacrum. The chest is deep and the abdomen voluminous. The tail is short, but being set deep and low, it reaches to the hocks.

The udder is of medium size but well shaped, with evenly spaced teats.

Average liveweights of mature males range from 400 kg in Greece to 800 kg in Italy; of females from 250 kg in Albania to 617 kg in Bulgaria. Height at withers varies from 120 cm in the Macedonian buffaloes to 136 cm in the Italian breed.

The Balkan buffalo is a triple-purpose animal. Milk production is, however, increasing in importance while its use for draught is declining. In Bulgaria and Yugoslavia considerable emphasis is now being placed on the production of buffalo meat and meat products. In Greece animals slaughtered at 18 to 24 months of age dressed out at 50 percent.

In Italy, buffaloes are kept for intensive or semi-intensive milk production. Herd averages range from 1 500 to 2 200 kg per lactation. Estimates from other countries are often much lower as the calves are gen-

erally suckled naturally. The well-known mozzarella cheese of Italy is made from buffalo milk, sometimes mixed with cow milk, and almost all the production of the Italian buffaloes goes into its preparation.

The Mediterranean type is recognized as a breed by the Brazilian Herdbook Society.

Introduction into Africa, America and Australia

Notes on the introduction of water buffaloes into many areas of these continents are given on pages 236, 244, and 256 respectively. Notable success has been achieved in Brazil with several breeds. In the Northern Territory of Australia feral Swamp buffaloes provide valuable meat supplies and animals for redomestication under ranch conditions.

2. GENETICS. BLOOD GROUPS

Mendelian genetics

All inheritance is due to genes but the individual genes are not always identifiable. Those controlling such characters as colour and variations in structures of animals are usually identifiable. They are the qualitative characters identified by Mendel and the genes controlling them are called Mendelian genes. They may be dominant or recessive. Their study has not yet progressed far in buffaloes.

Another group of characters controlled by identifiable genes are the polymorphic protein types in blood and milk, including blood groups.

Chromosomes

The Swamp buffalo has a diploid number of 48 chromosomes and the River type 50, but the amount of chromosomal material is similar in the two types. The Swamp buffalo lacks one of the smallest chromosome pairs, but the first chromosome pair has longer arms and is metacentric rather than submetacentric.

The Swamp × River cross has diploid 49 chromosomes. Another generation backcrossed with a Swamp sire has also 49, but third and fourth backcrosses with Swamp sires have the typical Swamp chromosome pattern.

All crosses between the two types are fertile, in contrast with crosses of other species with different chromosome patterns. For example, horse × donkey hybrids are all sterile; in the European cattle × American bison hybrid, sometimes referred to as the cattalo or beefalo, only the male hybrid is sterile. It has recently been claimed that fertile male hybrids have been bred.

Water buffalo hybridization

Mating between domestic cattle and water buffaloes has often been observed and artificial insemination has been tried but no case of conception has been confirmed. Hybrids have been reported but not scientifically investigated and the possibility of their existence seems most improbable.

European and Zebu cattle, bison and yaks have diploid 60 chromosomes and the pattern is quite different from that of water buffaloes. The Cape buffalo has 52, the Congo buffalo 54 and the gaur 58.

Colour

When black River and grey Swamp buffaloes are crossed the progeny are invariably black; thus black is dominant. On the other hand, they lack chevrons and white stockings which are presumably recessive characters.

Many black River breeds have white markings on the head and tail switch and the general pattern is retained in crosses with grey Swamp buffaloes. There is, however, great variation in the distribution of white.

Albinoid Swamp buffaloes are quite common in some areas, for example in the north of Thailand, but they are extremely rare in River breeds. They have been seen in Bulgaria, Yugoslavia and Pakistan. Evidence on the mode of inheritance is conflicting but it is generally believed to be recessive. There is a strong prejudice against the colour in some areas and albinoid males are rarely used for breeding. It is just possible that white is recessive to black in River breeds and dominant in Swamp buffaloes, but it is more likely that it is recessive in both. In cattle both dominant and recessive white genes are known.

Brown calves are quite frequently produced by black parents even in herds where brown animals are culled. There is no information on brown × brown matings. All breed standards prefer black and there is persistent selection against brown but, in spite of this, the frequency may still be quite high in many herds.

Piebald

There is no information on the mode of inheritance of the various piebald, skewbald, red-pied and red-black pied characters. In cattle pied is usually recessive to self-colour.

Red

Red buffaloes, similar in colour to red shorthorn cattle, have been reported in Thailand. In China, tan or reed-flowered buffaloes were described, but later investigations suggest that they are merely light grey-brown specimens, with red-brown hair.

Walleyes

River buffaloes not uncommonly lack pigmentation of the iris of the eye, referred to as walleyes or glass eyes. When the lack of pigment is

complete the eye appears to be blue. One or both eyes may have the characteristic. They are rare in Swamp buffaloes and common in River breeds, particularly in the Nili-Ravi. In crosses between a walleyed River male and Swamp females there were 25 walleyed progeny, indicating a dominant inheritance. Mating between walleyed River males and females produced 87 walleyed offspring out of 89, while no walleyed offspring came from normal-eyed matings. Walleyed offspring from normal-eyed parents have, however, been observed. Unilateral walleye in a Bulgarian buffalo, the progeny of normal parents, has been reported. The occurrence of unilateral walleyes suggests incomplete penetrance by a dominant walleye gene, or inheritance in a recessive manner.

Horns

Hornless buffaloes are very rare, and the condition is often associated with defects of the genital organs. A few naturally hornless buffaloes have been seen in Indonesia, Peninsular Malaysia, Papua New Guinea and Iraq. Loose, hanging horns are more common both in Swamp and River types. When affected animals are mated to normal animals they produce offspring with normal horns. It is possible that, as in cattle, hornlessness is due to a single dominant or semidominant gene but that the range of expression in progeny may extend from complete hornlessness, through scurs and hanging horns, to short or even normal attached horns.

The size and shape of horns of offspring of parents with different kinds of horn are always intermediate between the parental types. This suggests that horn size and shape are quantitative characters controlled by multiple genes, not by single gene differences.

Udder

Abnormalities of the teats are rare — teats lacking, more than the normal four, or teats fused together — but have been noted in buffalo females. Since these conditions are hereditary in cattle, it is probable that they are hereditary in buffaloes also, but they are not necessarily due to single genes.

Tail

Short tails have been seen in Malaysian Swamp buffaloes and in Murrahs. Before a genetic cause is assumed it must be confirmed that the shortness of the tail is not due to accident or tail necrosis (see p. 68).

Crossbreeding

At one time it was suggested that Swamp and River buffaloes would not cross, since an adult of one type suddenly confronted with an adult female of the other reacted with either alarm or indifference. However, if the two types are reared together from calfhood, there is no difficulty. This is now a common practice in several countries.

The crossbreds inherit the black colour of the Indian parent but are intermediate between the two types in conformation and in the shape of horns. Reports from the Philippines indicated that the crossbreds were heavier and taller at birth and had a higher growth rate than either pure breed. It was also reported that the crossbreds had superior milk yields, size and draught capacity. These claims suggest a useful source of hybrid vigour. However, a report from Sri Lanka suggests that first crosses are intermediate in milk yield between the parent breeds.

Inbreeding

There is no information on the effects of inbreeding buffaloes but, from the results in cattle, it can be predicted that it would increase calf mortality, reduce birth weight, fertility and milk yield, and slightly reduce growth rate and adult size, but would have little effect on butterfat percentage.

Blood groups and protein polymorphisms

Another group of characters that are controlled by single genes comprises the polymorphic protein types of blood and milk, including blood groups.

A large number of blood groups are known in the human and in many domestic animal species. They are important tools in research on animal breeding, confirmation of pedigrees, on the causes of certain diseases and on the zoological relationship between species. Knowledge of inherited blood characteristics has been lacking but is now accumulating, thanks chiefly to research in India, Bulgaria and Italy.

Three different kinds of test are used to identify blood groups. In cattle, sheep and buffaloes the haemolysis test gives the best definition of result. In early work, using blood of cattle and buffaloes, some identical factors were found to be present in both species. Later, a very close parallel was found to exist between the J systems of the two.

Blood from a sample of Swamp buffaloes, tested against 56 cattle reagents, showed varying degrees of reaction to 25 of the reagents. The two species share at least three antigenic factors. Blood of River buffaloes reacted to about half of the reagents.

In recent research in India, using 33 buffalo reagents, many subgroup antigens were detected. In Italy, 38 ut of 42 cases of uncertain parentage in buffaloes were resolved by the use of 15 blood group factors, 4 serum allotypes and 2 polymorphic serum proteins.

Protein polymorphisms

New techniques for separating proteins have led to the detection of a great number of genetic protein variants in man and farm animals. Using starch gel electrophoresis, the migration of coloured protein, such as haemoglobin, can be seen directly on the gel. Colourless proteins are rendered visible by stains, and special techniques show the multiple molecular forms of enzymes.

The pattern in haemoglobin of buffalo blood appears to be more complex than in that of cattle or sheep. It is believed that the variants are genetically controlled.

The blood proteins include albumins, transferrins and esterases. Three types of transferrins have been identified in the blood of Swamp buffaloes. Three types were also found in Bulgarian and Murrah buffaloes, but it is not known if these types are identical with those in Swamp buffaloes.

Polymorphism has also been found in serum albumins of Murrah buffaloes. Studies suggest that the variation is controlled by two co-dominant genes. A similar variation was found in Bulgarian buffaloes.

Three types of serum amylases were detected in Bulgarian buffaloes, also controlled by genes.

Research on blood groups and protein polymorphisms in water buffaloes, and in other domestic animals living under similar conditions, deserves much more attention than it has received in the past.

Quantitative genetics

Variation in productive traits, like milk yield and growth rate, is due to many genes whose individual effects cannot be determined because they are small and are obscured by environmental influences. These are the quantitative characters and their study is based on analysis of the resemblance and the differences between related individuals. The extent to which the performance of an individual is repeated from one year to

another is defined as the repeatability of the character. It is, of course, influenced by many factors, including genetics, management and disease. Heritability of a character is defined as the proportion of the superiority or inferiority of the parents that is transmitted to the offspring.

The information available is derived from studies of records of River breeds in Egypt, India, Italy and Pakistan.

Reproduction and fertility

The age at first calving is normally controlled by the breeder and the genetic factor may be disregarded, although it has been shown to be considerable. There is genetic correlation between body weight at one year of age and the age at first calving. Repeatability and heritability of fertility are low.

The number of calvings in a lifetime is affected to a greater degree by culling, infertility, accident and disease rather than by genetic factors.

Calving interval

The period between one calving and the next may be divided into the gestation period and the service period, that is, the interval between calving and the next successful service. Variability of the gestation length is very low. Repeatability and heritability of the service period might be expected to be very low, but some high figures have been reported.

Milk yield

The repeatability of milk yield is remarkably consistent and the results of studies are very similar to those obtained in dairy cattle. In milk records, persistency of yield is not so important as initial or maximum yield. Investigations show that the genetic factors in the case of buffalo females are within the range of those of dairy cattle. Milk composition — fat and solids nonfat — has a high heritability and is less affected by environmental factors than the yield. The butterfat percentage of buffalo milk is already high and it might be advisable to study the level of protein in milk when selecting for production.

Body weight and growth rate

Most estimates of heritability of birth weight are high. The connexion between length of gestation and birth weight does not appear to be very close in buffaloes. Similarly, the connexion between length of gestation, sex of the calf and birth weight does not show any significant variation.

Body weight at given ages, and weight gain during the periods between these ages have high heritability.

Genetic improvement

In comparing females and evaluating males with a view to selection for breeding, care must be taken to avoid the confusion that environmental factors may cause. Improvement of fertility can only be attained by attention to details of management and health control, but some success may possibly ensue from crossbreeding, which sometimes leads to hybrid vigour.

The heritability estimates for milk production traits in buffaloes, although variable, are sufficiently similar to those in cattle to assume that the same breeding programmes would be appropriate. Improvement in yield by selection without progeny testing within a closed herd will be slow. Attempts to improve yields of Swamp buffaloes by selection would be too slow. It would be much more rewarding to introduce River breeds and to use them for grading up the local animals.

Studies of records of the performance of Egyptian buffaloes on state farms suggest that progeny testing of males on the basis of milk yields of five daughters may be recommended. Selection should include careful attention to the conformation of udder and teats.

In view of the high repeatability of yield, selection should be based on first lactations. The accuracy of selection is not necessarily increased by waiting for the results of a second lactation since, in cattle at least, heritability of second lactation yield is lower than that of the first. Selection for colour, horn form and body conformation must be discouraged, since they are not related to milk production. Increase in yields tends to lower the percentage of total solids in milk, so it is advisable to cull females that give milk with low percentages.

In selecting dams of breeding sires it may be desirable to wait until the completion of three or four lactations to ascertain the durability of the female — that it has remained healthy, free from udder trouble, and that it has bred regularly.

Since growth rate and body weight are characters of high heritability, which can be measured in the breeding animals of both sexes, no progeny test is needed in selection for these traits. The important factor in comparison of individuals is the uniformity of feeding and management. For meat production it is also necessary to compare carcass characters and to follow up with progeny tests, since it is not possible to evaluate accurately carcass quality and yield in the living animal.

3. EFFECTS OF CLIMATE

The normal body temperature, respiration rate and pulse rate of domestic buffaloes at rest and in the shade are lower than those of cattle.

TABLE 3. — AVERAGES FOR NORMAL ADULT FEMALES IN OPEN SHEDS

	Buffaloes		Cattle		
	Indian	Egyptian	Indian	Egyptian	Shorthorn
Body temperature, °C	38	38	38.6	38.2	38.6
Respiration rate per minute .	21	24	26	29	34
Pulse rate per minute	41	56	52	61	64

The body temperature of calves is higher than that of adult buffaloes. The average for Egyptian buffalo calves up to one year of age is 38.5°C, the respiration rate is 29 per minute and the pulse rate is 69 per minute. There is no significant difference between sexes, in calves, but in adults the respiration rate of males may be lower than that of females. Pregnancy and lactation increase the rate of most body functions; temperature may be as high as 38.5°C in normal pregnant buffaloes.

Water buffaloes become distressed if they are forced to stay in the direct rays of the sun for a few hours, and are intolerant to extremes of cold. A sudden drop in the air temperature, exposure to cold winds, or housing in draughty buildings can lead to severe chilling, pneumonia and possibly death. Nevertheless, some buffaloes are maintained in areas where winter weather is quite severe and they are protected when necessary by housing and rugs. Some are kept in mountainous countries and may be seen at altitudes of up to 2 700 m in Nepal.

Daily effect of hot weather

When buffaloes are kept in the shade, without wallows or sprays, the rate of breathing increases as the air temperature rises during the day. A close relationship exists between the two. The body temperature and pulse rate also rise, but there is a time lag of about three hours and the rises continue after the air temperature begins to decline.

Buffalo calves under one year of age are more severely affected than mature animals in hot weather. They tend to lose their appetite and condition, body temperature may rise to critical levels, and heat stroke may result. With treatment, and the cooler air of evening, they recover.

When buffaloes are fed for milk production more effort is required by the body functions to dissipate the extra heat of the food calories, and more care must be taken to cool the animal by sprays or sluicing. At high altitudes, the increase in respiration rate on hot days is less marked than that at lower altitudes. The increase in body temperature is about the same but the increase in pulse rate is more pronounced. Little correlation has been found between atmospheric humidity and respiration and body temperature at any given air temperature.

Exposure to sunshine

Buffaloes are creatures that love shade and water, and prolonged exposure to sunshine in hot weather causes more distress than it does to cattle — body temperature and respiration rate increase, rumination stops, discomfort is shown by kicking, tail movements and extending the head. After exposure for two hours there is panting, dribbling from the mouth and discharges from the nostrils and eyes. If moved into shade the animals quickly begin to recover. Care must be exercised when buffaloes are moved during the heat of the day. The pace of droves of cattle cannot be maintained. Many deaths have been caused in Australia by persisting in droving without rest periods by herdsmen accustomed to moving mobs of cattle.

Albinoids do not appear to suffer more than the normal dark-coloured buffaloes.

The dissipation of surplus body heat

Buffaloes do not lose much body heat by sweating; the loss in expired air is more important. In natural conditions they keep cool by wallowing whenever the air temperature is above 29°C. After one hour in the wallow the body temperature falls to the level that it registered before the daily

rise due to work effort and the elevation in air temperature. In hot weather buffaloes will, when permitted, stay in the wallow all day, with breaks for grazing. Natural rain showers and artificial sprays also lower the body temperature, the degree depending on the duration and the temperature of the water. Sprays are not so effective as wallowing but are preferable to the use of contaminated wallows. Buffaloes will also wallow briefly in cool weather.

Currents of air increase the efficacy of sprays. Calves may have water poured over them from time to time during hot days. Water intake has little lasting effect on body temperature. Hot dry winds increase body heat, even of animals in the shade.

The general conclusion must be that, in hot sun, the body temperature of buffaloes can only be kept normal by wallowing or by frequent application of water, preferably with a wind to dry off. Shade is the most important factor. Only frequent and massive application of water is more helpful than shade alone.

The skin of the water buffalo

The skin of the buffalo is different from that of cattle in several important details. The total thickness is about the same but the epidermis, and particularly its horny layer, is much thicker. There are about 100 to 200 hairs/cm^2 of skin, each with its associated sweat gland and sebaceous gland. This represents only about one tenth the density of these structures in the skin of cattle. The number of hairs is fixed before birth, so as the animal grows bigger the hairs become spaced much more widely apart.

The sebaceous glands are much larger in buffaloes and the secretion is white, whereas it is yellow in cattle. The sweat gland is a simple oval sac or a wide convoluted tube.

The skin thickness increases with age. It is greater in males than in females and there is some variation between breeds.

Research in the U.S.S.R. has shown a correlation between skin thickness and milk yield: high-yielding buffaloes had thinner skin than poor milkers.

Since the natural home of the buffalo is in shade or water, the black or dark-coloured skin must be a concealing characteristic rather than a protection against ultraviolet radiation. In the absence of a reflective hair coat, such as that in cattle, the dark skin is a grave disadvantage in direct sunshine because it absorbs infrared radiation. In shade, however, the dark buffalo will act as a typical "black body" radiator of heat. The paucity of sweat glands is clearly a result of the semiaquatic life of the wild ancestors.

In some countries it is customary to clip buffaloes in order to control lice and help in grooming. This may be a disadvantage. The coating of mud that the Swamp buffalo acquires is an excellent protection against the sun's rays and also against lice, biting flies and mosquitoes. In tropical Latin America it is claimed that the mud also provides protection against vampire bats.

Effect on breeding

Conception rates are highest during the cool season and lowest in hot, dry seasons. Cooling milking sheds with sprinklers and fans did not increase fertility. Wet screens and fans produced more satisfactory results in India. The use of hormones to stimulate oestrus was helpful in those conditions.

The quality of semen and also the volume of each ejaculate were at their best in the spring and poorest in the summer. The pronounced seasonal pattern of breeding in buffaloes is considered in the chapter on reproduction (see p. 35).

More research is needed on many aspects of seasonal breeding, including studies of the hereditary factor. It is possible that selection for heat tolerance in dairy buffaloes may lead to reduced milk yield. It would be better to rely on improved management, provision of shade, protection from hot winds, and adequate wallows or sprays. For working buffaloes, selection for heat tolerance would be useful. Before such a programme is undertaken, however, it would be desirable to know if the domestic animal has already acquired a heat tolerance superior to the wild species and to what extent breeds differ, in the same environment, in heat tolerance and draught capacity.

Effect on milk production

Milk yields are lower during hot seasons and tend to improve as cooler conditions prevail. Showers or sluicing with water before each milking is beneficial. Wet screens keep milking sheds cooler and increase the intake of food by the buffaloes, and milk yields improve. In trials in India, average daily yields increased, following the introduction of wet screens, from 4.5 to 5.8 kg.

Effect on digestion

Buffaloes eat less during hot weather. In addition, digestion of proteins and fats is less efficient. This has been shown to be due to a loss of

activity of the digestive secretions of the stomach. Carbohydrates are affected to a lesser degree. The greatest seasonal difference is in the quantity of water that is lost by evaporation in the breath and from the skin. It is estimated to be three times greater in summer than in winter.

Murrah heifers in India, kept in shade and sprinkled for ten minutes every day, showed an average daily weight gain of 0.46 kg. A similar group of heifers, without shade or sprinkling, averaged 0.40 kg.

4. REPRODUCTION

Anatomy

The reproductive organs of the water buffalo are, in general, similar to those of cattle. In the male the sheath is much more closely bound to the belly than in the case of Zebu bulls. There is only a short free portion at the prepuce, and there is no tuft, or only a few short hairs. The scrotum of the Swamp male is short, even when relaxed, and it has no neck. In River breeds the scrotum is larger and pendulous, with a distinct neck, but it is smaller than in European breeds of cattle. The testicles of the buffalo are smaller than those of bulls. They descend into the scrotum when the calf is about 6 months old, but in some Indian breeds they may be present there at birth. The penis is shorter but it is protruded by the same muscle action as in cattle. The seminal vesicles and prostate glands of the buffalo are also smaller.

In the female the uterus is shorter, its horns more tortuous and the walls more muscular than in cattle. The ovaries are smaller, the corpus luteum is pinkish grey with red veining and becomes grey subsequently; it is never yellow at any stage. Minor differences have been noted in the organs of various breeds and types.

The male buffalo

Water buffaloes attain sexual maturity later than cattle. Swamp buffaloes are generally slower than River breeds in arriving at breeding age. Young males in Egypt, India and Pakistan are put to the first service at about 3 to 3½ years of age but in Italy and the U.S.S.R. they may be used as early as 2 years. Good service behaviour may continue until the animal is 12 years old or even older. However, there is frequently a decline in potency after 7 years of age, and signs of senility may be observed after 15. A good River male can settle 100 females a year, serving each of them several times while they are on heat. Some investigators state that effective capacity is no more than 50 per year, and that the service life may be only four or five years.

There is no rutting season. In Egypt, about 75 percent of services occur during four months of the year. A male may be used three times a week during this season, but the quality of semen may be impaired and low conception rates follow. Reports on frequent collections of semen for artificial insemination services are conflicting. Collections have been made from Murrah males twice a week for three years without any decline in semen quality. In India, it was found that if buffalo males are kept in suitable conditions and protected from extremes of temperature, their fertility remained normal during the off-season. Conception rates reached 63 percent after natural mating and 52 percent after artificial insemination.

Service behaviour

Nearly all the research on the physiology of reproduction in the buffalo has been concerned with River breeds. Much more information is needed regarding Swamp buffaloes.

There is a strong seasonal influence on mating and, unless special measures are adopted to protect the animals from direct sunshine and hot air currents, service behaviour and semen quality will suffer during the hot season. Considerable differences may be noted between individual males and breeds. At one centre the Murrah bulls failed to maintain adequate semen quality in summer whereas Nili-Ravis showed little deterioration.

Heat stress reduces libido. Most natural matings occur at night. In some circumstances this may be due to the use of males for work with consequent control during the daytime. Buffaloes will also mate while in their wallows. When favourable conditions prevail they will mate at any hour.

The thrust of buffalo males is always less vigorous than that of bulls. In making collections of semen at artificial insemination (A.I.) centres more patience is called for. Little difference in the time taken is noted when using males or females as teasers in the service crate.

Reports on the results of feeding special diets to males at A.I. centres are inconclusive. At one centre it was found that the addition of 10 percent skim milk to the rations improved both the speed of collection and the semen quality.

Semen

The semen of healthy buffaloes is milk white. It becomes thin and watery when collections are repeated too frequently and during the hot

season. Considerable variations in the volume of ejaculates and in quality are observed in different males. The volume is less than in bulls. River buffaloes rarely exceed 5 ml, the average being about 3 ml, but some exceptional ejaculates, up to 13 ml, have been recorded. Increasing the frequency of collections leads to a reduction in volume. In India, two collections in rapid succession did not affect the volume, but further collections did. In Egypt, on the other hand, no significant difference was seen during a series of collections at differing intervals.

Spermatozoa

The concentration of sperm in semen samples varies widely. Reports from India give figures from 631 to 1 034 million/ml; in Egypt, 210 to 2 000 million/ml; and in the U.S.S.R. 980 million. In four collections made in rapid succession the highest concentration was in the second, the others being about equal. Frequent collections may stimulate sperm production in some males.

The concentration of sperm in the semen of Murrahs was higher in summer than in winter at one centre. Seasonal changes may be due to changes in the activity of the thyroid glands and the testicles.

The spermatozoa of buffaloes can easily be differentiated from those of cattle. The head is more rectangular and the various component parts are shorter. There is little variation between sperms of individual males. Initial motility and speed of travel of sperm of River males are lower than those of Zebu bulls. Motility is lower in summer than in other seasons. A characteristic of buffalo semen is the initial lack of motility of the sperm, becoming normal on dilution and storage. This is noted more frequently in winter and least in spring. Nonmotile sperms in semen samples frequently become active in the female reproductive tract.

After insemination spermatozoa reach the far end of the uterus in a few minutes. They survive in the genital tract of Indian buffaloes for 36 to 49 hours, but in Caucasian buffaloes they seldom live longer than 24 hours.

Abnormal spermatozoa

Common abnormalities are coiled tails, bent tails, absence of tail, deformed head, enlarged midpiece and protoplasmic droplets. Double tails are rare. There is a wide seasonal variation in different countries. Reports from India give a percentage of abnormal sperms ranging from 2.7 to 17.2. In Egypt, the range was 15 to 32 percent, and in the U.S.S.R. a low average of 3 percent was reported.

The number of abnormal sperms increases in samples taken in rapid succession. A high percentage indicates poor semen quality.

A recent report gives an average of 10 percent of abnormal sperms in 982 semen samples from Surti males. The average volume of the ejaculates was 3.03 ml.

Dead spermatozoa

In India, more than 22 percent of dead sperms were present in first ejaculates and 17 percent in the second. Other centres also reported similar findings. But during the peak of the breeding season the vitality of the sperm was fragile. Reports from Egypt give percentages of about 20 and, in variance with the Indian experience, the same ratio was found in samples taken in rapid sequence.

Research has shown that there is a correlation between the duration of life of spermatozoa and the fructolysis index. Enzyme activity increased in cool seasons and declined in hot seasons. Levels were much lower than those of cattle semen. The poor storage quality of buffalo semen may be the result. The utilization of oxygen by semen samples declines rapidly in summer but is sustained at a high level for two hours after collection in winter. There are noteworthy differences between semen of buffalo and of cattle. Considerable biochemical research has been undertaken, but much more is needed.

Artificial insemination

Several claims have been made for the first successful application of A.I. to domestic buffaloes. It is probable that the credit must go to the work in India in 1939. The technique is now practised on all the state dairy farms in that country.

Little information is available on A.I. in Swamp buffaloes. Many of the countries where they are most numerous lack A.I. services and the technical equipment necessary for the collection, storage and distribution of semen.

The methods used so successfully for cattle have to be modified for buffaloes.

Collection of semen

The short artificial vagina, 35 to 40 cm, is preferred. It is satisfactory for buffaloes, easy to handle and is less wasteful of semen than the longer type. The temperature should be 39°C.

Massage techniques can be used but the buffalo male is much less responsive than the bull. Unsuccessful attempts to collect semen by using electric stimulus have been reported.

The response of buffalo males varies widely with different individuals and with management systems. Males reared with females showed more active response than males reared and kept in isolation.

Dilution of semen

The semen extenders used successfully in A.I. in cattle are less satisfactory with buffalo semen. Many modifications have been tried. The merits of the diluents are judged by the motility of the sperm after varying periods of storage and by conception rates following the use of diluted semen in A.I.

Egg yolk is the basis of many of the extenders with a very wide variety of additives: citrate, fructose, sulphonamides, sodium bicarbonate, glycine and cysteine. Milk in various forms, tomato juice and coconut water have all been used with varying degrees of success.

In the U.S.S.R. a diluter containing egg yolk, glucose and citrate has been recommended.

Recent trials in India of a large number of semen extenders show that satisfactory results followed the use of milk whey. Milk is curdled by citric acid, the whey is separated by high-speed centrifuge, then neutralized. After storage at 5°C for up to 72 hours the conception rate in 297 inseminations was about 50 percent. With 3 percent glycerol and semen diluted 1:60 the results were satisfactory. Before deep-freezing 7 percent glycerol is added. Cow milk gave better results than either buffalo or goat milk. Neither fructose nor lactose improved the storage quality.

Another satisfactory diluent was prepared from skim milk powder, reconstituted in distilled water, with egg yolk, glycine and glycerol. Reports on the addition of antibiotics are conflicting.

The effect of mixing semen from several buffaloes was studied. After storage, the motility of sperms was superior to that of individual samples.

Oxytocic hormones have been used in semen extenders with advantage in one series of studies.

The routine rate of dilution of semen by A.I. services for buffaloes is usually 1:10, but equally satisfactory conception rates have been reported following dilution at 1:20.

Colouring of semen samples is desirable to prevent errors in identity and breed of different males. Several colouring agents used for cattle semen have also been used for buffalo semen and no difference in conception rates followed their use.

There is a wide variation in the resistance to cold shock in semen from different buffalo males. It must always be cooled gradually before transport or storage.

Method of insemination

Most inseminators prefer to feel the neck of the womb by one hand in the rectum while manipulating the pipette in the other. Great care and gentle handling are imperative, since the lining membrane of the rectum can be easily damaged and bleeds readily. Many investigators use the vaginal speculum. Insemination of buffalo females twice during the heat period is practised in some areas, with improved conception rates. The early recognition of signs of oestrus is of paramount importance.

Conception rates

Conception following natural mating of buffaloes in India has been reported to be as high as 80 percent.

Following A.I., claims made by centres in various countries show a very wide range of figures. Different systems of recording inseminations and repeats and of the diagnosis of conception are used and other factors are involved, such as the use of frozen semen. The ratio of inseminations required per conception gives a useful indication of the efficiency of the service.

Conception rates following the use of stored semen are always lower in buffaloes than in cows in India but, in reports from Egypt, there are some examples of better results in buffaloes than in cows.

In the U.S.S.R. an average conception rate of 77 percent is claimed. In India, a range of 58 to 75 percent is reported. In Egyptian buffaloes the range was 36 to 82 percent.

The average number of inseminations per conception reported from India was 1.36. In over 1 000 conceptions in Surti buffaloes at the Kaira District Cooperative the ratio was 1.96 for heifers and 1.70 for mature females. In Egypt a ratio of 1.51, with a conception at first service of 55 percent was recorded. Out of 102 conceptions in Murrahs, 66.2 percent were at the first insemination, 21.6 percent at the second, and 12.2 at third or subsequent inseminations.

The female buffalo

Puberty

The female buffalo attains sexual maturity at a later age than European and Zebu cattle, the disadvantage being offset to some extent by the longer productive life of the buffalo.

Reports on age at the onset of first heat show a wide range of variation. The differences are due to many factors, including systems of rearing, levels of nutrition, and seasonal and genetic influences.

The average age at first oestrus in Murrah heifers was reported to be 34 months; in Egyptian buffaloes it was 13 to 18 months. Caucasian buffaloes kept in conditions of high-level nutrition came into heat as early as 18 months of age in some instances, but many did not show any signs until 3 years of age. The age of Bulgarian buffaloes ranged from 30 to 33 months, but some exceptions came on heat much earlier.

The Swamp buffalo of the Philippines is reported to be 25 to 29 months old at first oestrus. The Cambodian type attains puberty at around 3 years of age. The average age for Swamp buffaloes in Australia is just under 2 years.

Service at the first heat is often infertile or may be followed by abortion, so time and production suffer delays. In well-managed herds of River buffaloes service is generally withheld until the heifers are 30 to 36 months of age. The weight of the animal is considered to be more important than age at the time of first service. The body weight of Egyptian buffaloes at first oestrus averaged 198 kg, while at first conception it was 319 kg, and the average age about 21 months.

The first service of Bulgarian buffaloes is usually deferred until they are 3 years old. Swamp buffaloes may be 5 years of age at first conception.

Oestrus

Signs of heat in Swamp buffaloes are generally more evident than those in River breeds. The caraballa — the Swamp female of the Philippines — shows more pronounced symptoms than many other types. But the European buffaloes are said to behave in typically bovine fashion: they show agitation, bellow, ride other animals, run tail-up, and tend to wander far when there is no local male. Anatolian buffaloes sometimes become nervously aggressive.

Oestrus often passes unnoticed in warmer climates and symptoms may be absent or very weak during hot, dry seasons. The vaginal mucus, characteristic of heat in the cow, is scanty or absent. Investigations in India showed that silent heats had occurred in over 14 percent of females examined. In one report from Egypt a figure of 86 percent is given.

The technique of crystallization of mucus from the neck of the womb can be used to detect oestrus in buffaloes. When the mucus dries on a slide it forms a fern pattern if the animal is on heat, but not otherwise. In India, conception rates have been improved considerably by testing, when oestrus is expected, and the hour of its onset can be determined.

In Egypt, the test was found to be less reliable. In research in India it was reported that during the hot season many cases of silent heat occurred and that, if the subjects were kept in shaded and cooled sheds, conception often followed. Without tests or the presence of a male, only about 6 percent of heat periods were detected during the hot season.

Oestrus detection in buffaloes using an ohmmeter to measure the electrical resistance of the vaginal mucosa deserves examination and experimentation. The method has been successful in cows and sows and the apparatus is marketed commercially.

In Egyptian buffaloes the onset of oestrus is often during the evening or at night, but in India it is said to occur frequently in the morning, and in such cases the duration is very short.

Duration of heat

The average duration of oestrus in Murrahs varied from 24 to 72 hours, with an average of 29 hours. In Pakistan, the range was 3 to 69 hours, average 19 hours. It lasted longer in older animals and in those that were not served. In Egyptian buffaloes the average was 12 hours; in the Bulgarian 24 to 36 hours, and exceptionally up to 48 hours. In China, in the local Swamp type, heat periods lasted an average of 53 hours, in Murrahs 59 hours and in crosses 55 to 78 hours. It is said to persist in Malaysian buffaloes as long as two weeks if conception has not been achieved. This, if true, would be a striking deviation from the normal pattern of breeding behaviour. Heat periods in the Philippine caraballa last from 24 to 36 hours, but some have lasted up to five days.

Oestrus during pregnancy was observed in 6 percent of pregnant Murrahs, occurring on average at 108 days after conception. In Zebu cows, in the same environment, the incidence was higher.

Oestrus after calving

In the River breeds, the first heat period after calving is generally seen about the 42nd day. The average interval in Egyptian buffaloes was 44 days, but a range of 120 to 147 days has also been reported. Reports from other countries are equally conflicting. The season of calving and many other factors are involved. Spring and summer calvers had the longest service intervals. Oestrus occurring within 30 days of calving is usually infertile. Conception improved progressively with longer service intervals.

Induced oestrus

Hormones have been used with success in the treatment of sexual inactivity in female buffaloes. Pregnant mare serum (PMS) given daily for

three days induced oestrus and ovulation in four to six days. Conception resulted at first service in most cases and normal pregnancies followed. Experimental use of PMS in sexually active females did not cause multiple pregnancies.

Stilboestrol was formerly used in the treatment of infertility but its use cannot be recommended. Although heat often follows there is usually no ovulation.

Synchronized oestrus

In certain circumstances it may be desirable to ensure as many as possible of the calvings of a group to occur within a limited period. Hormones have been used successfully to synchronize oestrus and service.

Surti buffaloes were given daily doses of 1 or 2 mg melangesterol acetate in groundnut oil with concentrates for 18 days. Four or five days after treatment stopped, 22 out of 24 came on heat and conceived to A.I.

In the U.S.S.R. various hormones were tried in different dosage rates. The best results were obtained with six daily doses of 50 mg progesterone with PMS. More than 94 percent came on heat within an eight-day period after treatment ended.

The oestrous cycle

The complete cycle from the onset of one heat period to the next in females that have not conceived was just over 21 days in Egyptian buffaloes; in heifers the cycle may be longer. Very short cycles may be the result of oestrus without ovulation. Double cycles (44 days) and treble cycles (69 days) may be due to silent heats. Very long cycles are presumed to indicate conception with death of an embryo. The cycle in Bulgarian buffaloes is also 21 days, and is more variable than that of cows. In Malaysia, in both Swamp and River buffaloes, it was reported to vary from 28 to 30 days. Averages recorded for Murrahs are 19.3 days and 21.4 days.

Changes in the ovary during the cycle

The changes in the ovary follow the normal bovine pattern: oestrus, follicle formation, extrusion of the ovum, development of the corpus luteum which persists through pregnancy or, if conception has not taken place, it gradually regresses and this allows the new oestrus and follicle development. Ovulation occurs in the Egyptian buffalo at 18 to 48 hours after the onset of heat. The interval in *desi* buffaloes in India was 5 to 24 hours following the end of oestrus. After squeezing out the corpus luteum by hand, there was an interval of 20 hours before the onset of heat.

The corpus luteum is smaller than that of the cow. The ova are about the same size.

Early diagnosis of pregnancy

Recent investigations showed that, in Egyptian buffaloes, a typical fibrous plug was present in the neck of the uterus in 96 percent of pregnant animals. The specific gravity of cervical mucus was 1.008 or above in 92 percent of pregnant animals. Both tests can be used from 14 days after conception. Fern pattern was noted in cervical mucus in 70 percent of nonpregnant buffaloes.

The gestation period

The gestation period of the water buffalo is longer than that of cattle. Studies of many thousands of breeding records in various countries show a range of extremes from 281 to 334 days, but most reports give a range of between 300 and 320 days. That in cattle is generally accepted as 278 to 290 days.

Average gestation periods show striking variation in different continents: in India and Pakistan 308 days; in Europe 314 days; and in Egypt, 317 days.

Swamp buffaloes carry their calves for one or two weeks longer than River buffaloes kept in the same district.

In Egyptian buffaloes, old females had longer pregnancies than young; reports on other breeds show no age difference. In Egypt, male calves were carried longer than female calves. In India the opposite has been reported, but there is a correlation between the length of gestation and the weight of the calf at birth, and also with the weight of the dam. Twin conceptions, which are very rare, tend to shorten the gestation period by about 20 days.

Age at first calving

In well-managed herds, first service is withheld until the heifer is in a physical state for productive life. The season of calving must also be considered, and there are the questions of health and nutrition. However, there is also a genetic factor. Swamp buffaloes are generally older than River breeds at first calving.

Records from India show that the great majority of buffaloes calved

for the first time between 30 and 48 months, with extremes of 28 and 52 months, and an average of 40. In Pakistan, the range was 32 to 72 months. In Egypt, the extremes were 22 to 60 months, with an average of 38 months. Egyptian dairy females that calved relatively young had longer productive life records than those that calved for the first time at a more mature age.

Time taken in calving

The average time taken by Murrahs for the whole process, from dilatation of the birth passage to the expulsion of the afterbirth, was 302 minutes.

The average weight of the afterbirth was 3.22 kg.

The average time taken for complete involution of the uterus in Murrahs was about 39 days, but there were wide differences in individuals, with extremes of 15 to 67 days. There was little difference in age groups and the season of calving appeared to have little effect. The speed of involution had a direct effect on the length of the interval to the subsequent conception.

Birth weight of calves

This subject is considered in the chapter on nutrition (see p. 48).

Sex ratio of calves

In records of a very large number of Murrah calvings there were 51.5 percent male calves. Another study found 52.06 percent males. On the other hand, one investigator found more females than males.

In Nagpuri buffaloes there were 53.29 percent males. Two reports from Egypt give percentages of 53.44 and 52.

In Italy there were 51.76 percent male calves.

Twins

Buffalo twins are extremely rare, and in many areas they are unknown. Reports have sometimes been based on seeing a female buffalo suckling two calves at the same time, but the propensity of buffalo cows to foster any hungry calf is well known. Twinning has not been observed in Swamp

buffaloes in Australia. Examination of reproductive organs of more than 1 000 slaughtered buffaloes showed that twin ovulations had occurred in only four instances and that twin conception had followed in only two cases. Twin conception may lead to abortion and is considered to be an undesirable character.

The calving interval

Wide differences are reported in the length of the interval between one calving and the next in buffaloes. It is often very protracted and a serious disadvantage in commercial production. In working buffaloes service is often withheld so that calving will not interfere with the cultivation of land in the well-defined seasons. Very long calving intervals are common in rice-growing countries.

In southeast India the calving interval is reported to be around 500 days. In another part of that country there was a range of 436 to 420 days.

Four reports from Egypt give averages of 488, 552, 585 and 650 days. In Italy, the range reported was from 344 to 473 days, with an average of 409 days. Other figures that have been published fall between these extremes.

Seasonal breeding of buffaloes is the most important cause of long calving intervals. The hereditary factor is almost negligible.

In Bombay and Calcutta, many good milch buffaloes are slaughtered at the end of a single lactation because of the economic effect of long intervals between lactations.

Older buffaloes tend to have shorter calving intervals than younger ones. The interval following the first calving is generally longer than later intervals. Heifers that calved at 30 to 34 months of age had shorter intervals than those that calved for the first time at a more mature age.

Seasonal breeding

The marked pattern of seasonal breeding of domestic buffaloes profoundly affects production of milk and meat. The seasonal influence on the age of first calving and on calving intervals has already been noted. Sexual activity is drastically reduced during the hottest months and is weak for a further period of up to four months, so that the female does not calve at the peak of the production season in any two years.

In India, the peak of the calving season is through July and August. Most services follow during October and November, when natural pastures

are at their best. There is very little evidence of sexual activity from March to the end of June. The seasonality of calving causes flushes of surplus milk followed by periods of shortage.

In the Philippines, the greatest breeding activity of the Swamp buffaloes coincides with the wet and cool months. Similar observations have been reported from most of the countries that have well-defined climatic seasons. It seems to be agreed that the seasonality of breeding is related to high air temperature and to direct exposure to the sun's rays.

Measures to provide shelter from the sun's rays and from hot air currents, by wet screens, showers, wallows and fans during the hot months, extend the breeding season.

Silent heats may, however, be prevalent, with irregular oestrous cycles. The provision of teaser males is recommended for the detection of heat but is not infallible.

Buffalo males used for breeding must also be kept in cool sheds and sluiced two or three times daily or allowed regular wallowing periods. Otherwise they lose their libido and their semen quality deteriorates.

When these measures were put into effect in India many females were found to come into heat and to conceive to A.I. Conception rates as high as 63 percent have been achieved during hot seasons.

Disorders of reproduction

These are considered in the chapter on aspects of disease (see p. 73).

5. NUTRITION

Increasing interest has been aroused in recent years in the remarkable capacity of buffaloes to convert poor fodders into milk and meat, and investigations in many countries have added greatly to the store of knowledge. In view of this and in order to estimate existing evaluation, it is essential to review the information available on the weight of the domestic buffalo at birth and at all stages of growth.

Wide variations are found in reports from different countries. Many factors influence the weight of the calf at birth: the male calf is usually heavier than the female; calves of mature females are heavier than the first-born; some breeds are heavier than others and the heritability of birth weight is fairly high.

Some averages and ranges are shown in Table 4.

TABLE 4. — BIRTH WEIGHT OF BUFFALO CALVES

Country	Breed	Male	Female	Both
		Kilograms		
India	—	28-33	23-32	—
"	—	29.01	28.33	—
"	Murrah	33.32	31.92	—
"	"	—	31.10	—
"	"	22-34	19-27	—
"	"	33.73	32.82	—
"	Nagpuri	—	23.63	—
"	"	—	—	28
Egypt	—	—	—	36.05
"	—	37.95	35.46	—
"	—	—	—	33-40
"	—	37.92-38.42	35.43-36.35	—
"	—	27.69	56.29	41
Italy	—	41.50	—	—
"	—	—	—	41.46

Growth rate of buffalo calves

Many reports are available on weight gains of different breeds and types and, of course, there are wide variations. The different methods of rearing account for the greater part of the variation but heredity is also important. Where work capacity or meat production is the objective, selection for weight gain, along with better nutrition, can be rewarding.

Buffalo milk attracts a higher price than cow milk in Egypt. Many calves are, therefore, reared on cow milk. Calves on buffalo milk, however, showed 18 percent better growth rate than those on cow milk. Other reports describe digestive disturbances and advise dilution of buffalo milk with water.

A recommended early weaning system allows natural suckling for 38 days from birth, then feeding on concentrates, rice germ meal, fish meal, and berseem (a clover); vitamin E and animal protein are considered to be important. Although the calves were not so heavy at 4 months of age as the naturally reared calves, the cost was considerably less. In another series of trials, Egyptian buffalo calves that received 103 kg whole milk and were weaned at 45 days of age on maize, barley and molasses made the highest weight gains.

Buffalo veal is highly esteemed in Egypt and many calves are slaughtered at 30 to 40 days of age. In one veal production trial, buffalo calves had an average birth weight of 41 kg and weighed 61 kg at slaughter. They showed an average daily weight gain of 0.59 kg and high dressing-out percentages.

In all calf-rearing systems the need for care in all details of management and hygiene cannot be overemphasized.

Milk substitutes are used in buffalo calf rearing in Pakistan, Italy and other countries.

Growth rate to 2 years of age

Italian buffalo calves with an average birth weight of 43.58 kg showed a mean of 169.79 kg at 6 months of age, a daily weight gain of 0.71 kg. Growth was attained more economically than in calves of European breeds of cattle. Similar results were reported from the U.S.S.R., but in Yugoslavia there was little difference between buffalo and cattle calves. Egyptian male buffalo calves, during the first six months of life, had an average daily weight gain of 0.59 kg, and females of 0.54 kg. During their next six months both sexes had the same growth rate of 0.45 kg per day. From 12 to 18 months males attained 0.64 kg per day, and females 0.36 kg.

Female Indian buffalo calves made average daily weight gains of 0.59 kg during the first six months and 0.68 kg during the second six months. Male Indian buffalo calves, 8 to 11 months old, were fed on three different levels of nutrition for a period of nine and a half months. Those on the highest level made an average daily weight gain of 0.63 kg, those on a medium level 0.4 kg, and those on a low level lost weight. The weight loss was halted when wheat straw was allowed in unlimited supply. In another trial, male Indian buffaloes showed an average daily weight gain, from 12 to 18 months of age, of 0.36 kg.

In Trinidad, buffaloes of 6 to 12 months of age, on pasture during the dry season, with sugarcane bagasse and molasses, had an average growth rate of 0.922 kg; on poor pasture alone the rate was 0.49 kg per day. In another trial, with buffaloes in Trinidad, during a period from 6 months to 2 years of age, the average total weight gain was 281 kg. Of this, 100 kg were gained during the last six months.

In Zaire, a few River buffalo calves gained 1 kg per day from birth to 8 months of age. Males from birth to 12 months averaged 0.91 kg per day, and females 0.89 kg.

In Yugoslavia, buffalo males of 12 to 14 months were kept in feedlots and fed on hay, green fodder and concentrates for 105 days. They made an average daily weight gain of more than 1 kg, some individuals attaining 1.5 kg. Young bulls of improved cattle breeds did even better, but the buffaloes reached a satisfactory grade of finish at 300 to 350 kg, whereas the bulls only reached a comparable grade at 400 to 450 kg.

Trials in Iraq compared growth and food conversion rates of male buffaloes and cattle. They were aged from 12 to 15 months at the start and were kept on green roughage, alfalfa, wheat straw and concentrates for 126 days. The buffaloes made an average daily weight gain of 1.163 kg, and the young bulls 0.889 kg. The buffaloes consumed 4.32 kg of digestible nutrients for each kg liveweight gain, the bulls 4.60 kg.

In Trinidad, young castrated buffaloes were kept on pangola grass pasture for 280 days. The average daily weight gain was 0.67 kg. A second group was fed supplements of citrus pulp, coconut meal and salt and gained 0.66 kg per day. Crossbred cattle steers gained 0.57 kg per day. In another trial, buffaloes made growth at twice the rate of Jamaica Red cattle and three times that of Brahmans. No wallows were provided, but had they been available appetite and weight gain might have been even higher.

In feeding trials in Egypt, 18-month-old buffaloes made average increases of 359 kg, while Egyptian cattle gained only 263 kg.

In recent trials in northeast Brazil, Mediterranean breed buffaloes were fattened on elephant grass with wheat bran and mineral supplement for

140 days. The average liveweight at the start was 213 kg and at the end 333 kg, giving a daily weight gain of 0.857 kg.

The average daily weight gain of 50 Surti males in India throughout the first 24 months of life was 0.436 kg.

Fattening

Kept in conditions of good management and nutrition, buffaloes in Pakistan had average daily weight gains of 0.86 kg. In another investigation, males on local feed in a period of 70 days made an average gain of 1.04 kg per day.

Different systems of fattening buffaloes were compared in the U.S.S.R. Some groups were on pasture, others stall-fed with alfalfa hay and concentrates. As might be expected, there were wide differences in weight gains, from 0.453 kg to 1.134 kg per day. Castrated buffaloes of about 2 years of age were fattened for a period of 93 days and made an average weight gain of 1.123 kg per day. Bulls of a local breed of cattle averaged 0.680 kg per day.

These reports, and many similar ones, show that water buffaloes are efficient utilizers of feed in systems of all kinds. Buffaloes are able to fatten on feed that cattle waste. In the U.S.S.R. the residue of feed of 15 cattle sustained one buffalo. It has often been observed that buffaloes maintain good condition in environments in which cattle could barely manage to exist.

The rate of fattening of mature animals depends on their condition at the beginning of the fattening period; the leaner ones make the bigger gains. Older buffaloes have a better capacity for fattening than is generally attributed to them. In the U.S.S.R. buffaloes of 7 to 11 years of age were fed on large quantities of wet sugar-beet pulp for 120 days. Males made an average daily weight gain of 0.71 kg, the females 0.97.

Bulgarian buffaloes were fattened on alfalfa hay and cob meal, with a concentrate mixture of maize meal, wheat bran, sunflower seed meal and barley meal, and minerals and salt. They made excellent weight gains and dressed out at about 54 percent.

Digestion

The anatomy of the first three compartments of the stomach — the rumen, reticulum and omasum — is essentially the same as that of cattle but the structures and development of the fourth compartment, the abomasum, show striking differences. The digestive activity of the abomasum

of the buffalo is more severely affected by high air temperature than in the case of cattle. Appetite and digestion suffer in hot seasons unless provision is made for body cooling by showers or wallows. When the temperature falls at night the appetite and digestive activity are restored.

The average weight of the contents of the buffalo rumen is heavier than in cattle and the microbial populations are more numerous.

The rumen of any ruminant calf is poorly developed at birth and grows with the intake of fibre. The rumen of the buffalo calf becomes functional at an earlier age.

In all the ruminant species there is a mutually beneficial relationship between the microbial population in the rumen and the host animal. The contents of the rumen constitute a continuous biological process: food is broken down, microbial organisms produce proteins that are subsequently utilized by the host animal, and some absorption of nutrients takes place. Variations in the number and kind of microscopic organisms result from changes in food and other factors. These changes lead to biological changes in the rumen. Lush grass and clover produce increased quantities of volatile fatty acids and ammonia. Excessive fermentation may cause bloat. This condition is considered in the chapter on aspects of disease (see p. 72).

There are seasonal changes in the proportions of food constituents. In summer the intake of carbohydrates is higher than in winter, and the intake of fats and protein is lower. Rations that are deficient in carbohydrates lead to marked changes in the microbial populations of the rumen. These changes are more marked in buffaloes than in cattle. Feed probably remains longer in the rumen of the buffalo than in that of cattle and is exposed to more microbial action. Total microbe counts decline when feed is ingested, but they increase to normal within six hours.

Ammonia and soluble nitrogen disappear from the rumen fluid of buffaloes more rapidly than from that of cattle: this may be evidence of a more efficient utilization of protein by the buffalo.

The lining of the rumen is dark-coloured or black; the function of the pigment is not known. The study of the physiology of digestion in the buffalo has not kept pace with that in cattle and sheep. Some excellent research has been undertaken in Egypt, India, the U.S.S.R. and elsewhere, but in many of the investigations the number of animals involved has been quite low.

Digestion of fibre

There appears to be little difference in rumen digestion of fibre in cattle and buffaloes. Efficiency depends on feed constituents other than the

fibre content and on the proportions in which they are present in the rations. Many other factors affect digestion in general: extremes of climate, diseases and parasites, deficiencies of vital feed constituents, inadequate water supplies, unsatisfactory management practices, and so forth.

One group of microscopic denizens of the rumen that help in the digestion of fibre is the protozoa, single-cell animal organisms, generally actively motile; some of them are thought to be of species particular to water buffaloes. Buffalo calves have active protozoa in the rumen at an earlier age than calves of cattle kept in the same environment. In early weaned buffaloes there may be protozoa in the rumen as early as one month of age.

Trials of digestibility of speargrass, groundnut cake and Russian rye have been undertaken in India, of lucerne and other fodders in Egypt, of guinea grass in the Philippines, and in many countries of clovers, hay, cereal straws and other feedstuffs. The efficiency of digestion of fibre in buffalo calves was studied in Egypt.

Experiments do not show that buffaloes can digest fibre more efficiently than other ruminants but, on the other hand, a recent review of feed utilization in four species concludes that buffaloes and goats are more efficient than cattle and sheep. Buffaloes have been shown to utilize the following feedstuffs more adequately than cattle: guinea grass, speargrass, groundnut cake, wheat straw, rice straw, sorghum straw, pearl millet and green berseem. Recent trials in the Philippines showed that the carabao, on poor quality roughage, had a better feed conversion rate than cattle.

The fact that buffaloes can be maintained on poor fodders does not justify poor husbandry. Good nutrition is necessary for efficient breeding, production and work.

Urea in rations

Urea is fed to ruminants to increase the digestibility of fibre by providing the essential ammonia for the cellulose-splitting bacteria in the rumen, and in order to reduce the cost of feeding where grain and molasses are cheap and protein feeds are costly. The disadvantage is that the rations may be unpalatable and the intake reduced. There is also a danger of ammonia poisoning if too much urea is consumed, and in some special conditions such as low nutritional levels.

Trials in India, using urea and molasses to replace 25 percent of the nitrogen in the groundnut cake in the rations, showed buffalo and Hariana heifers to have the same weight gains, but Sahiwal heifers were essentially different. Murrahs and Tharparkar cows were fed on various levels of urea up to 3 percent of the concentrates, with molasses at 10 or 20 percent.

Protein digestion in the rumen was more efficient in the buffaloes than in the cattle. Murrah heifers, 11 to 12 months of age at the start of a trial period of seven months, were fed on wheat straw with concentrates and urea replacing 42 percent of the nitrogen of the concentrates fed. The average daily weight gain of the urea-fed group was 0.56 kg, that of the controls 0.33 kg.

In many rice-producing countries the straw is burned. Buffaloes can make good use of it. In the Philippines rice straw is soaked for eight hours in a 10 percent solution of urea, with molasses, and fed to milk-producing buffaloes. Rice straw is also fed with molasses, rice bran, coconut meal and urea.

Egyptian buffalo calves, naturally suckled until weaned at 45 days of age, were fed on a high-energy concentrate diet, adjusted to the stage of growth, with mineral supplement and 5 percent urea. The average daily weight gain during the period of 5 to 12 months of age was 0.99 kg, that of controls without urea 0.89 kg. From 12 months to attaining a liveweight of 400 kg the corresponding gains were 0.93 and 0.80 kg.

In India, the best feed utilization rate was attained with a concentrate mixture including 2 percent urea and fed with 15 percent molasses.

Some investigators believe that there is no shortage of nitrogen or ammonia in the normal rumen, and that the limiting factor may be energy, calling for more soluble carbohydrates in the rations. Molasses may be fed up to 2.25 kg daily in winter and up to 0.9 kg in summer. More than these quantities may cause diarrhoea; some cases of skin rash have also been reported.

Some feed materials

Mention must be made of some of the more important feedstuffs and supplements used in the various regions where buffaloes are kept.

Pastures and grasses

Most working buffaloes are maintained on rough grazings, bunds between padi fields and fallow land between crops, with a small allowance of cereals, bran and straw during periods of cultivation of the land or of haulage work. Where common pastures are used they are almost invariably overgrazed during dry seasons. Buffaloes kept for milk production are often maintained on improved pastures, or may have cut grass and green fodders. Controlled grazing is practised in some meat-producing areas. Buffaloes may cause damage to pastures by their efforts to make

wallows; they are also said to cause more damage to fencing than cattle. These disadvangates can be overcome to a large extent by the provision of shade, wallows or other cooling devices and by routine dishorning or dehorning. Many semiwild herds live in forest or swamp lands. Some of these systems are described in the sections on various countries in part II of this study.

Buffaloes thrive on many aquatic plants and in time of flood will graze submerged, raising their heads above the water and carrying quantities of edible plants. They eat reeds, quassab, a giant reed, birdi, a kind of bulrush, kaulan, a sedge; water hyacinth; canarana, muran and other marsh grasses. Some of these plants are of great value to local peoples in many ways; others, such as water hyacinth, are a major problem in some tropical valleys, and water buffaloes may help to keep waterways clear.

Grasses used in improved pastures are well known in cattle-raising countries. Examples are colonial grass, elephant, guinea, jowar, leersia, mauritius, napier, pangola, para, Rhodes, sourgrass, speargrass, stylo, and many others.

Green fodders are used widely for intensive milk production and for fattening. Many fodder crops are conserved as hay, chaffed or pulped. Fodders include alfalfa and lucernes, berseem and bancheri; the leaves, stems or trimmings of banana, cassava, fodderbeet, halfa, ipil-ipil and kenaf; maize, oats, pandarus, groundnut, sorghum, soybean; sugarcane and bagasse; and turnips. Citrus pulp and pineapple wastes have been fed safely to buffaloes. In Egypt, whole sun-dried dates are fed to milch buffaloes up to 25 percent of standard feed mixture. No digestive disturbance was observed. Results were less satisfactory in yearlings.

Concentrates described in rations include barley, bean meal, cob meal, coconut and copra meals, corn gluten, cottonseed cake, fish meal, gram, groundnut cake, maize meal, molasses, rice germ meal, sugar-beet pulp and sunflower seed meal.

Artificial flavourings have been used but did not lead to increased food intake or to higher weight gains.

Special feeds used for exceptional purposes are rice gruel, eggs, milk, and wine.

Many investigators have remarked on the buffalo's taste for salt and on the benefits derived from its provision. It aids appetite and digestion, is a convenient vehicle for mineral supplements and helps to maintain a happy relationship between the animals and their attendants. It is provided regularly for semiferal buffaloes in some countries. The animals learn to associate the herdsmen with the supply and rounding up is made less arduous.

Mineral supplements are essential in some districts where deficiencies

are known to occur. Deficiencies are suspected in many other areas and salt licks with mineral supplements are beneficial in all production herds. Ground limestone or sea shells may be given where appropriate.

Little information is available on the vitamin requirements of buffaloes. Vitamin E is considered to be indispensable for artificially reared calves in Egypt. The water buffalo has a very efficient mechanism for dealing with carotenes and, whatever the amount present in the rations, only traces are found in body fat and milk, which are both white. The fat and milk of cattle have varying levels of the yellowish colouring of carotenes.

Drinking water

This may not seem to be an item worth considering in the nutrition of the water buffalo but shortages do occur in areas where streams and water holes dry up in long, dry seasons, as in the Northern Territory of Australia, where many deaths have been recorded. In Pakistan, milking buffaloes are watered twice daily, before milking. The average intake is about 45 litres for maintenance and a similar quantity for milk production.

Feeding for milk production

The water buffalo is a slow and voracious feeder, but when the air temperature rises above 32°C appetite declines, milk yield falls, and more water is needed. Feeding extra rations for milk production in hot weather increases the liability to heat stress and, unless measures are taken to reduce body temperature, milk yield suffers.

The daily requirements of the dairy buffalo for maintenance and for the production of the first 4 or 5 litres of milk are similar to those of the dairy cow. Most urban dairymen in India feed straw and chaffed sorghum with concentrates. Green fodder such as lucerne or berseem may be given to replace concentrates. It tends to improve the breeding rate and yields. The amount of cellulose digested by buffaloes is greater than that utilized by dairy cattle. Recent trials in India, feeding Murrahs at various levels of nutrition, showed that the lowest rate of concentrates fed — 0.3 kg per litre of milk — gave the highest economic reward. The concentrate mixture was composed of maize 20 parts, groundnut cake 20, ramtil cake 10, wheat bran 35, and rice polishings 15.

Milking buffaloes on military farms in Pakistan are given up to 54 kg green fodder daily — sorghum, green maize, clovers, alfalfa, turnips or green oats, usually chopped — rice straw 4 to 6 kg per day, and concen-

trates according to milk yield. A typical concentrate mixture is cottonseed cake, 2 parts, one part each of wheat bran, crushed barley or maize, and gram. A maintenance ration would be 1.8 to 2.7 kg of the concentrate mixture, and the production ration 1 kg for each 3 kg of milk.

Steaming up of buffaloes before calving is rarely practised, though preliminary trials have given encouraging results.

Alfalfa has become a popular crop in Iraq; buffaloes do well on it and like it. Milking buffaloes in Iran are given up to 9 kg daily of a mixture of rice bran and rolled barley with 12 kg alfalfa and the same quantity of chopped straw.

A daily ration of 35 to 40 kg of para grass or guinea grass with 1 or 2 kg molasses, 1 or 2 kg hay or straw, with salt and mineral supplement, should suffice for a buffalo giving a total milk yield of 1 200 to 1 600 kg in a lactation.

It has been suggested that the high butterfat percentage of buffalo milk is associated with the high efficiency of fibre digestion. It is, however, more likely that it is a species character and therefore hereditary. It is claimed that increasing the amount of long fibre in the food leads to higher butterfat content of the milk and that the same increase cannot be attained by feeding additional grain concentrates.

Feeding Indian buffaloes four times instead of twice a day led to increased milk yields. It is essential to avoid the hottest hours of the day when planning feeding programmes.

6. ASPECTS OF DISEASE

Diseases and disorders of the domestic buffalo have received a great deal of attention during the last quarter century. Much painstaking research has been conducted in the search for knowledge but relatively little has had practical application in the prevention and control of disease in buffaloes.

Parasites and parasitic conditions are of such importance that they are given a separate chapter in this study (see p. 79).

A complete review of the literature on diseases of buffaloes would in itself fill a volume. It would have many references to conditions that are common to other domestic species. Many of the diseases and disorders of buffaloes are much the same as those that afflict cattle, and only the differences in prevalence, symptoms, pathology and control measures will be discussed here. Several obscure conditions still await clarification.

The idea that buffaloes are resistant or even immune to many of the infections of cattle has been founded on the health of isolated populations, such as those in Australia or Trinidad, which are free from the most damaging plagues of livestock. If an exotic disease were to be introduced into such a population, the buffaloes might be found to be highly susceptible.

The degree of reaction to exposure to an infection is influenced by the virulence of the pathogen, the resistance of the animal to that agent, the breed, level of nutrition, stresses of climate, work or production and to many other factors. Variations are found in different infections and environments and it is not wise to generalize.

When the domestic buffalo is maintained under good management it is remarkable for its long productive or working life. It is, however, thought to put up a poor fight against disease and there is some truth in the saying that a sick buffalo is a dead buffalo.

Field investigations are essential in the study of disease. They should be given priority over pure research in the allocation of any funds that may be available.

Diseases caused by viruses

RINDERPEST (cattle plague)

In the Far East, rinderpest runs a far more acute course in buffaloes than in cattle and the death rate is higher. Outbreaks have been reported in which the mortality reached 100 percent of affected buffaloes. In the Indian subcontinent outbreaks have resulted in death rates of up to 87 percent. An epizootic in Burma was reported to have been the cause of death in 85 percent of buffaloes.

Reports from Egypt show great variation in the virulence of the infection. In one outbreak there was a mortality rate of 77 percent in unweaned calves and of 20 percent in mature buffaloes. The disease is usually relatively mild in adult Egyptian buffaloes and the popularity of the animal is due, in part at least, to its apparent resistance to rinderpest. There may be a breed resistance as well as environmental factors involved. Treatment with internal antiseptics is believed to reduce the death rate but this requires confirmation.

In an epizootic of "Djembrana disease" in Bali, Indonesia, in 1964/65, about 10 percent of the cattle and buffaloes perished, and there was a higher rate in some districts. It is now believed that the epizootic was, in fact, rinderpest. A disease currently known as Djembrana disease appears to be a different entity. Local veterinary investigations indicate the possibility of a tickborne rickettsial infection.

Vaccines prepared from live attenuated virus produced in goats were used with varying degrees of success for many years. Modern techniques of vaccine production, using attenuated virus grown on cell cultures, have provided efficient and safe control where regular vaccination can be applied.

The national eradication plan in India has made good progress; ten vaccine production laboratories can now produce 70 million doses a year. The number of outbreaks in the season 1972/73 was 160, whereas the number reported annually 15 years earlier was in the region of 8 000. During the interval the number of animals affected has been reduced from around 20 000 per year to 5 500. Buffaloes are used for testing the safety and efficacy of the vaccines.

RINDERPEST-LIKE DISEASES

The existence of conditions with some clinical similarity to rinderpest raises important questions. As rinderpest is brought more and more under control these conditions come to light. The number of cases reported is

increasing and more areas of the world appear to be involved as investigations proceed.

The existence of mucosal disease has long been recognized in India. An outbreak in Madras in 1962 affected only buffalo calves and caused a mortality of 5 to 10 percent. Many local names have been given to outbreaks and, in some instances, the true nature of the disease was not determined. In Indonesia, a disease in buffaloes was described under the name of "Purwokerto disease;" it may be related to this group of viral conditions.

Viruses have been isolated from cases of virus diarrhoea and mucosal disease in buffaloes in several countries. In Australia, a proportion of cattle and buffaloes have antibodies in their blood against mucosal disease virus. It is believed that most of the infections take place without causing clinical manifestations.

Two strains of enterovirus have been isolated from buffalo calves in India.

Much more research is needed to identify the causes of these conditions and to indicate measures of control.

FOOT-AND-MOUTH DISEASE

The domestic water buffalo is susceptible. Opinions on the resistance of buffaloes, as compared with that of cattle, are contradictory.

In most of the regions in which buffaloes abound the virus of foot-and-mouth disease is always present. Outbreaks occur quite frequently and cattle and buffaloes acquire a degree of resistance. Symptoms are mild in the majority of affected animals and recovery is rapid; a few contacts may show no sign of infection. There are, however, always some cases of severe disease to be seen in outbreaks involving many herds. Lesions in the mouth lead to loss of appetite and condition, teat lesions cause difficulty in milking, secondary infections lead to mastitis, and foot lesions may become septic and cause chronic lameness. The drop in milk production in the area of an epizootic may be spectacular. There is usually a high death rate in calves and young stock that are infected for the first time. Fattening animals may take weeks to replace the lost weight.

Apparently healthy animals may remain carriers of the virus after recovery from the disease.

Buffaloes have been introduced into countries that are free from foot-and-mouth disease, such as Australia, Trinidad and one or two others. It is probable that the animals will be highly susceptible should the virus gain admittance.

At the Kaira District Cooperative Milk Producers' Union, India, where

some 200 000 Surti buffaloes are the sole source of the milk supply, it is said that outbreaks are less frequent than in the cattle and working buffaloes in the surrounding area. This is attributed to the fact that the buffaloes are stall-fed and do not wander about as do the other livestock.

At the Aarey Milk Colony, Bombay, about 16 000 buffaloes are kept in what is virtually a flying herd and outbreaks of foot-and-mouth disease occur as often as twice a year. The loss of milk is serious and many animals dry up completely. Infertility slows down the reproduction rate, and many calves die.

Vaccination is not yet a widespread practice. The mild form of the disease masks the losses. It is sometimes claimed that the cost of vaccination is greater than the losses sustained, a claim that would probably not stand thorough investigation. Some countries that have policies for vaccination of cattle exclude buffaloes.

The results of vaccination in buffaloes are seldom as satisfactory as in cattle. Attempts to improve the efficacy of vaccines for buffaloes are under way. One approach is to use virus of buffalo origin grown on cell cultures also of buffalo origin.

Aphthization, the deliberate spreading of virus from one animal to another, is still practised in some areas in order to shorten the course of an epizootic and to leave all the animals resistant.

Treatment of affected animals is based on curing the lesions on the feet, mouth and teats. The compounds recommended are very varied and some are astonishing. Superstitions, charms and amulets are associated with foot-and-mouth disease, as with disease in general, in many lands. Outbreaks are considered to be inevitable and are accepted with fatalism by many pastoral people.

Rabies

Rabies virus is present in most of the countries in which buffaloes are kept but reports of the disease in these animals are not numerous. Cattle are affected much more frequently, possibly because they are less able to defend themselves against mad dogs and wild animals. In Democratic Kampuchea, rabies causes many losses in cattle but seldom occurs in buffaloes.

The symptoms are similar to those of paralytic rabies in cattle. A Philippine carabao was bitten on the muzzle by a mad dog. Symptoms appeared a month later and included digestive and brain disturbance with violent butting of the head against a tree. Paralysis and death quickly followed. The dog was killed by another carabao which was treated with rabies vaccine and remained healthy.

In Trinidad, [illegible] rabies is transmitted by vampire bats, no case has been recorded in [illegible] buffalo. Both buffaloes and cattle are vaccinated every year. The Connaught vaccine, prepared from virus grown on cell cultures, is safe and effective, giving a good degree of protection for at least three years.

Buffalo pox

The virus of cowpox can be transmitted to buffaloes, causing a mild condition with rapid recovery. Natural cases have been reported in India, Indonesia, Italy and the U.S.S.R. It may be associated with smallpox in man or with vaccination of humans against that disease. Studies of the causal virus of natural infection in buffaloes in India showed that there were distinguishing characteristics of buffalo pox virus.

Arthropod vectors of virus

Biting flies, mosquitoes and ticks are concerned in the transmission of several infectious and parasitic conditions of cattle and buffaloes. The virus of ephemeral fever has been isolated from mosquitoes in Australia, where research on virus infections of livestock is making excellent progress.

The vectors of pathogens, flies, ticks and other invertebrates are discussed in the chapter on parasites and parasitic disease (see p. 79). The special problems of African livestock diseases are noted in the chapter on the water buffalo in Africa (see p. 236).

Diseases caused by bacteria

Haemorrhagic septicaemia

Outbreaks of this disease in buffaloes in the tropical regions of Asia often appear in the form of acute, virulent infections with a high death rate. In many countries it is the most damaging affliction of buffaloes. In Thailand, deaths may occur of up to 10 000 animals each year, most of them working buffaloes. The people of affected areas run grave danger of famine as a result of failure to cultivate food crops through lack of working animals.

Estimates of deaths from haemorrhagic septicaemia in India range from 30 000 to 50 000 annually. An epizootic in Sri Lanka in 1956 killed about

5 000 cattle and buffaloes. In the marsh region of Iraq, where the buffaloes are estimated to number 150 000, outbreaks of the disease have wiped out whole herds and, as the buffaloes are the mainstay of the marsh Arabs, the consequences were disastrous.

The disease is caused by *Pasteurella multocida.* It affects other domestic animals but buffaloes seem to be the most susceptible. There are many serotypes of the organism. The types that cause haemorrhagic septicaemia in buffaloes and cattle are Roberts' type 1 and Carter's type B. Infection is probably spread from one animal to another by contaminated food or by infective air currents. Biting flies, ticks and leeches have been blamed. It is known that apparently healthy cattle may be carriers of *Pasteurella* organisms.

Symptoms of the disease in buffaloes are fever, dullness and salivation. Prostration and death may ensue within 24 hours. The course of the disease in cattle is usually less acute than in buffaloes and there is more time for the development of lesions and obvious signs of infection in the affected organs.

The throat form of the disease is common in buffaloes. The swelling spreads from the throat along the lower border of the neck to the brisket and, in some cases, to both forelegs.

Treatment with antibiotics or sulphonamides is only useful at the onset of infection.

Three highly effective kinds of vaccine are now available and should be used much more widely in disease control programmes. The Chinese are operating very extensive campaigns of vaccination with outstanding success. Regular vaccination is also practised in Italy and in some areas of the east. Protection lasts for the period of greatest risk, the rainy season. Research continues with the objective of achieving a longer-lasting immunity.

Difficulties beset the application of vaccination in many lands. The financial obstacle is ever present; the physical difficulties are sometimes insuperable. Transport may be by small boats as, for example, in the marshes of Iraq. In other areas roads may frequently be impassable and facilities for controlling the animals may be lacking. In districts where buffaloes live in a semiwild state, as in parts of Indonesia and the Philippines, in the Northern Territory of Australia and in the Amazon valley of Brazil, vaccination becomes impracticable.

At the best of times, buffaloes are apprehensive of strangers and they vigorously resist the needle. Crushes or stocks are essential where considerable numbers are to be dealt with. And adequate equipment must be provided for keeping the vaccine in the required condition and for the sterilization of instruments.

applied. Reactions are often more pronounced than in cattle and there are relatively more doubtful and nonspecific reactions in buffaloes. The predilection of these creatures for wallowing in contaminated water may account for the nonspecific infections. It is possible that more accurate and definitive results would be obtained by using the comparative intradermal test with mammalian and avian tuberculins.

In a limited series of tests in India 18 percent of buffaloes gave positive reactions; in Pakistan a figure of 25 percent is reported. Many positive reactors in Brazil were found, after slaughter, to have no visible lesions of tuberculosis — the so-called no lesion reactors. But this finding does not prove that the animals were free from infection.

The indirect haemagglutination test has been studied in India. It proved to be more sensitive than the tuberculin test, with few doubtful and nonspecific reactions. Widespread application would be a slow and costly procedure. The test could be of value applied to doubtful reactors to the tuberculin test.

Buffalo leprosy

This condition has been reported from Indonesia but not from other countries. It is primarily a disease of buffaloes, although one case has been described in a Holstein-Friesian cow in which the lesions were similar to "skin tuberculosis." The lesions in the buffalo are said to be similar to those of human leprosy but without the involvement of nerve tissues. Nodules form under the skin in almost any part of the body, varying in size from 0.5 to 6 cm across and they may be very numerous. The animal's general health is not affected nor is the working capacity impaired.

An organism, *Mycobacterium leprae*, has been isolated from lesions but it did not reproduce the disease on inoculation into experimental animals.

Johne's disease

Symptoms of this disease in buffaloes are similar to those in cattle — chronic diarrhoea, wasting and emaciation. Little information is available on the prevalence of infection in buffaloes. More diagnostic investigations should be made where diseases of this group occur.

Brucellosis (contagious abortion)

Brucellosis in buffaloes has been confirmed in most of the countries in which investigations have been undertaken. In some areas its existence is suspected but not yet confirmed. There may be a few districts which

still remain free from the infection. Blood testing of buffaloes is not an easy procedure. Facilities for controlling the animals are needed and equipment for the collection and storage of blood samples has to be provided. Control programmes are costly and progress is inevitably slow.

A survey in India showed that *Brucella abortus* was by far the most prevalent cause of abortion in cattle. In Haryana state, out of 589 cattle tested 2.3 percent were positive; out of 1 058 buffaloes 13.1 percent were positive. Infection is believed to be spread by marketing of positives. Two strains indistinguishable from *Br. melitensis* have been isolated from the genital tract of buffaloes.

Brucellosis is common in Italian buffaloes; abortions occur from the sixth to the eighth month of pregnancy. *Brucella abortus* has been isolated from buffaloes in many herds. Blood testing of buffaloes in the state of São Paulo, Brazil, disclosed 47 percent positives.

Brucella infection has been found in a variety of conditions in buffaloes, such as inflammation of the testicle and arthritis of the knee joint.

In Egypt, out of 76 isolates from buffaloes, cattle and sheep, the commonest type was *Br. abortus* biotype 3.

There is little information on vaccination of buffalo calves against brucellosis.

Human beings are susceptible to *Brucella* infections and disease in domestic animals is a public health problem. Contact with animals at the time of abortion is particularly dangerous and the use of raw milk for children is inadvisable in many lands. There is also a risk in eating and handling cheese and other products made from raw milk.

ANTHRAX

It is not known for certain if buffaloes are more susceptible to anthrax than cattle. Opinions from different regions are contradictory. There seems to be some variation in the relative incidence in different countries. The fact remains that deaths of buffaloes from anthrax are serious and persistent in many contaminated areas.

Many cases of sudden and unexplained deaths are not reported and investigations into the cause are not undertaken. It has been estimated that, in some regions, the number of deaths from anthrax may be 20 times the number officially confirmed.

Animals that become acutely ill are often slaughtered, meat is distributed, and hides are salvaged. Or the dead animal may be buried in a shallow pit without precautions against contamination of the soil. When blood and excreta of infected animals are exposed to air the anthrax bacillus forms spores that are extremely resistant and remain infective

in the soil almost indefinitely. Marshy places where buffaloes congregate are particularly vulnerable.

Anthrax in domestic animals is another serious public health hazard.

Leptospirosis

Leptospirosis has been diagnosed in buffaloes in Bulgaria, Egypt, India, Romania and the U.S.S.R. Investigations in Taiwan, China, failed to reveal infection in buffaloes. Blood tests in the Philippines showed that the majority of carabaos had immune bodies to *Leptospira.* Losses from this infection are known to occur in animals in many countries.

Many serotypes are involved and complicate plans for control by vaccination. Where there are facilities for typing *Leptospira,* and the appropriate vaccines are available, a fair measure of protection can be attained. But there is always the danger that the animals may become carriers of infection.

Some types are pathogenic for man. Workers in padi fields are commonly infected from water contaminated by rodents and other animals. More research is required to define the role of the buffalo as a reservoir of *Leptospira.* Mechanization of rice cultivation has reduced the incidence in humans in Australia and Italy. In New Zealand, on the other hand, the number of cases of infection in workers in herringbone milking parlours has increased, presumably due to more intimate contact with airborne infection from the excretions of the cows.

Diseases of the kidneys are not uncommon in buffaloes and many of them are due to leptospirosis. The contamination of wallows by excreta of the animals maintains a high level of microbial populations in the water. In some countries human urine is given to buffaloes as a tonic; this may well be a further source of infection. The presence of rats and other rodents around milk production establishments is a further danger.

Several types of nephritis (disease of the kidneys) have been studied in Egypt, Greece, India and Romania. In the countries that have cold weather in winter, buffaloes should not be allowed to stay long in wallows and rugs should be provided when the air temperature falls. Working buffaloes also require protection during their rest periods.

Mastitis

Research in India and elsewhere has shown that most of the bacteria that cause mastitis in dairy cows also infect buffaloes. The same defects in management practices are involved.

A survey in Egypt showed that the incidence of mastitis in buffaloes

increased with the number of lactations, and that the infection was less frequent in buffaloes than in Friesian cows. Some evidence came to light that the daughters of certain sires were more resistant than those of other sires.

Wherever buffaloes are kept for intensive milk production mastitis is an important cause of economic loss. On the other hand, Swamp buffaloes, kept for work and giving only a small quantity of milk for the family, rarely have mastitis.

Although the udder of the buffalo is pendulous and the teats long, mastitis due to injury is not seen as frequently as one might expect.

In Iraq, marsh buffaloes are rarely affected, but when they are moved to resettlement areas in the Baghdad milk production zone, they frequently develop mastitis.

Tail necrosis

This condition is observed in cattle and buffaloes in many countries. In Egypt it is known as *arrada*. It begins with swelling and inflammation of the tip of the tail. At first it may be masked by the hair of the tail switch. Then it is seen to be extending gradually up the tail. The primary lesion becomes cold and insensitive, the hair falls out, the dead tissue may separate from the healing areas and parts of the tail may slough off. In some cases most of the tail is lost. Working animals are the most common subjects of tail necrosis.

The microbe *Corynebacterium bovis* has been isolated from affected tissues and it reproduced the disease when injected into experimental animals. It causes many different necrotic conditions in livestock in all parts of the world. Some research workers believe that a deficiency of essential fatty acids in the diet is involved.

Treatment is usually by amputation of the affected part of the tail. However, the condition may recur in the remaining part, in which case further surgery becomes necessary.

Tail necrosis is also seen in Deg Nala disease.

Diseases of bones and feet

Osteomyelitis

This bone condition has been reported in buffaloes in some of the Indonesian islands. It is a severe infection of bones and bone marrow with the microbe *Clostridium gigas*. Lameness of varying intensity is

followed by abscess formation and there may be arthritis, dislocations or fractures.

Foot rot

Chronic infections of the feet are seen much less frequently in buffaloes than in cattle. They result from infection of wounds or secondary infection of lesions of foot-and-mouth disease or of rinderpest-like disease. The larvae of the fly *Chrysomia bezziana* may burrow deeply into tissues that have been damaged by accident or disease.

Some animals become permanently crippled. Lameness in working animals during the season of cultivation of padi fields may have serious consequences for local families.

Conditions associated with fungi

Deg Nala disease

This condition was first reported in buffaloes in Deg Nala, Pakistan. It is now seen in many rice-growing areas in other countries. The disease occurs in well-defined districts and may be restricted to particular villages or even individual fields. Most cases are seen in winter. The incidence of Deg Nala is increasing and the areas affected are extending. There have been outbreaks of a very serious nature with a mortality rate as high as 64 percent.

When the condition is first noted, swellings on the lower surfaces of the body are characteristic. Later, ulcers form on the extremities, legs, tail, ears and, in some cases, on the muzzle and tongue. Tissues may slough off, then healing usually follows. When the feet are affected the animal may be permanently crippled.

A toxic product of the growth of a fungus on rice straw or fodder is believed to be the cause. Ergot has been suggested as the fungus but it has not been found in some places where the disease is prevalent. Six other fungi have been identified in association with rice straw and fodders in affected areas. The condition has been reproduced by feeding rice straw of the IR 8 variety; many outbreaks have occurred where it is grown.

Aflatoxicosis

A toxin produced by a fungus growing in feed meal, aflatoxin, has caused outbreaks of poisoning in domestic birds and mammals. A case

in an Indian buffalo is reported. The animal aborted and the foetus was studied. Changes in the liver suggested that the cause of abortion was aflatoxin.

Chronic granuloma

Small tumour-like swellings of the skin of Indian buffaloes have been described. They were seen chiefly on the lower jaw. They grew very slowly, some of them attaining the size of a tennis ball. They eventually burst, discharging a creamy pus, and there was no tendency to healing. The cause was thought to be a fungus but it was not identified.

Ringworm

Only one species of fungus has been identified as the cause of ringworm in buffaloes: it is *Trichophyton faviforme*. Young animals are the most likely to be affected.

Some skin infections

A condition seen in Egyptian buffaloes and known locally as "oedematous skin disease" is characterized by swellings and nodule formation and generally ends in death. The swellings, usually in the lower chest, abdomen or legs, varied in size from a hen's egg to a watermelon. Postmortem examination revealed inflammation of areas of the digestive tract, fluid in the chest, abdomen and legs and typical toxic changes in the viscera.

An organism closely resembling *Corynebacterium pseudotuberculosis* was isolated and was believed to be the cause of the disease. Infection was presumed to be spread via small wounds and punctures of the skin by thorns or by bloodsucking flies.

Another condition, ulcerative dermatitis, has been described in Egyptian buffaloes. Again an organism like *C. pseudotuberculosis* has been isolated. It is thought to be related to lumpy skin disease of cattle, but that has never been officially recorded in Egypt. Another authority expressed the opinion that the condition in buffaloes resembled ulcerative lymphangitis of cattle in the Rift valley of east Africa.

In Burma, another ulcerative skin disease in buffaloes was said to have appeared during the occupation by the Japanese army. It was also stated that it produced a condition in man resembling yaws. Ulcers up to 12 cm in diameter were described, most commonly on the legs. They were

star-shaped with raised edges and tended to spread or heal with scar formation. There was little effect on general health.

These few examples of skin conditions suffice to show the need for thorough investigation whenever diseases of doubtful aetiology are spreading in any locality.

Noninfectious skin conditions

Leucoderma or vitiligo

This condition is seen in Indian buffaloes. Areas of skin are devoid of pigment, the areas are identical in pattern on each side of the animal, and there is a tendency to extend progressively. Affected specimens are said to be fairly common in some districts in India. A few have been seen in Pakistan.

The cause is not known. There is no danger to the animal's general health but the condition is unsightly. There is no recommended treatment.

Photosensitivity

Light-coloured calves are usually the only ones to be affected. The skin of the muzzle and neck has the appearance of sunburn and the superficial layer sloughs off. It may be due to the effect of the sun's rays on sensitized areas of skin. In cattle it affects areas of unpigmented skin.

Affected buffaloes have been seen in the Amazon valley of Brazil where the farmers consider it to be a sign of weakness. Affected calves are slaughtered.

An exceptional case was reported in an Indian buffalo calf. Although black-skinned, there were lesions in the skin of the back and thighs and signs of toxic changes in the liver and kidneys. Poisonous plants and some forage plants have been suspected of stimulating photosensitivity.

Diseases of the eyes

Conjunctivitis

Seeds, chaff, husks and other small irritating particles often become attached to the membrane covering the eyeball and lining the lids. A severe inflammation of the membrane is caused, tears flow copiously, the

whole area of the eye becomes painful, the eyelids swollen and the eye closed. If the foreign body is not removed, the front of the eyeball becomes clouded and the tears thicken with pus. Early treatment with simple eye washes usually leads to complete recovery.

Close herding for long periods in dusty surroundings results in conjunctivitis in many buffaloes, particularly in the older animals. Ammonia vapour from old accumulations of urine also irritates the membranes of the eyes.

A form of contagious ophthalmia has been reported in Egyptian buffaloes. The organism *Rickettsia conjunctivae* was demonstrated. It is seen in buffaloes more frequently than in cattle. Infection is believed to be spread by flies and dust particles.

Infectious bovine kerato-conjunctivitis has been diagnosed in buffaloes in several countries. It is not known whether the cause is the same as in cattle, the very small bacterium *Moraxella bovis*.

Digestive disorders

Bloat

Abnormal distension of the first compartment of the stomach of cattle has been recognized for centuries. It can be a serious economic problem in intensive dairying districts. Buffaloes are not so liable as cattle to bloat and in some countries the condition appears to be unknown. On the other hand, it is reported to occur quite frequently in buffaloes of the Landhi Cattle Colony near Karachi, Pakistan. As many as five cases may be attended in a day out of a buffalo population of at least 35 000. The change of diet on arrival at the colony is the most frequent cause, and some cases are due to impaction. Replacement animals are given extra green fodder for about two weeks after arrival. Cases are usually of a mild type.

In the Far East, bloat occurs most commonly at the beginning of the rainy season. In India, cases are seen at all seasons and there does not appear to be any direct connexion between bloat and the feeding of legumes. It is possible that differences in the conformation of local types of buffalo and the wide variations in environment and management in different regions account for the discrepancies in reports on the prevalence of bloat.

When given the opportunity, buffaloes are selective grazers and consume fibrous roughage as well as lush leguminous plants. This aids ruminant digestion and prevents bloat. The freedom from bloat in some areas is

explained by the absence of "bloat pastures." Working buffaloes generally have short periods of feeding between working stints, so they do not get over-full. Wallowing and grazing alternate.

Curious beliefs exist about the cause of bloat in many countries. Some of the remedies are even more curious.

"Hardware disease"

Like cattle, buffaloes may develop perverted appetites and swallow a wide range of indigestible articles, some of them surprisingly large. Among the many things that been recovered from buffaloes, the commonest are pieces of wire, nails, knitting needles and coins. They tend to be retained in the second compartment of the stomach and, if sharp-pointed, they pierce the wall and the diaphragm and prod the pericardium and even the heart itself. Buffaloes are more prone to the disorder than cattle.

Diagnosis can be confirmed by the use of a metal detector, in expert hands. A suitable instrument should be available in all districts where large numbers of cattle and buffaloes are kept. The operation for the removal of foreign bodies via an opening into the rumen is usually completely successful if performed before serious heart damage has supervened. At the Aarey Milk Colony, Bombay, more than 100 such operations are performed each year.

Diaphragmatic hernia

A recent report from India describes six cases of hernia of viscera through the midriff in buffaloes. If buffaloes are prone to this accident, more reports of the condition might be expected from meat inspectors. It must surely be very rare.

Disorders of reproduction

Infertility

In male buffaloes

Apart from numerous studies on semen quality, the diseases of male genitalia of buffaloes have not received the attention that their importance should command. Abnormalities of the testicle are not common in Egyptian buffaloes but degenerative changes, similar to those found in senile cattle, are sometimes seen in buffalo males at an earlier age — 6 to 7 years.

In India, several types of defect are reported and some abnormalities of the testicle are relatively common. A surprisingly high percentage show a deposition of calcium in both testicles. A buffalo affected with tuberculosis of the testicle was responsible for a number of cases of tuberculosis of the uterus.

Buffalo males of milk breeds often have poor service capacity. It may be largely due to hereditary factors. It is a serious problem where A.I. services are concerned. Such males should be culled.

In female buffaloes

Much more attention has been given to the disorders of reproduction in the female. Studies in many countries indicate a high percentage of defects in genital organs collected at slaughterhouses. This may be explained, in part at least, by the fact that many of the animals would be slaughtered because they were barren. Defects are more frequent in older females than in heifers. Many are due to infection or injury at calving, retention of the afterbirth and, in various countries, to malpractices, some of which are described later in this chapter (see p. 76).

Clinical investigations in herds where infertility was causing concern have been reported. Abnormalities of the ovaries were common. In Egypt, the percentage distribution of the various causes of infertility in buffalo females was similar to that in cows. The causes of infertility in 3 330 Egyptian buffaloes were:

Inactive ovaries	81.7%
Persistent corpus luteum	12.6%
Silent heat	3.0%
Ovarian cysts	0.12%
Infection of the uterus	2.4%

In a study of more than 1 000 buffalo females in Andhra Pradesh, India, more than half were due to physiological causes, such as inactive ovaries, silent heat, and so on. Retarded development was responsible in 13 percent of cases and there was one freemartin.

Out of 1 725 unselected Indian buffalo females at an abattoir, 4.6 percent were pregnant; 52 percent had normal ovaries at various stages of the oestrous cycle; ovarian abnormalities were found in 48 percent — the most frequent being nonfunctional ovaries.

Out of 112 buffalo females slaughtered at the Bombay abattoir, 50 had lesions of the fallopian tubes (leading from the ovaries to the uterus). In some cases both tubes were affected.

In a survey of more than 20 000 cattle and buffaloes in India, 242 buffalo cows and 58 buffalo heifers were found to be infertile. Inactivity of the ovaries was by far the most frequent cause. Infection of the uterus and vagina was present in many of the adult buffalo females. Retained afterbirth was the cause in 3 percent. No fewer than 15 percent were returning to service, although no abnormality could be detected. There were no buffalo freemartins or mummified foetuses.

Out of 500 female buffaloes slaughtered in Iraq, 27.4 percent had disease or abnormality of the genital tract.

In Australia, the virus of bovine rhinotracheitis was found in the prepuce of buffaloes and 95 percent of blood samples contained antibodies to the virus. The virus is spread by uncontrolled mating in semiwild conditions, but it does not appear to cause any health problem in buffaloes.

The microbe *Vibrio fetus* has been isolated from buffaloes in India, the U.S.S.R. and Malaysia. It is worldwide in distribution and causes serious economic loss in cattle-breeding areas. It may be prevalent in buffaloes in places where no investigations are undertaken. The very long calving intervals reported in many countries may be due to vibriosis. The death of an embryo at an early stage of development is a common sequel to infection.

Both males and females may be infected and spread vibrios in mating. Cross-infection between cattle and buffaloes has been reported. The use of communal males and trade movements of breeding animals are responsible for the wide distribution of the infection.

Males intended for use at A.I. centres must pass the most rigorous tests to ensure freedom from vibriosis.

Trichomonas foetus is a single-cell parasite of the genital tract of cattle. It causes serious loss in breeding, unless measures to control infection are taken, and it is found wherever cattle are kept in considerable numbers. There is only one record of infection in buffaloes which may be resistant to the parasite. More investigations are needed.

General infections which may cause infertility have already been noted: brucellosis, tuberculosis, foot-and-mouth disease and several ill-defined virus infections.

Physiological causes of infertility

Heat stress may cause the death of the foetus; it also slows down breeding activity in all stages. The need for protection against the sun's rays and extremes of climate have been discussed above (see p. 30).

After a normal oestral period or a completed pregnancy, the corpus

luteum of the ovary gradually regresses to prepare the way for the next heat and ovulation. Not infrequently, the corpus luteum persists and prevents further oestrus.

The stages of activity of the ovary are detected by palpating with one hand inserted in the rectum. A persistent corpus luteum can be expressed from the ovary and heat usually follows in about four days. Ovulation also follows in about half the animals so manipulated, but the procedure is not without risk. Should the animal be pregnant she will probably abort. The lining membrane of the rectum is easily damaged and bleeds profusely. Weekly examination of both ovaries is recommended before deciding to squeeze out a corpus luteum. Diagnosis of pregnancy by rectal palpation is of utmost importance. This is the essential first step in ascertaining the cause of infertility.

Sexual inactivity in Egyptian buffalo females was treated with hormones (PMS), heat was brought on and conception followed first service. In India, PMS was injected into females at different stages of the oestrous cycle. Multiple ovulation and cystic ovaries occurred in some cases. Many pregnancies were recorded.

Stilboestrol was formerly used to stimulate oestrus but it rarely led to ovulation and its use is no longer recommended.

Malpractices

Several unnecessary and undesirable procedures are adopted to stimulate milk letdown and they may lead to infection of the genital tract and to infertility.

In India, Pakistan and some other countries, the vagina is inflated by mouth or through a bamboo tube. The procedure is known as *phooka*. In Iraq, a hand or the tail switch, or even a piece of wood is inserted into the vagina.

Infection may also be carried into the uterus by dirty hands or instruments at calving. Wallowing in contaminated water and general insanitary surroundings are obvious sources of genital infection.

Milk fever

There are few reports on milk fever in domestic buffaloes. It may be presumed that the disorder is rare. Cases reported in Haryana, India, recently occurred at 24 to 48 hours after calving. Treatment with calcium borogluconate was effective. Two cases out of 14 treated suffered relapse and were given Mifex (M & B) and recovered.

Calf mortality

Wild arni and feral water buffaloes have high fertility and calf survival rates. The calves of domestic Swamp buffaloes are generally reared naturally and successfully. On the other hand, the mortality rate of calves in the milk-producing herds of River breeds is usually very high. The death of most of the calves is the result of lack of care and poor nutrition. Wherever buffalo milk is in demand the calf is not allowed to compete. One observer noted that, in the Bombay area, the only calves in some dairy herds that managed to survive were those kept alive intentionally to stimulate milk letdown. In one milk colony the calf mortality was more than 60 percent.

In two herds of Egyptian buffaloes the mortality during the period from birth to 3 years of age was 33 percent. More than 80 percent of the deaths occurred during the first six months. The most important disease conditions were pneumonia, digestive disorders, parasites and navel infection.

Many calves in the well-managed dairy herds are reared sucessfully on the bucket.

The overall mortality of buffalo calves born in state farms in Uttar Pradesh in the period 1964-71 was 22.23 percent. Good conditions prevailed. Most of the deaths occurred in the first two months after birth.

Calf mortality was higher during the winter and in calves that were small at birth.

The death rate in young buffaloes can be reduced by attention to hygiene, less crowded conditions, regular dosing against *Neoascaris* roundworms, and early treatment for digestive and respiratory disorders. Antibiotics and vitamin A are recommended.

The nutrition of young females during their first pregnancy has an important effect on the resistance of the calf in the early weeks of life.

A tendency to fail to suck, and to general weakness and inability to stand, may be due to anatomical deficiences of genetic origin.

Public health

Where buffaloes are used in rice cultivation they live in close contact with the family, sharing the slow painstaking work in the padi fields and exposed to the same environmental conditions. Little attention has been paid to the domestic buffalo as a possible reservoir of infections and parasites that may afflict the human population. Among the more important

diseases of mankind which are also found to be associated with buffaloes it is sufficient to mention leptospirosis, brucellosis, salmonellosis, tuberculosis and the parasitic conditions schistosomiasis and capillariasis.

It is strange that so little work has been undertaken on the role of the domestic buffalo in public health. Rabies is a grave problem in some regions. Fortunately, buffaloes appear to be less frequently affected than other livestock. Anthrax is always a hazard to the health of people living in infected areas. Tetanus is a common sequel to castration and other operations performed without due care to sterilization of instruments. It can be a fatal infection of wounds in human beings.

7. PARASITES AND PARASITIC CONDITIONS

Many parasites of cattle are also found in water buffaloes. There are, however, notable differences in degree of infestation or infection and in the damage caused. There are a few parasites which are exclusive to buffaloes.

The range of species that buffaloes may harbour is very wide but the number of parasitic diseases is relatively small.

Parasites of the skin

Lice

Only one species lives on the water buffalo, the large, bloodsucking louse *Haematopinus tuberculatus*, which is about 3.5 mm long. Its presence is betrayed by its large, light-coloured eggs, 1.2 mm long, firmly attached to the sparse hairs, often in large numbers.

Heavy infestation may contribute to unthriftiness, owing to irritation rather than to loss of blood.

Many treatments have been advocated but trials of the newer insecticides are needed. A recent report on treatment with malathion states that a 1 percent solution, sprayed on and well scrubbed into the skin, killed both the lice and the eggs.

The buffalo fly

Siphona exigua is found in India, southeast Asia and Australia. The flies remain very closely associated with their hosts, which include cattle and buffaloes, only leaving when disturbed or, briefly, to lay their eggs in dung pats. Large numbers may be seen on buffaloes but they do not, as a rule, cause the suffering and skin sores so often seen in cattle.

Other species of *Siphona* which feed on buffaloes include *S. sanguinolentus* in Burma and *S. irritans* in Italy.

Black flies

Sometimes called buffalo gnats, black flies cause serious disturbance to cattle, buffaloes and man in many countries. The fly rasps the skin layers and feeds on blood. Severe attacks by vast numbers may cause death in a few hours. Fortunately such attacks are unusual, but deaths of both cattle and buffaloes have been reported in the Balkan region.

Swellings of the belly and legs may be confused with those seen in haemorrhagic septicaemia.

Other bloodsucking flies

Mosquitoes, tabanid flies, stable flies and louse flies feed on buffaloes, but little information is available on the effects of heavy infestation. Some species are known to transmit diseases, such as surra and anthrax.

Warble flies

Most of the countries in which buffaloes are kept are free from warble flies. In Italy, in a district in which cattle were heavily infested with the larvae of *Hypoderma bovis*, no infestation was found in the buffaloes. In Bulgaria, however, larvae of that species were present in 28 out of 806 buffaloes. In India, the larvae of *H. lineatum* are occasionally found in buffaloes. In Shanghai, 3.5 percent of imported buffalo hides were reported to be damaged by warbles.

Chrysomia, Wohlfahrtia and *Booponus* flies

There are relatively few published reports of cutaneous myiasis in the buffalo. The condition undoubtedly occurs but is less common and probably less severe than in cattle. The larvae of *Chrysomia bezziana* have been found in skin lesions of buffaloes in southeast Asia. They burrow deeply and cause severe tissue damage.

The fly *C. megacephala* is widely distributed in the Far East and in Australia. Its larvae are occasionally found in wounds of buffaloes, cattle and sheep, sometimes associated with *C. bezziana*.

The larvae of *Wohlfahrtia magnifica* have been found in a buffalo in Turkey.

Larvae of the oriental foot fly *Booponus intonsus* develop in the coronary band above the hoof of buffaloes, cattle and goats. So far they have been reported only in the Philippines and in Sulawesi, Indonesia. No recent information on their distribution is available.

TICKS

Many species of ticks have been collected from buffaloes. Most field workers have observed that buffaloes rarely suffer heavy infestation under natural conditions. Although Swamp buffaloes in Australia appear to be extremely resistant to *Boophilus microplus* infestation, they are quite susceptible when exposed under stall conditions.

Recent trials of pesticides in India showed that spraying with a 1 percent solution of malathion was very effective against nymphal and adult ticks, but reinfestation was observed to begin within a few days after treatment.

MANGE

Sarcoptic mange

This is a widespread and serious disease of buffaloes. It is caused by *Sarcoptes scabiei* var. *bubulus*. The lesions are similar to those of sarcoptic mange in other animals, starting with small papules which become scabs, partly through the burrowing of the mites in the skin and partly through the rubbing caused by the intense irritation. The first lesions are generally seen on the thin-skinned parts: neck, brisket and inner surface of the legs. In neglected cases the whole surface of the animal may become affected. The skin is thickened in folds, the animal is weakened, and death may ensue. Many calves are lost through neglect of this condition.

Although sarcoptic mange may be seen in buffaloes at any time of the year, clinical disease is most prevalent during dry seasons and periods of drought when wallowing is restricted and the nutritional level is low.

Psoroptic mange

Buffaloes frequently harbour mites of the genus *Psoroptes*, and there are reports of infestations in Egypt, Pakistan, India, Burma, Indonesia, the Philippines and Thailand.

The mites are usually found around the base of the horns, but cases of extensive body infestation have been reported as well as some of mixed psoroptic and sarcoptic infestations. The incidence of clinical psoroptic mange is probably much lower than that of sarcoptic mange in southeast Asia. It has, however, been stated from Egypt that psoroptic mange is the more common form, and that it affects principally the shoulder region and root of the tail.

Treatment of sarcoptic and psoroptic mange

A 0.03 percent suspension of gamma-BHC was used in Burma for adult buffaloes and calves over 3 months of age. It was sprayed over the whole body three times at intervals of ten days. Satisfactory control was achieved and no evidence of toxicity was observed.

Recent trials in India compared several pesticides: dieldrin, 0.1 percent; Asuntol, 0.5 and 0.25 percent; Neguvon, 0.15 percent; and lindane, 0.05 percent were all effective against sarcoptic mange in buffaloes. Bercotox 0.1 percent was less effective. No ill-effects were seen.

Demodectic mange

This condition is rare in buffaloes. It is common to find young cattle with lesions of demodectic mange, while buffaloes kept in close proximity are free from the disease. It has been reported in buffaloes in Egypt, India, Indonesia, and Peninsular Malaysia. Lesions are described as nodular in character, ranging from a pinpoint in size to 5 cm in diameter. It remains an open question whether or not the mite in the buffalo is *Demodex bovis.*

Leeches

Several species of leeches live in the padi fields and swamps of south-east Asia and are often found attached to the skin of buffaloes; hence they are referred to as buffalo leeches. They get into the nostrils and throat while the animal drinks and into the vulva while wallowing. They sometimes cause difficulty in breathing.

Leeches are found in other continents in areas that are favourable for water buffaloes.

In Bulgaria, leeches are removed from the throat by making the subject breathe the vapour of chloroform and oil of turpentine.

Parafilariasis

This is a skin disease caused by a minute worm of the genus *Parafilaria.* Although the parasite is found in cattle in many countries, it has only been reported in buffaloes in India. The lesions in buffaloes are identical with those in cattle: nodules measuring 2 to 3 cm in diameter, usually on the neck and body of adult buffaloes during the monsoon summer months. The nodules bleed, generally on sunny days, and eggs and microfilariae can be detected upon microscopic examination of the discharge.

More research is needed to define the species of *Parafilaria* in cattle and buffaloes and to discover the life cycles and intermediate hosts.

Cutaneous onchocerciasis

This is another nodular skin condition seen in cattle and buffaloes in a number of countries. The nodules are found in the deeper layers of the skin, generally on the brisket and over the ribs. In cattle they are commonly in the region of the stifle joints and located in the tissues underneath the skin.

Anatomical differences in the *Onchocerca* worms collected in the Far East and in Australia suggest that several different species are involved.

Ear sore

This condition is a severe dermatitis of the inner surface of the ear flap. The affected skin becomes scabby and the irritation is intense.

Several species of *Stephanofilaria*, microscopic worms, cause parasitic conditions in livestock. In Indonesia, the parasite of ear sore of buffaloes was identified as *S. dedoesi*, which causes a dermatitis in cattle known as *cascado*, on the neck, withers, dewlap and around the eyes.

In India, a new species called *S. zaheeri* has been described, but it may be identical with *S. assamensis*, which causes hump sore of cattle in India and Pakistan. A new species was also claimed in the Andaman islands and called *S. andamani*. A recent report states that ear sore was found in 132 buffaloes out of 190; that cattle were affected with hump sore; that *S. assamensis* was identified in material from cattle; and that larvae of the parasite were found in a fly, *Musca conducens*, collected near the affected animals.

Stephanofilaria may cause dermatitis on the neck, chest, belly and around the eyes of buffaloes. Microfilariae and parts of worms may be present in scrapings from only about 10 percent of cases, but diagnosis on clinical grounds presents little difficulty.

Parasites of the eye

Thelazia

Buffaloes are hosts to several species of *Thelazia*, very small worms that live in the conjunctival sac of the eye. Three different species have been isolated from buffaloes and cattle in India: 65 out of 182 buffaloes were found to be harbouring *Thelazia*; and 6 out of 22 cattle examined.

Heavy infestations cause inflammation of the conjunctiva and excessive flow of tears and may play a part in the clouding of the eye so frequently seen.

Infestation is widespread and probably occurs wherever buffaloes are kept.

Many methods of treatment have been advocated. The most effective is to instil drops of a 3 percent solution of piperazine adipate in water into the conjunctival sac, followed a few minutes later by an eyewash of 3 percent solution of boric acid in water.

Eye-frequenting moths

Many species of moths are known to feed at night on the eye secretions of animals in Africa and Asia. As many as a dozen may be seen around the eye of a buffalo, which shows little sign of discomfort, although the flow of tears may be increased. Some species are able to pierce the conjunctival membrane and feed on blood.

A moth that is not an eye frequenter pierces the skin of buffaloes in Peninsular Malaysia.

There is no information on the role of these insects in the spread of infections.

Parasites of the blood

Protozoa

Many genera of these microscopic, single-cell parasites live in domestic animals. Some are found in the blood, others in the cells of the digestive tract. A few species live in the reproductive organs, causing infertility, while several live in a mutually beneficial relationship in the first stomach of ruminants. In this section the blood protozoa are considered.

Plasmodium (Vinckeia) bubalis

This species occurs exclusively in buffaloes. It has been identified in the Indian subcontinent and in Thailand. It does not cause any significant symptoms. The vector is unknown.

Babesiosis

Several species of *Babesia* that cause disease in cattle can be transmitted experimentally to buffaloes but clinical babesiosis has rarely been diagnosed.

ANAPLASMOSIS

Anaplasmosis, caused by the very small parasites of the red blood corpuscles, has been reported in buffaloes in China, Egypt, India and Indonesia, and in the Philippines.

Among the symptoms reported are loss of appetite, constipation, membranes and skin stained yellow, persistent swelling of the feet. The death rate from anaplasmosis in the Philippines reached 17 percent, but elsewhere clinical cases are rare. In India, blood tests revealed many positive reactors indicating widespread latent infection, but at a much lower rate than in cattle. Active disease may follow when other infections such as rinderpest or other stresses are encountered.

It is generally assumed that the species of *Anaplasma* in buffaloes are the same as those in cattle, but very little experimental work has been undertaken.

THEILERIASIS

The domestic buffalo is extremely susceptible to *Theileria parva* which causes East Coast fever in cattle in east Africa. The parasite rendered early attempts to introduce buffaloes into that region unsuccessful. Susceptibility to *Theileria* and *Trypanosoma* species foiled many an effort to acclimatize water buffaloes in several other African countries.

Theileria annulata

This parasite is known to exist in buffaloes in the Near East, especially in Egypt, where the disease is known as Egyptian fever. It has been found in India and in the U.S.S.R.

T. mutans

Protozoa resembling this species have been found in cattle and buffaloes in a number of countries in southeast Asia, Egypt and other countries. It is well tolerated by its hosts.

TRYPANOSOMIASIS

Several different trypanosomes cause disease in animals in many tropical and subtropical regions. They are actively motile in the blood plasma and are spread from one animal to another by bloodsucking flies.

Trypanosoma evansi

This trypanosome is frequently found in blood samples from buffaloes in India, Pakistan and southeast Asia, but it has not been reported from

Australia. Symptoms of illness are rarely seen in buffaloes although occasional acute cases do occur.

It is possible that some strains are more virulent than others. Stresses, such as vaccination against rinderpest, may change a nonclinical infection into a peracute case followed by death within hours. Such cases are sometimes confused with anthrax or haemorrhagic septicaemia. Disease running a less acute course may have symptoms similar to those of surra in other animals: intermittent fever, loss of weight and, in some cases, congestion of the conjunctiva and swelling of the throat and sometimes of the tongue. Brain disturbance has been reported. Young and debilitated subjects may die but the older and stronger gradually recover.

Treatment with quinapyramine sulphate at 5 mg per kg body weight in 10 percent aqueous solution injected subcutaneously is recommended. Diminazine aceturate was successful in experimental buffalo calves, but it was not free from danger.

Parasitic worms in blood vessels

Elaeophora poeli

The existence of this parasite has long been known and is mentioned in the early literature on the worms of animals. It is found in buffaloes and cattle in India and southeast Asia.

The worms live in the main artery of the thorax. The female, which may be up to 30 cm long, lies with its front end fixed to a nodule in the wall of the artery; the male worm is found in the nodule. Although the nodule may measure up to 2 cm in diameter, it does not appear to be of any clinical significance. The life cycle is not known.

Onchocerca armillata

This parasite is commonly present in the main artery of the thorax of cattle in Africa and Asia. Infection in buffaloes in India has been reported, and in a few countries in southeast Asia. The incidence in buffaloes is much lower than in cattle. It appears to be of no clinical significance.

Schistosoma

Several species of these parasitic flukes are found in buffaloes. *S. nasalis* lives in the veins of the membrane lining the nasal cavity; the others are found in the veins of the liver or of the intestines.

They all have complex life cycles. The eggs escape through haemorrhages or ulcers into the nasal cavity or into the intestine. They hatch into free-swimming miracidia which infect water snails. They then divide

in another stage in the snail and emerge as cercariae which penetrate the skin when the animal wades into the water or the mucous membrane of the mouth when the animal drinks. They migrate in the host animal until they reach the appropriate veins, where they develop into the adult form.

S. nasalis

This species of fluke is found in both cattle and buffaloes in India, Pakistan and a number of countries of southeast Asia. The inflammatory reaction in the nasal membrane, set up by the passage of the fluke eggs, is much more marked in cattle than in buffaloes. The latter rarely show any clinical signs of infection.

S. spindale

This fluke in the adult stage lives in the veins of the intestines of buffaloes in many areas ranging from Pakistan to Viet Nam. Some parasitologists consider the buffalo to be the principal natural host of *S. spindale*, but it is found quite commonly in cattle, sheep and goats in some countries. A very high incidence of infection has been reported in both cattle and buffaloes in Democratic Kampuchea.

Haemorrhages and even ulceration may be found in both large and small intestines. Large numbers of eggs are present in the lesions. The adult flukes may sometimes be found in the gut, having passed through ulcers. In chronic infections the wall of the intestine is thickened. The cercariae cause "sawah itch" in workers in padi fields.

Little clinical evidence of infection is seen in the majority of buffaloes, but emaciation, bloody diarrhoea and enteritis may affect some, particularly buffaloes under 2 years of age.

S. indicum is a rare parasite of buffaloes in India and Pakistan.

S. bovis is a common fluke of cattle in the Near East. Buffaloes are likely to be infected.

S. japonicum, which is probably more harmful than other species, is found in a wide range of host animals, including buffaloes, in the Philippines.

PARASITIC FLUKES

Orientobilharzia

Three species of this genus of parasitic flukes have been reported in buffaloes.

O. turkestanicum infects large numbers of cattle, sheep, goats and buffaloes in India, Iraq, Pakistan and the U.S.S.R. It does not appear to be harmful to the larger animals.

O. dattai has been reported in buffaloes in India.

O. harinasutai has been found in buffaloes in Thailand.

Parasites of the respiratory system

Infestation of the nasal membrane with leeches and *S. nasalis* has been dealt with above.

Syngamus laryngeus

These roundworms live in pairs, permanently coupled, attached to the lining membrane of the larynx. Infection of cattle and buffaloes is widespread throughout the Indian subcontinent and southeast Asia. Worm burdens are usually light, 1 to 12 pairs in a host animal, but as many as 68 pairs have been collected from a single adult buffalo.

The health of the animal is not, as a rule, affected.

Dictyocaulus viviparus

These roundworms are fairly common in buffaloes in Burma, Democratic Kampuchea, Egypt, India, Italy and the Philippines. In tropical and subtropical conditions, clinical lungworm disease is rarely seen. This is surprising, in view of the warm, moist environment favourable for the worm larvae. In Italy, however, classical parasitic bronchitis in buffaloes has been reported. In Egypt, an outbreak in weaned calves resulted in many deaths and large numbers of lungworms were found in the bronchial tubes.

Parasites of the stomach and intestines

Amphistomes

Of these flukes, 18 species have been found in the first two compartments of the stomach of buffaloes in eastern countries and in Egypt and Turkey.

As in the case of other parasitic flukes, they have complex life cycles involving snails as intermediate hosts. Cercariae develop and emerge to encyst on aquatic vegetation. The larvae develop in the small intestine. Very large numbers cause diarrhoea, dysentery, anaemia, and in some

cases death. Adult stages are reached in the stomach and cause little disturbance to health.

One species, after passing the larval development in the small intestine, migrates to the bile ducts of the liver to become adult there. Another species is found in the adult stage in the colon and rectum.

Roundworms of the abomasum

Several species of roundworms are known to live in the fourth compartment of the stomach of buffaloes. They appear to cause less damage in buffaloes than in cattle. Apparently healthy buffaloes may be seen living in contact with cattle suffering from acute and even fatal infections with these parasites.

Roundworms of the small intestine

Neoascaris vitulorum

This is the most important parasitic worm of the very young buffalo calf. It causes heavy mortality and seriously impedes herd expansion in many parts of the world. At a clinic in India 60 percent of buffalo calves were infected. The incidence was highest in calves born in winter.

Infection may be acquired from the dam before birth but it is probable that most infections are transmitted soon after birth. Many investigators have reported the presence of the worm in buffalo calves during the first two weeks of life. Recent investigations in Bangladesh and in India show that the larvae of the parasite may be present in milk during the first 24 days after calving, but they were not found thereafter. Calves were infected, naturally and experimentally, with the milk, and worm eggs were present in the faeces at 32 days of age.

Natural infection in buffalo calves is generally much heavier than in cattle calves. The number of worms in the small intestine may be enormous and in some cases the gut may be blocked by them. Worms sometimes invade the bile ducts or the stomach. Perforation of the small intestine has been recorded but it is an exceptional occurrence.

In severe infection, the calf is dull, loses its appetite and may show symptoms of colic and diarrhoea. A characteristic odour is said to be detectable in its breath.

Many forms of treatment have been described with varying degrees of efficacy. The present recommendation is to give a piperazine compound at 100 to 200 mg of the base per kg body weight. In the U.S.S.R. sodium sulphate is preferred for developing countries because of the lower cost

and ready availability. The dose is 3 to 4 g per kg as a 10 percent solution in water.

Strongyloides papillosus

This is another roundworm that is common in buffalo calves and causes diarrhoea. Deaths have been reported in calves up to 5 weeks of age.

Larvae have been found in the milk of buffaloes on various days up to the twenty-third day after calving.

Paracooperia nodulosa

Roundworms that cause nodular lesions in the small intestine of buffaloes have been reported in Bulgaria, Burma, Hungary, India, Pakistan, the Philippines, the U.S.S.R. and Peninsular Malaysia. The most widely distributed species is *P. nodulosa.*

Larvae are taken in with the food and invade the lining of the small intestine and occasionally of the large intestine. A nodule forms around each immature worm and may reach 3 to 6 mm in diameter and may be visible on the surface. Adult worms are found in the gut or partly in the nodule.

Young buffaloes between 6 months and 2½ years of age are most frequently found to have the nodular lesions.

Diarrhoea, anaemia and emaciation leading to death have been described as the outcome of severe infections. No information is available on treatment.

Hookworms

Species of *Bunostomum* and *Gaigeria* roundworms have been recorded in buffaloes in Burma, India, Pakistan, Thailand, the U.S.S.R. and Peninsular Malaysia. Considering the environment in which buffaloes live, the parasites must be much more common than reports indicate. There is surprisingly little information available on the intensity and significance of the infections.

In a study in Assam, 30 percent of buffaloes harboured hookworms. The incidence was highest in those kept in limited pasture areas rather than in animals belonging to peasants. In Thailand, the incidence in adult buffaloes was low.

Hookworms cause characteristic lesions on the surface of the small intestine, with occasional haemorrhagic nodules. Calves may die from severe infection but adult buffaloes do not appear to suffer.

Roundworms of the large intestine

Oesophagostomum

These parasites have been found in buffaloes in most of the countries in which the animals are kept. Worm larvae form nodules in the wall of the large intestine and the adults live in the gut. Two species have been identified.

The intensity of infection is generally light and little disturbance to health is observed. But in Italy, where loss of appetite and condition are reported to be common, there may be diarrhoea and even death from severe infection. In one outbreak the mortality in calves under one year of age reached 50 percent. Routine treatment of buffaloes of more than 2 years of age was advocated. The dosing should be at the end of spring and summer, with an additional dose in July in humid seasons. Among the compounds recommended were phenothiazine, thiabendazole, trichlorphon and piperazine.

Other roundworms of the digestive tract

There are a few records of some other roundworms in buffaloes, as listed below. They are of little significance unless present in very large numbers.

Parasite	Site	Countries
Gongylonema pulchrum	Oesophagus	India, Turkey and U.S.S.R.
Trichostrongylus axei	"	U.S.S.R.
T. colubriformis	Small intestine of young calves	India
T. longispicularis		India
Cooperia punctata	Small intestine of young calves	China, India
C. laterouniformis		U.S.S.R.
C. oncophora		U.S.S.R.
C. zurnabada		U.S.S.R.
Chabertia ovina		India, U.S.S.R.
Capillaria bovis		Peninsular Malaysia
Trichuris spp.		Burma, India, Sri Lanka, Thailand
T. ovis	Caecum	China, India, Indonesia
T. discolor	"	India

Tapeworms of the digestive tract

Species that have been found in buffaloes include *Avitellina centripunctata, Stilesia globipunctata, Moniezia expansa* and *M. benedeni.*

The adult forms live in the small intestine and do not appear to be of any clinical significance.

Protozoal parasites of the intestines

Coccidiosis

Coccidia cause serious losses of calves wherever buffaloes are kept in insanitary conditions. In one study in India, 80 percent of buffalo calves harboured the parasites. Coccidiosis was reported to be the cause of most deaths of calves in Sri Lanka. In Italy, it is probably more widespread than is generally realized. It is said to cause more losses in River breeds than in Swamp buffaloes. This may be because River breeds are usually kept in larger herds in greater concentrations.

At least 14 species of *Eimeria* have been identified in material from buffaloes. Most of them infect cattle, but two species may be exclusively parasitic in buffaloes. *E. bareillyi* has been found only in buffaloes in India and Italy, and *E. azerbaidjanica* in the U.S.S.R. Further research is needed on the species of coccidia in buffaloes.

Coccidiosis in buffalo calves is often acute, with thin bloody diarrhoea and false membranes on the lining of the gut.

Satisfactory results of treatment with sulphadimidine have been reported. Other reports, however, state that results were less satisfactory than in calves of cattle. Other species of coccidia may have been involved; different dosages have been used. One treatment was to give 5 to 8 g as an initial dose, followed by half-doses on two subsequent days. Another procedure was to give 10 g as a single dose.

There are no reports available on treatment with the newer drugs which have been used with success for cattle.

Ciliates and amoebae

Several species of ciliates live in the rumen and caecum of buffaloes. They are not harmful; in fact, some of them live in mutually beneficial relationship.

Species of *Entamoeba* have been recorded in buffaloes in Egypt and in the Philippines. They are not known to cause disease.

The cysts of these protozoa are frequently seen in the course of microscopic examination of faeces.

Parasites of the liver

Flukes

The environment in which the water buffalo flourishes is also ideal for the water snails and mud snails which serve as intermediate hosts of liver flukes.

Several species of *Fasciola* have been collected from the bile ducts of buffaloes. *F. hepatica* is widespread in Europe and in the higher altitude districts of India. *F. gigantica* is reported from most countries in the east.

Meat inspection at the abattoirs in Hong Kong revealed 80 percent of buffaloes to have some degree of infection. Heavy mortality has been reported in areas in the Philippines where snails abound.

The disease is generally chronic, with loss of condition, reduced productivity and work capacity, and also loss of value of livers on slaughter. An acute form occurs sometimes in buffalo calves in Pakistan.

Old buffaloes continue to pass relatively large numbers of eggs. This suggests that the infection is not as self-limiting in the buffalo as it is in cattle.

Control by reducing the snail population is not feasible in the majority of its habitats, nor is it possible to keep buffaloes away entirely from infested areas. Regular treatment is therefore advisable in many places. Carbon tetrachloride is well tolerated, provided that the animals are not being fed on a high level of nutrition. A dose of 12 ml in buttermilk or *lassi* is recommended. The drug, given by stomach tube at 0.04 ml per kg body weight, has proved to be effective against *F. gigantica*. It can also be given by intramuscular injection.

Hexachloroethane removes flukes but some symptoms of poisoning in a few animals have been observed. Hexachlorophene is efficient against adult flukes but has less effect on parasites under one month of age. Nitroxynil, rafoxanide, oxyclozanide and avlothane have also been found to be highly efficient against adult liver flukes.

Two or three treatments may be necessary each year.

Gigantocotyle explanatum

This amphistome has been found in the bile ducts of buffaloes in India, Iraq, Pakistan, Sri Lanka and in most of the countries in the east. Cattle

are also infected but the number of parasites is usually much greater in buffaloes. The bile ducts may be almost packed and the wall of the duct becomes thickened. Emaciation in affected buffaloes has been observed in Sri Lanka. The immature amphistome develops in the small intestine. In heavy infections it may cause enteritis.

Nothing is known of the action of drugs against this parasite.

Dicrocoelium dendriticum

This parasitic fluke has been reported in buffaloes in hill districts in India and in Italy, Turkey and the U.S.S.R. It is not considered to be of any serious clinical significance.

Eurytrema pancreaticum is a pancreatic fluke that is commonly found in buffaloes and cattle in southeast Asia. The adult worm lives in the ducts of the pancreatic gland. Buffaloes appear to have a high tolerance for the parasite.

Parasites of the peritoneal cavity

Setaria

Several species of these filarial worms are found in the abdominal cavity of buffaloes. The classification into species remains confused.

S. digitata may be transmitted by mosquitoes into unusual hosts in which the migration of immature filariae may cause disease in the eye or in the spinal cord. The mature worm in its natural host does not cause any significant lesion.

Parasites of the genital tract

Trichomonas foetus

This protozoal parasite, which causes infertility in cattle, has been recorded in buffaloes in Egypt, but although investigations have been made elsewhere, it has not been reported in buffaloes in other countries. The water buffalo may be an unusual host.

Leeches

Leeches are frequently found attached to the vulva and may enter the vagina.

Parasites of importance in meat inspection

Sarcocysts

Sarcocysts, which in the buffalo are very large, 1 to 2 cm long, and easily visible, are found in the muscle of the gullet, tongue and cheek. They may be present in any muscle of the carcass. Generalized infection is occasionally encountered.

Sarcocysts do not appear to trouble the host but they cause the rejection of meat at slaughter. At abattoirs in Hong Kong 60 percent of buffaloes harboured the parasite. The buffaloes were imported from countries in southeast Asia. In Taiwan, China, the incidence was 56 percent.

Onchocerca gutturosa

This small roundworm is found in the connective tissue of the ligament supporting the neck, in the cartilage of the shoulder blade, and around the stifle joint. It is normally a parasite of cattle but it has been recorded in buffaloes in Australia and India.

Hydatid cysts

These cysts are frequently found in buffaloes particularly in India, Iraq and Pakistan, but there may be marked variation in incidence in different districts. They are less common in Burma, Thailand, and some other countries.

Hydatid cysts are the larval stage of the tapeworm *Echinococcus granulosus* of dogs, jackals and other canidae. The cysts in buffaloes are most commonly seen in the lungs, but they are not infrequently present in the liver, and a few may be found in other organs.

Cysticercus bovis

These cysts are the larval stage of a tapeworm. There are reports of infection in buffaloes in Bulgaria, Egypt and India. The incidence is very low and much less than in cattle.

Other parasites of importance in public health

The cercariae of *Schistosoma spindale* penetrate the skin of workers in padi fields causing a severe reaction. They are known by different names in various countries.

The water buffalo is one of the natural hosts of *S. japonicum* which, in its adult stage, is also a serious parasite of people.

The larvae of *Neoascaris vitulorum* and of *Strongyloides papillosus* have been recovered from milk of buffaloes during the first month after calving. They are not known to be a health hazard for humans but may be a further point in favour of pasteurization of milk.

8. MANAGEMENT

The system of management of the domestic water buffalo depends on the purpose for which it is bred and maintained. Separate chapters are given to the working buffalo, milk production and meat production. In this section general observations are made on customs and practices.

Domestic buffaloes are docile, trainable and easily controlled by their attendants. They are accustomed to being groomed, massaged and hand-fed. In hot countries they are regularly sluiced with water or provided with facilities for wallowing. The hair may be clipped or shaved and the skin anointed with mustard oil or some other preparation to keep it supple, lustrous and free from parasites.

The majority of domestic buffaloes are kept by people who work on small farms in family units and their animals live in very close association with them. The women and girls in India generally look after the milking buffaloes while the men and boys are concerned with the working animals. Throughout the east, they are commonly tended by children who are often seen leading or riding their charges to wallowing places. The children go into the water to sluice the buffaloes and clean their nostrils, eyes and ears, attentions that are obviously relished by the animals. A buffalo immersed up to its nostrils and sighing contentedly is a picture of bliss. It is quite a common sight to see a huge Swamp buffalo quietly grazing while its small attendant is fast asleep on the broad back.

Alternative names for the water buffalo

In Malaysia and a large part of the Far East, it is known by the Malay word *krbau*, in Indonesia this becomes *kerbau*, and there are other variations. The Swamp buffalo in the Malay language is *krbau-sawah* and the River buffalo is *krbau-sungei* or *krbau-sapi*. In the Philippines,

the form is *carabao,* with a feminine form *caraballa,* now applied to both the Swamp buffalo and to the more recently introduced River breeds.

In Brazil, the *búfalo* has the feminine form *búfala.* The Arabic for the female buffalo is *ghamousa,* and in Turkey it becomes *camus* (pronounced jamoosh). In Trinidad, a special beef type has been developed and is called the buffalypso, while the local buffaloes are called bison or hog cattle.

In China, the buffalo is *shui niu,* the water ox.

It is unfortunate that there are no terms analogous to cow, bull, heifer, steer, and so on, and to avoid misunderstanding it is often necessary to give a description such as "a female water buffalo of less than 2 years of age." In the Philippines, the following terms have beene advocated: caracow, carabull, caraheifer, carasteer, and so on. These forms are not likely to be used generally any more than carabao is at present. Alternative terms have been suggested: buffbull, buffcow, buffheifer and buffsteer. As the value of the buffalo becomes more widely recognized, some such terms must be added to the glossary of words used to describe the different classes of livestock.

Protection against extremes of climate

The system of management must provide protection of buffaloes against prolonged exposure to the rays of the sun. During the hottest hours of the day they must be allowed to rest in shade or in wallows. Stabled animals suffer much discomfort when hot breezes blow. Relief can be afforded by wet screens which cool the air currents.

Care must be exercised to avoid exposure to cold air currents and sudden changes of air temperature. In the temperate climate of European countries, and at high altitudes, such as in Nepal, rugs must be available for use whenever required.

The effects of climate are considered in chapter 3 (see p. 30).

Wallowing

The buffalo has a predilection for water. The Swamp type likes to wallow in a mudhole that it will make for itself. The area is often quite small, rarely holding more than two or three animals. The aim is to acquire a plastering of mud over as much of the skin as possible. This mud coat gives some protection against the sun's rays and against lice, ticks and biting flies. It is said that in tropical South America it also reduces the risk of bites of vampire bats. In southeast Asia the Swamp

buffaloes wallow up to five hours a day in summer. In winter most will wallow briefly but some do not wallow when the air is cool.

The River type prefers water of a stream, lake or pond and herds wallow together closely bunched. Under some management systems the buffaloes are sluiced regularly or sprayed instead of being provided with wallows. The equipment for road haulage includes a bucket or scoop for sluicing during rest periods, which are taken where water is available.

Many intensive milk production establishments have wallowing tanks made of brick and cement. They are generally insanitary, unless very large supplies of fresh water are available. Buffaloes often wait until they are immersed in the wallow to unload their dung and urine, so the wallows soon become heavily contaminated and potential sources of infection with bacteria and parasites.

Running water is not always free from some risk of infection with parasitic worms, leeches and, in Brazil, of attacks by the predator fish, the *piranha*, which sometimes damages the teats. In Trinidad, many buffaloes are kept without wallows, but some rain falls on most days and a great deal during the wet season. When wallows are provided, the buffaloes spend more time in grazing and less in seeking shade. Calves go into wallows with their dams within the first few days of life.

Restraint and control

Nose rings and thongs

The cartilage of the nose is usually pierced with a bamboo spike, hot iron or sharp nail. A ring of wire or rattan is immediately inserted. Many deformed muzzles are seen as a result of tearing out of wire nose rings. Veterinary services in some districts use orthodox methods, instruments and bull rings. In some countries all working buffaloes, females as well as males, are ringed; in others few nose rings are to be seen.

Many kinds of nasal appliances are used: simple brass wire rings; a metal rod passing through the perforation and attached at each end to the simple bridle; a similar rod but with another piece of metal running over the nose, attached at both ends to the rod and to the bridle. Different patterns of the last type are made in various places.

The nose thong is commonly used in many countries. It is generally about 1 m long and passes through the perforation, the free end being on the animal's left. Many kinds of plugs are made to stop the thong pulling through completely: a disk of bamboo; a corona with sharp points on the side against the nose septum; a hammer-shaped device of

brass or bamboo. A thong of nylon cord with a perspex disk is now in common use.

A single rein is attached to the thong or bridle; the latter is a simple rope or cord halter often worn permanently.

Trained buffaloes require a minimum of restraint. Entire males are rarely as dangerous as bulls, but ringing can be justified. Females and castrates need only a simple halter and a nose thong. In Egypt, there is almost a complete absence of these appliances and the only means of control of working buffaloes is a light loop of rope around the horns. Occasionally a cinch is put on the left ear.

Calves are sometimes fitted with blab plates on nose rods. The plate falls over the lips when the calf raises its head into the position for sucking, but it falls forward and allows it to eat or drink in any other position.

Domestic buffaloes are occasionally tethered. The rope is fastened to the horns or halter and to a peg driven into the ground. They may be tethered by a rope fastened to one foreleg. Hobbles are sometimes seen, both forelegs being loosely tied together.

Stocks

The skin of buffaloes is very sensitive and it is advisable to have good control of the animal before vaccination or minor surgery. Simple stocks are made in several countries. They may consist of no more than a suitable tree trunk and a piece of wood, such as a fencing post, tied by a running noose in the form of an inverted letter V. The animal is held against the tree trunk by the post holding the neck and fastened securely.

For castration, the buffalo is fastened in the stocks and one hind leg is tethered to a peg in the ground.

Wider space must be allowed in the planning of crushes and loading ramps for buffaloes than for cattle.

Casting

Domestic buffaloes may be cast efficiently and safely by any of the methods used for cattle. Soft ground should be selected or ample bedding provided. The head must be secured safely. The single-line method of Rueff is favoured. A rope is fastened to the horns, then taken backward, and a running loop arranged just behind the shoulders. It is then taken back again and another loop is made round the belly in front of the stifle joints. The free end of the rope is pulled backward, the animal

goes down and remains quiet so long as the rope is kept taut. This should continue only long enough to allow the legs to be secured.

A rough and ready method in general use is to tie the forelegs together, then the hind legs, and push the animal over.

Drenching

Although the buffalo is a docile creature it is difficult to drench. In some countries they are accustomed to regular dosing, usually through a bamboo tube. Considerable strength and skill are called for in drenching buffaloes that are not used to the procedure. Examination of the mouth, as in the diagnosis of foot-and-mouth disease, can be a tiring job. Many medicines can be made up in the form of an electuary by mixing with honey or treacle and powdered liquorice into a sticky consistence. It is put into the mouth without distress to the patient or attendant.

Castration

The methods in general use are crude and inefficient. The suffering inflicted is oddly at variance with the gentle treatment traditionally accorded to domestic buffaloes. Castration is usually performed after the rice harvest. Males are rarely castrated as young calves, most owners preferring to wait until they are fully grown; then only those that are unsatisfactory in conformation or temperament are castrated. Sometimes the decision is delayed until the qualities of progeny can be assessed.

The commonest method of castration is to pound the testicles with a heavy stone or metal bar. The poor creature, normally not a vocal animal, screams piteously. Quite frequently, a testicle is deformed but not entirely inactivated, and the objective is not attained. In some areas of Brazil an elastic band is applied tightly around the neck of the purse; in other areas the knife or the emasculator is used.

The bloodless castrator, which is the recommended instrument, should be applied at two points on each cord, about 3 cm apart. The cords of the buffalo are much thicker and stronger than those of cattle. The bloodless castrator is the usual method in Turkey, where many buffaloes are castrated at about 12 months of age, although some may be operated on after they have been used for breeding.

A device known as the *pasuruan* is popular in Indonesia. It can be made by the local blacksmith and is a kind of bloodless castrator. It is heavy and cumbersome, but effective.

Muslim communities may oppose castration, since their religion forbids mutilation of animals.

Spaying of female buffaloes is almost unknown, but it may well have an application in meat production. The technique should be investigated.

Dishorning and dehorning

In this text "dishorning" is the removal of the horn buds of young calves to prevent horn growth; "dehorning" is the removal of the horns of a mature animal.

Natural poll buffaloes, i.e., those born without horn buds, are extremely rare. Polled animals are those that have had their horns removed.

Horn deformities and loose, hanging horns known as *deli* horns are frequently seen.

The adult buffalo uses its horns in defence and there are many stories of tigers being killed. Swamp buffaloes use their horns as antennae when entering strange stalls. They also play with bright objects, flicking them into the air repeatedly with their horns. The digging of mudholes has already been mentioned. But injuries among buffaloes by horning are less common than with cattle.

There are obvious advantages in polling for meat production conditions, particularly during the stages of fattening and marketing. Less capital outlay is required for installations such as crushes, pens, loading ramps and feedlot mangers for polled animals than for horned Swamp buffaloes. The procedures are likely to become routine in Australia and in the larger meat production estates in Brazil. In a vehicle that will only accommodate 10 or 12 horned types, 15 polled buffaloes can be trucked.

To the majority of owners in the east, the grand horns of the Swamp buffalo are things of beauty. The control of working animals without horns might present some problems.

Dishorning by chemicals or by gouging out the horn buds, or a combination of both, can be done before the calf is 3 months of age.

Dehorning is by hand saw or wire saw, with subsequent cauterization. Dehorning shears may be employed for young buffaloes past the age for dishorning. Anaesthesia is seldom if ever used for these operations in field conditions. A regional nerve block would probably be effective but would prolong handling time and increase the suffering of the subject. Little sign of distress is shown by buffaloes after expert dishorning or dehorning. They will feed within 20 minutes after release. They must be inspected every day for four days.

It is sometimes necessary to remove horns after injuries. The great

variation in horn size and shape calls for adaptation of surgical techniques. A method recently described in India requires the removal of a part of the frontal bone to enable a flap of skin to be stitched over the entire site. The buffalo is given a tranquillizer and regional nerve block.

Trucking and droving

With reasonable care, rest periods and good watering facilities, buffaloes can be transported for great distances without loss of weight. It is believed that they suffer less transit stress than cattle.

Long rail journeys in India, sometimes lasting up to 14 days, are made regularly. Each wagon carries eight buffaloes, often with calves, and one attendant.

Sea transport presents few difficulties. Buffaloes can be slung on and off shipboard but if roughly handled they are liable to become unmanageable and dangerous.

Buffaloes even in the feral state can be herded relatively easily. Like sheep, they are inclined to press together in tight mobs. They are herded efficiently by horsemen, motor vehicles and, in Australia, even by helicopter.

Buffaloes must not be driven over long distances during the heat of the day; time must be allowed for resting, watering and, if possible, for wallowing. Heat stress and death have been reported. Losses can be very high and occur suddenly. There are records of herds of buffaloes covering 48 km in one day, but it is inadvisable to attempt more than 30 km in average conditions.

Shoes and shoeing are dealt with in the chapter on the working buffalo (see p. 118).

Identification

Ear notches are made in many countries; they are usually cut with a knife and are often unsightly. In some areas there exist religious or aesthetic objections to any form of notching, tattooing or branding. This creates difficulties when animals have to be vaccinated and identified. Small, bright red, plastic ear tags are acceptable in districts where red is a propitious colour.

Hot iron brands are not so satisfactory for buffaloes as for cattle. Healing is rapid and the mark may disappear in a few months. Very large brands are sometimes applied and the hot iron is kept in contact

with the skin longer than is customary for cattle. Hides are damaged and their value diminished. In Sri Lanka, intricate patterns are branded over a wide area of the hindquarters and flanks. The purpose of this is sometimes said to be to ward off the evil eye. It is more likely to have its origin in the destruction of the value of the hide, since in former times rustling was widespread and buffaloes were stolen and slaughtered for the hide alone.

Horn notches or brands are made with the hot iron and are durable but not easily read from a distance. Temporary horn marking with bright paint is useful for studies of behaviour or movement patterns.

Branding by caustics is performed in parts of India and Nepal. It is not usually a satisfactory method.

Cryobranding (freeze-branding) calls for sophisticated equipment and a supply of dry ice. The hair coat of buffaloes is sparse and the regrowth of bleached hair may be limited and marking unsatisfactory.

In Brazil, black female calves were branded at 4 months of age, using a copper brand, dry ice and methyl alcohol. The brand was applied to the skin for one minute. All the marks were legible at 3 years of age. Results in older buffaloes were less satisfactory. The method is more costly than hot iron branding but is preferred for calves.

In Italy, three figure brands were clearly legible 12 months after cryobranding.

Tattooing is the method used in the milk colonies and military farms in India and Pakistan. The identification number is tattooed on the underside of the tail by means of an electric apparatus, as used for human subjects. Tattooing of the inner surface of the ear, as is common practice with cattle, is adopted for buffaloes in many countries.

Types and patterns of hair whorls are used in some areas where artificial marks are not permitted. The details of the whorls are highly individual. Certification and registration of ownership are based on such descriptions in many districts.

Tail docking

Docking of buffaloes is occasionally practised. On the island of Bali, the last 8 to 12 cm of the tail may be cut off to prevent a heavy accumulation of mud when working in padi fields.

Tails are also docked for superstitious reasons, or as a means of identification, or to stop contamination of milk by tail swishing during milking. It becomes necessary in cases of tail necrosis and in injuries to the tail.

Water buffaloes on range

Large numbers of buffaloes live in a semiwild state in all four countries of Borneo — Sabah, Brunei, Sarawak and Indonesian Kalimantan. Owners of large herds regard them as a safe form of capital investment and, when cash is needed, a few buffaloes may be rounded up and sold. Apart from this, they are only rounded up when required for meat or short spells of work in the *jijak* method of cultivation of padi fields. Local overstocking results in some areas.

The buffalo is not indigenous to any of the Borneo territories and, with the exception of a few recently imported Murrahs, all the introductions were of the Swamp breed.

In Sabah, large herds of cattle and buffaloes are maintained under ranch conditions in well-watered, open forest country. A ration of salt is given twice a week at the rate of 20 kg for 100 animals. The buffaloes and cattle, which run together, are given the salt on different days. The animals respond to the calls of the cowboys, but they remain timid. The practice might be applied in other areas where feral water buffaloes are rounded up for domestication.

In south Kalimantan, about 10 000 buffaloes live in herds of 50 to 500 in a low-cost meat production system. During the rainy season, from November to April, the lowland is flooded. During the dry season, owners build platforms of hardwood logs, the size depending on the number of animals in the herd. The surface is higher than floodwater level. The buffaloes graze natural pasture during the dry season. In the flood season they graze while wading or swimming, herded by boys in small boats and corralled at night on the platforms. Buffaloes with calves remain on the platform for six to eight weeks after calving. The calves stay on, suckled only at night. They go into floodwater at about 6 months of age.

The system is also practised in the Amazon region of Brazil and is referred to in the chapter on water buffaloes in the Americas (see p. 246).

Feral Swamp buffaloes are being domesticated in the Northern Territory of Australia. The system is described in the chapter on the buffaloes of Australia (see p. 256).

Most buffaloes in Sri Lanka have been kept for work in agriculture but more interest is now being evidenced in milk production and there are official projects for rearing under range conditions for meat. Crossing with imported Murrahs is planned. Range buffaloes go for slaughter at between 3 and 4 years of age. An interesting observation on range conditions in Sri Lanka is that buffaloes and cattle will mingle freely with herds of wild elephants.

Electric fencing

Buffaloes are more sensitive than cattle to electric current, even of low voltage. Reaction to electric goads may be violent and result in injury. Buffaloes quickly learn to respect electric fencing. They can be destructive to wire fencing, which they seem to regard as a challenge to their horns. Electric fencing could be used much more extensively for the efficient management of pastures for buffaloes.

Dipping and spraying

Parasites of the skin of buffaloes are not generally troublesome in natural conditions when wallowing is indulged in regularly. Dipping and spraying to control parasites are not practised as routine except in a few localities.

Swim baths and deep dips are not recommended, since buffaloes tend to regard them as wallows. They go in readily but they are reluctant to leave.

Well-planned and well-operated spray races are efficient. Buffaloes soon become accustomed to, and enjoy, the thorough wetting.

No ill-effects have been reported from the use of any of the preparations now recommended for cattle. Care must be taken to comply with instructions on dilution of the dip compounds. The skin of the buffalo may absorb chemical constituents rapidly and trials of small groups should be made before routine spraying of large numbers.

Buffaloes on at least one Australian estate go through a spray race as a normal routine during the dry season.

Tranquillization and immobilization

Immobilizing narcotics have been used for the capture of African buffaloes and for tamaraos. For domestic buffaloes, the only experience so far reported is in Egyption buffaloes, in which Rompun at the rate of 3 ml for an animal of around 400 kg body weight, injected into muscle, gave satisfactory sedation. The effect of the drug commenced seven to ten minutes after injection and lasted approximately five hours. Examinations of head, feet, genitalia and other parts can be made more thoroughly and efficiently after tranquillization. Minor surgical procedures are also simplified.

Breeding

Throughout the buffalo world, little attention has been paid to breeding techniques aimed at improved productivity, and it is only in a few areas that modern principles are applied to the domestic buffalo. Official policies for encouraging the development of buffalo rearing are often opposed by advocates of the introduction of exotic breeds of cattle. Where the essential husbandry skills are present, and nutrition and health control can be improved in step with breed selection, a gradual and enduring change in the productivity of buffaloes can be expected. In a few countries there are already official projects for milk recording, herdbooks, progeny testing and artificial insemination, and there are signs of awakening interest in other areas.

The Government of India has established a herdbook for the Murrah breed. The Ministry of Agriculture of Brazil has authorized separate herdbooks for Murrah, Jafarabadi, Mediterranean and Rosilho (Swamp) breeds. Herdbooks are kept for Italian buffaloes. A register of breeding stock is being organized in the Northern Territory of Australia to encourage the selection of Swamp buffaloes.

The amount of practical research devoted to improving buffaloes, as compared with that given to cattle, is negligible. Resources should be allocated to trials of fodder plants and various management systems. Genetic upgrading requires improvement in all aspects of management.

Weaning

In most parts of the world, weaning of buffalo calves is a gradual process associated with practices for stimulating milk letdown. On well-managed farms, for example the military dairy farms of India and Pakistan, calves are customarily weaned on the fourth day and patiently trained to drink from the bucket.

In Egypt, most buffalo calves are reared and weaned naturally, but on the larger establishments they are separated from the dam at 45 days of age and reared on the bucket. Early weaning systems are also practised in some Italian herds.

Where buffaloes are kept for work, calves usually suck freely for about one year or until the dam goes dry. Buffalo calves commonly suck from the two back quarters of the udder, which become more developed than the front quarters. In Muslim communities young animals have first claim on the mother's milk.

Milk substitutes are used for calf rearing in Bulgaria, Italy, Pakistan, and some other countries.

Calves may be prevented from sucking by fitting halters with spikes in the nose band, or by blab plates on nose rings or bars.

Buffaloes readily accept foster calves and may be seen to suckle up to four calves at a time.

If so allowed, calves will remain with their dams for two or three years and, in the wild and feral state, family groups of different stages of growth stay together in their own territories.

Milking

Some characteristics of the udder of the water buffalo are unique. The milk is held in the upper, glandular part and is not let down into the cistern until stimulated naturally by the sucking calf. The reaction time in some buffaloes is quite long and averages about two minutes. In dairy herds, letdown stimulus may be by spraying before milking, washing the udder with warm water, all the noises of preparation of utensils, the voices of the attendants, and by certain less desirable practices already mentioned.

The presence of the calf is the most common way of stimulating milk letdown and, in most regions, it is considered to be essential. It is neither necessary nor hygienic. Where once-daily milking is practised, and the calf is separated from the dam all day, or all night, it is allowed to suck for a few minutes before milking starts. In Italy, calves run along the passage of the milking shed at milking time. Itinerant milk sellers in many lands take the skin of a calf stretched on a wooden frame with the milking buffalo to the customer and milk on the spot.

Machine milking

The number of buffaloes kept for milk production is steadily increasing in India, Pakistan, Egypt, Bulgaria, the Philippines and other areas. Buffaloes respond readily to standard machines but some modification of the teat cups, vacuum and pulsator is necessary. Hand milking is often done in insanitary surroundings and without adequate facilities for cleansing the hands and utensils. Machine-drawn milk, when efficient routines are followed, is of much better hygienic quality than hand-drawn milk. Machine milking should be adopted much more widely, especially for the large herds on state and military dairy farms.

The use of machines reduces the tendency to elongated teats. Much

more force has to be applied to overcome the teat sphincter of the buffalo than that of the dairy cow. The force applied by hand, it is believed, is the cause of the elongation of the teats.

Experience at the Aarey Milk Colony in India shows that the vacuum should be at 48 to 51 cm mercury and the pulse rate (squeeze/release) should be 30:70 or 20:80. A heavier teat claw assembly than normally used for dairy cows is recommended. The average milking rate of 0.55 kg (1.4 lb) per minute is maintained, and a maximum rate of 1.55 kg (3.2 lb) has been recorded.

Common stimuli include massaging the teats and udder and forcibly scratching the buffalo's head.

Letdown may be reversed by such disturbances as fright and unusual noises. When disturbances are repeated the yield declines and the lactation period is shortened.

The muscle of the teat valve of the buffalo is much stronger than that of the average dairy cow. In hand milking, 2.5 times more force of compression on the teat is required. As the milk flow increases the resistance of the valve fades.

Investigations in the U.S.S.R. show that various types of machine stimulate letdown in different degrees. High-yielding buffaloes are generally easy milkers and the milk flow is faster with machine milking than with hand milking. A vacuum of 45 cm mercury is recommended.

Stripping is not necessary. The quantity of milk left in the udder on removing the teat cups does not affect the yield or fat content at next milking.

The famous Jemma herd of Italian buffaloes on the Torre Lupara estate, near Caserta, is now milked in a rotary, 24-cubicle parlour; 800 to 1 000 buffaloes are milked twice a day. They were accustomed to a herringbone parlour and readily adapted to the new equipment and routine. Daily yields average around 10 litres. The lactation average is 1 500 kg in a period of 270 days, and the productive life 20 years. The dairy herd will eventually be increased to around 1 500 buffaloes.

Assessment of age

The long life of the domestic buffalo is well known, and this means that the correct judgement of an animal's age is of considerable importance.

Horn rings and grooves may be a guide, particularly in the examination of animals of more than 10 years of age. There are great variations in the size, spacing and clarity of horn rings, depending on breed, sex, nu-

tritional levels and periods of ill-health. The number of rings can be estimated by rubbing a finger along the upper curve of the horn. Not infrequently, however, an animal is found to have smooth horns.

Investigations in an abattoir, comparing teeth and horn evidence, led to the formulation of the following summary. The first horn ring appears at about one year of age; the rings up to 3 years of age are blurred; the number of rings plus one is the best indication of age in years attainable by this method.

Water buffaloes have the same number and arrangement of teeth as cattle but individual teeth of buffaloes are stronger and erupt through the gums at later ages. The temporary incisors of the buffalo are similar on superficial inspection to the permanent incisors of cattle. The first pair are usually completely up by 7 days of age, but there is a wide variation in the ages of eruption of the other three pairs. The full mouth of temporary incisors is in wear at around 9 months of age.

The eruption of the permanent incisors occurs as follows:

First pair	—	2½-3 years
Second "	—	3½-4 "
Third "	—	4-5 "
Fourth "	—	5-5½ "

They are level at 9 to 10 years of age and reduction begins at 11 to 12 years. The central pair suffer more wear than the others. It is not possible to estimate the age by the teeth with accuracy beyond 12 years.

Temporary premolars erupt during the first week of life.

Permanent premolars and molars erupt in the following order:

Premolar	one	— 24	months
"	two	— 47	"
"	three	— 48	"
Molar	one	— 15	"
"	two	— 17	"
"	three	— 32	"

Considerable variations are seen in records of the ages of buffaloes at the various stages of dentition in different parts of the world. It is possible that the buffaloes of the Balkan region and also, perhaps, those of the Philippines may change their incisor teeth somewhat earlier than in other areas. One authority states that all the permanent incisors are level and in wear at 6 years of age.

In estimating the age of an animal, it is essential to take into account the size and development of the body and genital organs and, particularly important in the case of buffaloes, to distinguish between temporary and permanent teeth.

Slaughter

The methods employed in many countries are considered in the chapter on meat and meat production (see p. 138).

Use of products and by-products

Faeces

The Swamp buffalo excretes about 37.8 l (10 gal) of dung every day; it has a particularly strong odour. A report from Taiwan, China, gives average figures for faeces as 18.3 kg per day and of urine 12.7 kg.

The Philippine carabao yields 18.8 kg per day of solid faeces, or 6 853 kg in a year.

In many countries it is mixed with straw or chaff, moulded into patties, sun-dried and used as fuel for cooking. The practice is most widespread in those lands that have the greatest need for fertilizers, but it is often the only fuel available and is carefully conserved. There are, however, areas in which the value of buffalo manure is recognized.

The ash of buffalo faeces contains 10.58 percent phosphoric acid, 2.21 percent potash, and 4.37 percent lime.

Dung mixed with clay is used in wattle-and-daub building and for floors.

Bovine faeces are used by rural peoples as poultices and wound dressings. The practice is so widespread and popular that it might repay study.

Buffalo horns

Many practical and decorative articles such as buttons, combs, spoons and knife handles are made from horns. The colour ranges from jet black to a pale honey shade. The large horns of Swamp buffaloes provide an admirable amount of material for the craftsman. The horn becomes malleable on heating over an open flame. It may then be moulded in many forms, and finally fixed by cold water. A polished bugle-like instrument, the *tetuang*, is made in the coastal districts of Peninsular Malaysia and is used by orchestras and also for signalling at sea. It is about 46 cm long.

Horns are associated with many religious and superstitious practices. They may be buried, after ritual sacrifice, at the site of a new house, temple, bridge, or — rather incongruously — of an airport. They are to be seen mounted on the walls or gables of houses to keep away malevolent spirits and evildoers.

HIDES AND SKINS

Buffalo hide is an important item of export and also for local industry. Many countries export large numbers of hides and import finished leather products. Consideration should be given to the possibility of developing leather industries for such areas.

Pakistan is one of the world's largest producers of good quality hides and skins. About 900 000 buffaloes are slaughtered annually. Leather is considered to be the most important raw material in the country's economy after jute and cotton.

Three main types of leather are exported from India: vegetable-tanned, chrome-tanned and sole leathers. Buffalo calfskins are exported in two types: vegetable-tanned and chrome-tanned. Unfinished chrome-tanned calfskins, known as "wetblue" leathers, are also exported from India. Excellent research programmes are undertaken by the Central Leather Research Institute in Madras. Flint-dried hides are exported by Thailand and Indonesia.

Indonesia has a local heavy leather industry. In central Java, there is a thriving industry producing leather figures for puppet shows and shadow plays, the *wayang kulit*, which features epic stories from history and religion.

Buffalo hides are thicker than cowhide and less greasy. They can be split into three layers, the external layer for upper leathers, the middle layer for case and baggage leathers and the flesh split for chamois, lining, and other uses. Buffalo leather has a rough grain surface and is somewhat porous, but it is in no way inferior to cattle hide leather.

Heavy buffalo leathers are made into soles, belting, saddles, heavy luggage, etc. Medium leathers are used for slippers, sandals, straps, etc. Light leathers have a grain that cannot be imitated. Aniline hide and calfskin are popular in the world of fashion. Suedes are used for articles of clothing, gloves and upholstery.

Where hides are prepared on a village scale, they are generally of poor finish and quality. Rural people should be taught to make crust leather (rough-tanned) for final treatment in industrial tanneries.

Hides are often damaged by inefficient flaying, branding, and by sarcoptic mange. Damage caused by horns is said to be less common in buffaloes than in cattle, and warbles are rarely present in buffaloes.

Foods made from buffalo hide

A dried hide food for human consumption, known as *kerupik kulit*, is sold in Indonesia. In the Philippines cracklings called *chicharones* are manufactured, and in Thailand a fried skin called *nung-pong* is made, with several variations such as *khab-kwai*, dried, salted and fried, and as *chin-pong*, served in small bits. A favourite dish in the Philippines is made from a piece of hide from the back and tail, thus spoiling the shape of the hide for tanning. The dish is called *kari-kari*.

The hides are prepared by soaking in hot water, removing the hair, and cutting into small strips which are then subjected to prolonged boiling in water with salt. The strips are then sun-dried and stored. When required they are cooked in deep fat or oil.

All these foods are palatable and in popular demand.

Hair

The hairs of the water buffalo are twice as thick as those of cattle. They are strong and flexible, and more suitable for brushes than for felt. In Bulgaria, the hair grows well during the winter months. It is collected by combing in the spring or during the preparation of hides for tanning. The hair is cleaned, washed and sorted. The covering hairs are used chiefly for making artists' brushes, and also for certain optical items.

9. THE WORKING BUFFALO

The domestic buffalo is the working animal of many countries in the Far East. Most working buffaloes belong to small farmers. The buffalo is often their greatest capital asset and is invariably treated with gentleness and consideration. The remarkably long working life means that the owner and his animal often toil together for very many years. It is not rare to find buffaloes that continue to work well at the age of 30, and there are recorded instances of a working life of 40 years.

Training

Water buffaloes are docile and tractable. Many are trained by being yoked with a mature animal, which may be the dam. Others may be tied to the side of a buffalo pulling a cart. Sometimes the calf will accompany the dam from a very early age, stumbling alongside in the padi field as cultivation proceeds. In all these systems the training and transition into work take place gradually and almost imperceptibly.

Training of unbroken buffaloes begins not later than 3 years of age. As a preliminary, the animal may be tethered between two trees or to a log. A heavy yoke may be fitted on its neck. In some countries, as in Sarawak, Malaysia, trainers move from village to village demonstrating the best methods of handling and utilizing buffaloes.

There are populations of feral Swamp buffaloes in Australia, Brazil, Borneo, Indonesia and in the Philippines. The capture and training of these semiwild animals are now established procedures. Various methods are adopted: approach under cover of a decoy female buffalo; lassoing and hobbling; and rounding up into pens. The captured animals may be tied up without food or water for 12 to 24 hours. The nasal septum is then pierced and a ring is inserted. The captive is hand-fed, stroked, and finally led around. The human voice is an important factor in taming the buffalo. After a week or two, most buffaloes can be led around safely by children.

Further descriptions are to be found in the sections of part II of the present study dealing with individual countries.

An exception to the general rule about docility and good temperament is the Egyptian buffalo, which may act unpredictably. Unlike other breeds it can kick forcibly and in all directions.

Water buffaloes rarely attack man, and then only when baffled by circumstances, wounded or injured in transit. They do not use their horns aggressively but an attendant may be injured by a sudden movement of the animal's head in involuntary response to some irritation. The sharp tips of the horns are generally blunted in many areas where buffaloes are redomesticated. In Australia polling is becoming routine.

Buffaloes tend to be shy and apprehensive of strangers, adopting the typical alarm stance, with head raised, nostrils flaring and the mouth partly open. This is usually the prelude to sudden retreat.

Work in rice lands

The buffalo's love of water, its ponderous and deliberate movements, its large hoofs and flexible foot joints make it the ideal animal for work in the deep mud of padi fields. It has been referred to, with justification, as "the living tractor" of the east. It is generally accepted that it is possible to plough deeper with buffaloes than with either oxen or horses.

Individual neck yokes are used. The plough is usually wooden, and can be carried by the ploughman to the field. After ploughing, the padi land is flooded and the buffaloes are brought in again to harrow the soil until it is of the proper soupy consistency to receive the rice shoots. The buffaloes work belly-deep, churning the soil and breaking up the lumps. Peg tooth or comb harrows are the most commonly used types in the Far East. Many other patterns are to be seen in other regions. Single rope harness is the rule.

Swamp buffaloes are very sure-footed and step carefully over the bunds, separating padi fields without damaging them. The individual fields are often very small and, in hill districts, terraced to maintain water levels. Although so large and heavy, buffaloes are the most efficient and economic means of cultivation of small padi fields.

A primitive form of rice cultivation is practised in Borneo, where it is known as *jijak*, and in Indonesia, where it is called *perudja*, *feva* or *amate*. Groups of half-wild buffaloes are rounded up and driven round and round the flooded padi fields. The size of a group depends on the area to be cultivated. The feet of the animals break up and puddle the soil and press down the weeds. No implements or trained animals are

needed for this method, but it may do more harm than good on dry soils. An official scheme in Sarawak provides selected animals at economic prices and includes training courses for farmers. It aims to counter the adherence to *jijak*.

Capacity for work

A very large proportion of the available agricultural power in the Far East is provided by animals. In Thailand, farm buffaloes worked on average 122 days a year and five hours per working day. It is obvious that they are not employed to capacity, but they cost little to keep during idle periods, are self-renewing, and provide milk, meat, hides and manure.

Mechanization in such conditions cannot be justified. Small, hand-operated motor cultivators have been tried but found to be costly. They depreciate rapidly and often get bogged down. Increased efficiency should be sought through improvements to implements and harness.

In China, one fully grown Round-barrel type castrated buffalo of Jiangsu province can plough 0.25 to 0.33 ha of irrigated land in a working day of eight to ten hours, broken by five rest intervals. In Hubei province, a Wuchü castrate can do all the work required on an area of 2.3 ha. The capacity of the smaller buffaloes of other provinces is considerably less. In Taiwan, China, buffaloes on farms work less than two months per year. On average, a buffalo can plough about 0.25 ha in a day and can cope with 3 ha of padi land. A mature buffalo can pull a load considerably heavier than twice its body weight.

Many factors affect the working capacity of a draught animal: breed and size, physical condition and health, types of equipment and implements, and speed of travel.

During the rice harvest buffaloes are employed to transport the sheaves. Carts are used in some districts and are generally heavy and cumbersome. In other areas light bamboo sleds, on hardwood runners, are often seen.

Threshing

In most rice-producing countries, buffaloes are used for threshing. The threshing floor may be as much as 30 m in diameter. The area of earth is levelled, moistened, solidified and allowed to dry out. In some areas the soil is mixed with dung. Rattan mats cover the surface and sheaves are arranged in a layer that is kept at a depth of about 50 cm. Two, three or more buffaloes are led round and round in a tight circle on the

sheaves. Efforts are made to catch excreta in a bucket. The straw is removed at intervals. the grain and chaff collected and fresh sheaves arranged on the matting.

A heavy wooden sled with two or three rows of metal disks underneath is used in Egypt. It is pulled round by one or two buffaloes, usually muzzled and blindfolded.

Employing an average of three animals and an equivalent of three full-time labourers, about 490 kg of grain can be threshed out per hour. Threshing machines or hand threshing into wooden containers are more efficient and yield a cleaner product.

The bruising of the straw makes it more palatable for animals.

Haulage

The buffalo is unsurpassed in padi fields, but bullocks are preferred for road work in many countries. The buffalo is slower. However, when well treated, given rest periods and sluiced down or allowed to wallow at intervals, it can pull heavier loads and has greater staying power. It is usually controlled with a single rein attached to a nose thong or to one horn.

In many countries light carts are drawn by single animals, heavy drays by pairs or teams. Most of the vehicles are on fixed axles and solid tires. Modern carts with springs and pneumatic tires are easier to pull and to control.

In India and Pakistan, buffaloes are used for heavy haulage. A good pair of entire *desi* males can pull 2 tons, in good conditions and on pneumatic tires, for 25 to 32 km in a day. Oxen are sometimes yoked with buffaloes.

In China, a castrated male will move a load of 900 to 1 360 kg at 3 km per hour. A Wuchü castrate can draw a cartload of 500 to 600 kg a distance of 25 km in a day. Entire buffalo males in east Java pull similar loads at a slightly quicker pace. They work at night, taking produce to market in heavy two-wheeled drays without springs and on iron tires. They are not allowed into the town so they are unyoked at the boundary and are fed and sluiced or allowed to wallow.

Buffaloes are still employed for road haulage in Bulgaria and Yugoslavia, usually with four-wheeled wagons. They were formerly used widely in parts of Italy as working animals, but they are no longer so employed.

A pair of buffaloes may be seen in Turkey pulling a large water cask on two wooden wheels with iron tires. Female buffaloes are not worked in Turkey.

Some very powerful buffaloes in Brazil are reported to haul loads of 900 to 1 000 kg at 3 to 4 km per hour.

Warning of approach

Vehicles seldom have brakes and cannot be halted suddenly. Bells are fixed to many carts and are worn also by pack animals. They give warning in harmonious tones.

Carter's implements

The only necessities are a simple goad and a scoop or bucket. The goad is usually a stick, about 2.3 m long, not pointed or tipped, and always used with gentleness. It is a guide and the buffalo responds immediately to a touch of the goad on the yoke. The buffalo reacts to whips in an unpredictable manner.

The scoop is carried on the vehicle and is used to sluice the buffalo at resting places. It is made of bamboo or metal.

Shoes and shoeing

The hoofs of buffaloes that work on hard roads must be protected. Many kinds of shoes are fitted in different parts of the buffalo world. Old motor tires are cut up and fastened on with thongs around the fetlock and pastern; in Java these are called *trompahs*. Tightly woven straw pads fastened on with cords are used in Taiwan, China. In many countries the working buffaloes are cold-shod with an iron plate on each claw. Some variation in pattern may be observed, but they are all held in place by small horseshoe nails.

Pack animals

Buffaloes are widely used as pack animals. They may carry a few sacks of grain on their broad backs, or a rope net may hold a considerable load, with the herdsman usually on top. Buffaloes are more efficient pack animals than other species except camels.

The Tangyang type of buffalo in China can carry a load of 100 to 150 kg for 25 km in a day. Hundreds of buffaloes travelled as pack animals in former times in Java. They were equipped with pack saddles and plaited bamboo panniers. In other areas, pack saddles are fitted with hooks from which rattan baskets can be suspended. Some saddles are made of hide, others of plaited rice straw.

Riding buffaloes

Buffaloes are ridden in many countries. Riders may be seen in every possible attitude, bareback or on a saddle. The saddle is, in many instances, narrow and uncomfortable. The buffalo's wide girth makes riding astride most uneasy.

On the island of Marajó, in the Amazon delta, saddles are of leather. Many riders are barefoot and have small metal stirrups each holding only two toes. The buffalo is often seen to be carrying a pack load as well as the rider. Herdsmen tending buffaloes on range carry long, blunt, steel-tipped goads. Buffaloes are also used in the Amazon region for towing canoes during the flood season when fodder has to be taken to cattle marooned on grazed-out islands.

In most countries where Swamp buffaloes are ridden, it is quite a common sight to see a rider in a curious attitude on an animal. Mounting is generally from behind. Children place a foot above the hock and pull on the tail to get up on to the animal's back, or they simply run and vault over the hindquarters. In the Philippines, buffaloes are trained to kneel.

Racing

Racing buffaloes run at high speed and races are held regularly in Indonesia, Sabah, the Philippines and in some other countries. The animals are looked after with every care and are generously fed. Each may be worth more than eight working buffaloes.

In Bali, pairs of male buffaloes, matched in colour and size, are raced in light carts. Buffalo racing with light chariots was popular in Democratic Kampuchea until it was banned by law because of increasingly heavy gambling.

Mounted sports

A kind of tilting at the quintain is popular in some districts. The objective is to carry away a ring of 5-cm diameter, at full gallop, with a wooden lance.

Fighting buffaloes

The Toradja people on Sulawesi breed black and white spotted Swamp buffaloes exclusively for fighting and ritual sacrifice. They are known

as *tedong bonga*, and are large, heavy animals. Although bred for fighting, they are docile and tractable, and some are even timid in the presence of strangers. Each has an attendant who gives his charge special rations and regular massage. A good specimen is worth as much as ten black buffaloes.

The fights are usually pushing matches between two animals and they go on until one of them leaves the field. Occasionally there is a fight to the death.

War

During the wars between Siam and Burma, about 200 years ago, Siamese buffalo cavalry is said to have ensured the final rout of the Burmese.

Buffalo gun teams, of ten or more pairs, were used for many years by the Turkish army. There is a record of 20 buffaloes pulling a cannon from Edirne to Constantinople in 1453. Such teams were in use up to 1918. There were occasions, usually when crossing streams, when the buffaloes became unmanageable. Then cannon would end up in deep water, the equipment damaged beyond repair, with the animals wallowing happily. In their invasions of Europe, the Turks used buffaloes for hauling heavy battering rams.

The Bulgarian army used buffalo transport during the Balkan war and the first world war.

Other tasks

Domestic buffaloes are eminently suited to the plodding round to provide power for oilseed mills, sugarcane presses and devices for raising water. They are sometimes blindfolded.

Buffaloes are used in China and Sri Lanka to puddle clay for brick-making and for wattle-and-daub building. They go round and round in pairs in a shallow pit, water being added as required to keep the proper consistency as clay is added and removed.

In Taiwan, China, a train of four trucks on a narrow-gauge railway is drawn by a single buffalo.

Pairs of buffaloes may still be seen pulling snow ploughs in Bulgaria and Greece.

Buffaloes are also used for haulage in forestry operations in many countries.

10. MILK AND MILK PRODUCTION

Many characteristics of the dairy cow can be recognized in the improved breeds of dairy buffaloes. Various systems of breeding, feeding and milk recording are applied with equal success in buffalo milk production. Compared with the European breeds of dairy cow, the domestic buffalo commences its first lactation at a much later age, and tends to be a shy breeder, with long, dry periods and lengthy calving intervals. These disadvantages apply equally to Zebu cows in tropical climates. Milk letdown and milking time are slower and more force is required to overcome the sphincter at the tip of the teat than in the case of the dairy cow. In hot climates some breeds of River buffaloes may give higher yields than either European or Zebu breeds of cattle, provided that all the requirements for shade, sprinkling or wallows, and green forage are attainable.

Farmers accustomed to admire the finer points of the improved breeds of dairy animals may show a lack of enthusiasm for the water buffalo.

Buffalo milk has much more fat, more solids nonfat, and less water than cow milk. Otherwise they are remarkably similar in chemical composition and physical properties. Buffalo milk and dairy products are palatable and attract good market acceptance.

Most buffaloes of the improved dairy breeds are found in India, Pakistan, Egypt, Italy and Bulgaria. Considerably more than half the milk consumed in India and Pakistan is produced by buffaloes. In Italy, buffalo milk production is increasing steadily.

Swamp buffaloes can yield a small surplus to the calf's requirements, but they soon go dry. Some, however, have shown that there is a potential for improvement. Records rarely take into account the amount of milk consumed by the calf.

On the other hand, River type females yield enough for the calf and a copious and persistent flow beyond. The number of outstanding individual performances is constantly increasing.

Milk production can be improved by selection of high-yielding females

and sires of proved merit, but competent management is essential. There can be no improvement in the absence of rational breeding programmes, milk recording, balanced rations, protection against extremes of climate, the provision of shade and sprays or wallows, and the prevention of disease and control of parasites.

As yields increase, more food must be provided, concentrates and supplements being essential. More food means more body heat and increases the liability to heat stress in hot weather. Heat stress, in its turn, depresses appetite and thus reduces milk yield.

Controlled grazing and a regular supply of green fodder simplify feeding systems.

Research institutes, state farms and private and military dairy farms in Bulgaria, Egypt, India, Italy, Pakistan, the U.S.S.R. and elsewhere have undertaken programmes of selection for high performance. Research projects on many of the problems of production make some progress but the need for field investigations and trials of feeds and management systems is still most pressing. Upgrading policies are in hand in several countries and they have acquired high-quality males for improving local stock. Demonstrations of pasture management and of cultivation and conservation of fodder crops would help many rural communities in all the buffalo countries. In various areas complex systems of land tenure have to be taken into account in the formulation of livestock policies.

Milk yields

This section is concerned with buffaloes kept for milk production.

Daily yields increase up to the sixth week after calving, then slowly diminish. The quantity depends on breed, individual potential, the number of calvings, the stage of pregnancy and the standard of management. The maximum daily yield increases up to the third lactation and then remains approximately the same up to the ninth.

The tendency to a reduction of lactation yields after the third or fourth calving is generally due to poor management, inefficient milking or to mastitis. Many buffaloes in well-managed herds maintain level lactation yields for seven or more lactations.

Reports from India and Italy were in agreement that buffaloes that calved earlier than at 42 months of age produced more milk, on average, than those that calved for the first time at a later age. Studies in Egypt showed that calving at 32 months of age led to a shortened productive life, even in conditions of good nutrition and management.

The season in which a buffalo calves influences the milk yield. In the

U.S.S.R. there was a significant increase in spring calvers. The calving season in Egypt influenced yields but not butterfat percentages. Little seasonal difference was found in military dairy herds in India under efficient management. In the Philippines, buffaloes calving during the dry season, January to April, produced more milk than those that calved in the wet season, June to December.

The average quantity of hand-drawn milk of Indian *desi* buffaloes is estimated at 550 to 640 litres in a lactation, in addition to the estimated average intake by the calf of 140 to 180 litres. Wide variations are caused by seasonal availability of fodder. Zebu cows in the same districts show considerably lower yields.

Buffaloes of the River dairy breeds kept in well-managed commercial herds give much higher yields. The military farms report for 1964 records an average for Murrahs over a period of 26 years of 1 450 litres per lactation. Records of a typical college farm herd of 136 buffaloes for the first to fourth lactations show an average of 1 857 litres for winter calvers and 1 750 litres for those that calved during the monsoon season. Another college herd averaged 1 975 litres in lactations of 338 days. A small specialist herd had an average of 2 340 litres.

The average for 15 000 Murrahs in commercial herds at the Aarey Milk Colony was 1 820 litres. The milk requirements of India could be met by about half the number of cattle and buffaloes that are milked at the present time.

Records of a herd at a military farm in Pakistan give averages of 2 700 to 3 600 litres, with individual performances of up to 4 500 litres, and lactation periods extending up to 400 days.

In the U.S.S.R. averages reported ranged from 970 to 1 550 litres. Herds in state farms averaged 1 270 litres in Bulgaria. In Iran, daily yields of 4 to 10 litres were reported, with an average of about 6 litres and a lactation period of approximately seven months.

The rearing of buffaloes for milk production is increasing steadily in Italy, especially on small farms. Some good Italian buffaloes give 10 kg of milk per day with butterfat at 8 to 9 percent. Selective breeding started in 1942, and herdbooks were established in 1947. Reports show average first lactation yields of 1 661 kg, second lactations of 1 716 kg and third and later lactations of 1 809 kg. The herd of the livestock institute had an average of 1 950 kg for 604 lactations. The highest individual yield was 3 500 kg.

Average yields at the Egyptian experimental farms ranged from 1 099 kg for first lactations to 2 217 kg for all lactations. Average daily yields were from 5.7 to 6.9 kg. In village herds the daily yields ranged from 3.2 to 3.9 kg. The highest individual daily yield was 4.1 kg.

Length of lactation period

Records of milk yields of buffalo herds are usually kept in lactations of 305 days. Many individuals in well-managed herds go on milking far beyond that period. Selection for persistence of lactation can lead to increased production.

Length of dry period

The problems of short heat periods and silent heats are considered in the chapter on reproduction (see p. 35). They lead, along with the tendency to seasonal breeding, to long, dry periods. The average gestation period of River buffaloes is about three weeks longer than that of cattle, but it is not a serious handicap; the longer interval between calvings is a much more serious disadvantage. The late age at first calving and the long calving intervals can be remedied to some extent by skilful management and adequate levels of nutrition at all stages of growth and breeding.

In spite of the inherent difficulties of artificial insemination in buffaloes, great advances have been made in several countries with a commendable increase in the number of high-yielding dairy animals.

Feeding

The effects of sun and heat on appetite and digestion have been mentioned in the chapter on effects of climate (see p. 30). The hottest hours of the day should be avoided in feeding routines. Increasing feeding from twice daily to four times resulted in higher yields. The performance of dairy buffaloes in a commercial herd in Bombay was compared with that of animals from the same herd moved to a village near Poona. Conditions were similar in both places, but in Poona there was a good supply of green fodder. The average dry period in Bombay was 214 days, and in Poona it was 130 days. The average calving intervals were 494 and 388 days respectively. The average daily milk yields were 8 kg and 9.1 kg respectively.

Commercial urea can be fed as a partial substitute for high-protein feeds when the carbohydrate level in the rations is sufficiently high. Feeding for milk production is dealt with in the chapter on nutrition (see p. 48).

Experimental induction of milk secretion

Young female buffaloes developed satisfactory udders and teats following the injection of hormones. Some of them gave substantial yields, and lactation persisted from 200 to 375 days. After the fourth day of milking, the composition of the milk was normal.

Milk letdown, milking, machine milking

The special aspects of milking buffaloes are discussed in the chapter on management (see p. 97).

Mastitis is dealt with in the chapter on aspects of disease (see p. 67).

The same high standards of hygiene in all stages of milk production must be observed in buffalo herds as in production from otner species.

The composition of buffalo milk

Wherever it is available, buffalo milk is popular. It has a high nutritive value and is excellent for the preparation of dairy products. It is particularly valuable in the diet of people in many countries where deficiencies of proteins and other essential items of the diet are liable to occur.

The major constituents are those that are present in commercially important amounts, namely fat, protein and lactose. The minor constituents — minerals, vitamins, nonprotein nitrogenous compounds, pigments, enzymes and other substances present in very small amounts — are no less important in the nutrition of the calf than the major constituents.

TABLE 5. — AVERAGE PERCENTAGE OF CONSTITUENTS OF BUFFALO AND COW MILK

Type of milk	Fat	Protein	Lactose	Total solids
	Percentage			
Buffalo	7.64	4.36	4.83	17.96
European cow	3.90	3.47	4.75	12.82
Zebu cow	4.97	3.18	4.59	13.45
Human	3.9	1.3	7.0	12.45

The above averages are of midlactation or bulk samples. The milk of high-yielding animals has lower levels of solids and corresponding higher levels of water, but the total output of solids in a complete lactation is much higher in the case of the better milker.

TABLE 6. — AVERAGE PERCENTAGES AND RANGES OF SOME OF THE CONSTITUENTS OF MILK FROM 24 HERDS OF ITALIAN BUFFALOES

	Average	Range
	Percentage	
Fat	8.5	7.1-9.6
Total solids	18.9	16.8-20.8
Ash	0.84	0.79-0.90
Total nitrogen	0.710	0.571-0.809
Casein nitrogen	0.572	0.437-0.654
Nonprotein nitrogen	0.031	0.009-0.536
Lactose	4.6	4.0-5.1
Calcium	0.203	0.179-0.241
Phosphorus	0.129	0.118-0.139
Citric acid	0.219	0.158-0.290

The percentages of constituents vary with the stage of lactation, and follow the normal pattern of the variations recorded in lactation periods of the cow.

Knowledge of the chemistry of milk and dairy products of domestic buffaloes is due to the work at research centres in Egypt, India, Italy, the U.S.S.R. and elsewhere.

Some variations may be noted in reports on the analysis of milk from different types and breeds, as shown in Table 7.

WATER

The average water content of buffalo milk is around 82 percent, comparing favourably with the 87 percent of European cow milk and 86.5 of Zebu milk. The water content varies with breed, individual, daily yield, stage of lactation and season. It is highest at the time of highest daily yield.

TABLE 7. — AVERAGE PERCENTAGES OF CONSTITUENTS OF MILK OF SOME DIFFERENT BREEDS

Breed	Total solids	Fat	Protein	Casein	Lactose
	Percentage				
Egyptian	16.55	7.14	3.63	3.04	4.99
Indian	17.56	7.06	4.65	—	5.07
Iraqi	17.07	7.91	—	—	—
Italian	18.9	8.5	4.5	3.6	4.6
Philippine carabao (Swamp type)	20.36	9.65	5.26	4.24	5.29

TOTAL SOLIDS

The highest levels are present immediately after calving and in the drying off stage.

FAT

Wide variations in butterfat content are reported from different countries. They are all much higher than the figures for cows.

Some reported averages for cows include Friesian, 3.5; Guernsey, 4.97; and Zebu, 4.65. And for some exceptional percentages of Swamp buffalo milk: Zaire, 10.28; Nepal, 11.5.

Buffaloes in Bulgaria have been selected for high butterfat content for many generations. Levels are said to be very high.

There is less fat in the first milk drawn at a milking and most fat in the strippings. However, there is no advantage in stripping to increase the fat content as there is a corresponding diminution at the next milking. Exposure of buffaloes in Egypt to very high temperatures caused a marked drop in fat percentage as well as in yield. The fat globules of milk of buffaloes are much larger than those of cow milk. The globules of Egyptian buffalo milk are larger than those of milk of Indian buffaloes.

LACTOSE

Average percentage of milk sugars include milk of European cows, 4.6 to 4.75; Zebu milk, 4 to 5.1; Italian buffaloes, 4.4 to 5.07; U.S.S.R., 4.8 to 4.9.

Proteins - caseins, albumins and globulins

The proteins of buffalo milk are similar to those in cow milk, but they are not identical nor in the same proportions. Reports from many sources give average percentages for total protein in buffalo milk of 3.63 to 5.26; for European cows, 3.25 to 3.90; and for Zebu milk, 3.18 percent.

The caseins of buffalo milk differ markedly from those of cow milk. Research in the U.S.S.R. showed that the casein of buffalo milk contained 22 percent higher content of essential amino acids than cow milk casein. The age of the animal influences the amino acid content of casein, as does the stage of lactation.

The structures of serum albumin, lactoglobulins and immune globulin contents of milk were found to be similar to those of cows, ewes and goats.

Lactenins are naturally occurring substances that control bacterial growth in milk; they appear to be proteins. Their activity is higher in buffalo milk than in cow milk. They are destroyed by heat treatment.

The bile pigment, biliverdin, is a normal constituent of buffalo milk. It is referred to below in connexion with the preparation of ghee (see p. 133).

Nonprotein nitrogen compounds

The proteose-peptone fraction is included in this group of constituents. They are present in variable amounts, generally less than in cow milk. Also in this group are very small quantities of free amino acids, urea, uric acid, ammonia and some vitamins. Some of them are excretory products but they may be beneficial for the calf. Unless there is great care in the collection of milk samples from the animal there may be contaminants of many kinds.

Minerals

Calcium

There is more calcium in buffalo milk than in cow milk. The amount varies considerably between individual and stages of lactation. Average percentages of figures given by several authorities are buffalo milk, 0.18; European cow milk, 0.12; Zebu cow milk, 0.14.

Calcium plays an important role in the production of the curd in cheese-making.

Phosphorus

Average percentages are buffalo milk, 0.12 to 0.13; cow milk, 0.10 to 0.12. The milk of Egyptian buffaloes appears to have a slightly lower phosphorus content than the overall average. This is also true of Egyptian cow milk. Calcium and phosphorus are, of course, essential for bone growth in the calf.

Total ash

The percentage by weight of total ash in buffalo milk is around 0.79, that of cow milk 0.75. It includes sodium, potassium, chlorine, copper, iron, and some other elements in very small traces. The amounts of sodium, chlorine and potassium are greater in cow milk than in buffalo milk. It has been suggested that a chlorine level in excess of 90 mg per-cent indicates mastitis.

In recent reports from the U.S.S.R. the presence of 18 trace elements in buffalo milk is compared with 15 identified in cow milk.

VITAMINS

Vitamin A and carotenes

The most obvious visual difference between buffalo and cow milk is in the colour, buffalo milk being white. The yellowish colour of cow milk is due to the presence of carotene which constitutes part of the vitamin A content; but buffalo milk may have equal, or even slightly higher vitamin A content. These substances show marked seasonal variations in all species. Average values, in international units per 100 ml, are buffalo, 225; cow, 126; ewe, 125; and goat, 127.

It is evident that the buffalo has an efficient way of preventing more than the smallest trace of the pigment reaching the milk, whatever the carotene content of the diet may be.

The effects of pasteurization on the vitamin A levels in buffalo milk and cow milk are very similar. In the high-temperature, short-time process the loss is negligible.

The vitamin B complex

Values for all the substances in this group have been reported for buffalo milk. There appears to be more vitamin B_{12} in cow milk in Iraq. Values in both species are unaffected by the stage of lactation. The content of vitamin B_{12} in the milk of the Philippine carabao is reported to be 42 mg per 100 g; for cow milk the figure is 23.7; and for goat milk 1.0.

Vitamin C, ascorbic acid

The content in buffalo milk appears to be distinctly higher than that in cow milk, and even higher than in human milk.

CITRIC ACID

This is important as it holds part of the calcium in un-ionized form and is thus essential to rennet coagulation of milk. Figures reported for levels in buffalo milk vary considerably, possibly due to differences in techniques for the tests. The range is 0.196 to 0.245 percent.

CHOLESTEROL

Cholesterol is present in small and variable quantities in the milk of both cows and buffaloes. Toward the end of lactation in both species there is a marked increase in levels.

ENZYMES

All the enzymes so far studied in cow milk are present in buffalo milk. Some have important parts to play in processing milk and they are destroyed at temperatures close to those used in heat treatment of milk. They are associated with all the fractions of milk.

Colostrum

The secretion of the udder at calving and for a few days thereafter has a much higher concentration of solids, particularly in respect of minerals, than normal milk. All the major constituents, together with calcium, phosphorus and potassium and the fat-soluble vitamins, are more abundant. In addition, there are antibodies that protect the calf from infections during the first few weeks of life.

The rapid change from colostrum to milk is seen in the levels of major constituents shown in Table 8.

TABLE 8. — PERCENTAGE OF CONSTITUENTS OF BUFFALO COLOSTRUM AND MILK

	Total solids	Fat	Lactose	Protein
	Percentage			
Colostrum	26.6	9.55	7.54	9.59
After one week	18.9	7.61	4.41	5.55

The levels of fat soluble vitamins A and E fall rapidly after the colostral period until they reach the normal milk level.

Physical characteristics

Colour

Buffalo milk is white. The absence of carotene has been mentioned under vitamin A (see p. 129).

Acid/alkaline reaction

Reports give averages ranging from pH 6.60 to 6.85. Some variation may be due to seasonal factors or to the use of different techniques. A range for individual Egyptian buffaloes was pH 6.25 to 7.0; for Italian buffaloes, pH 6.55 to 6.71. As milk stands and lactic acid is produced by bacterial action the pH is reduced. Mastitis usually leads to a higher pH, sometimes to over 7.0.

Specific gravity

The average for buffalo milk is nearly always within the range 1.030 to 1.032; the average range for cow milk is 1.029 to 1.033. Individual animals may give milk which is outside these ranges. Milk with higher butterfat percentage has the lower specific gravity.

Freezing point

The depression of the freezing point is still used as an indication that water has been added. Averages for whole, unadulterated milk of buffaloes and cows are 0.544°C and 0.545°C respectively. Milk of either species with a freezing point of 0.530°C or lower should be regarded as adulterated. Colostrum shows a larger degree of depression than normal milk.

Electrical conductivity

The conductivity varies with the chloride content of the milk. Milk from a quarter affected with mastitis has greater conductivity than normal. Average values are: for buffalo milk, 6.62 millimhos/cm; for cow milk, 6.69; and for goat milk, 13.91. Recent reports from India give averages at 30°C for buffalo milk, 3.68 millimhos/cm; cow milk, 4.70; goat milk, 6.97.

Surface tension

Surface tension is affected by temperature. Values for buffalo milk and cow milk at the same temperature show little difference. For buffalo milk averages reported range from 46.21 to 48.74 dynes/cm; and for cow milk 47.55 to 49.36. Averages given by WHO Monograph Series 48 are: buffalo milk, 55.4; cow milk, 55.9. These figures appear to be somewhat high.

Fluorescence

Under ultraviolet light, buffalo milk shows a white fluorescence, cow milk canary yellow. Heating to boiling point does not appear to affect the intensity but adulteration does.

Heat stability

The range of heat coagulation times, at 130°C, for buffalo milk is very wide. Coagulation times are longer in early or late lactation, and shorter in midlactation milk. The addition of calcium chloride reduces heat stability and rennetting time. The stability of buffalo milk, heated under pressure to temperatures ranging from 110 to 140°C, is much greater than that of cow or goat milk.

A higher creaming temperature is advised for buffalo milk, namely, 35°C, and for cow milk 6 to 13°C.

Rennetting time

Under similar conditions of temperature and rennet concentration, buffalo milk coagulates more quickly than cow milk. If the calcium level of cow milk is raised to that of buffalo milk the rennetting coagulation time becomes approximately the same. Dilution with an equal volume of water lengthens the coagulation time of buffalo milk slightly, but markedly for cow milk.

Dairy products

Butter, ghee, samna, maslo

The very high butterfat content of buffalo milk makes it particularly valuable for the preparation of these products. As already noted, a

higher temperature is recommended for ripening cream of buffalo milk than in the case of cow milk. Churning is also assisted by higher temperature. The churning time of buffalo cream is shorter than that of cow cream. Increased fat content reduces the churning time, which is shorter in winter than in summer.

Butter is made in Iraq by churning and pounding in sheepskins.

Ghee is butterfat, dehydrated by slow heat, clarified hot and allowed to solidify. In Egypt it is known as *samna*, and in Yugoslavia as *maslo*. It has excellent keeping qualities when carefully prepared and loses little of the vitamin A of the milk. It is popular as a cooking fat in both Muslim and Hindu communities. Olive oil or mixed vegetable oils tend to replace ghee in Greece and in some other countries.

Ghee prepared by churning curds of buffalo milk has a slightly greenish tinge due to the biliverdin in the milk. Ghee made from separated cream does not have any of the pigment, which is bound to the protein fraction of the milk.

Butter oil can be stored in refrigeration and used with reconstituted skim milk powder to make a satisfactory milk for human nutrition.

Cheese

Buffalo milk has been adapted to the manufacture of several types of cheese. The product generally takes a longer time to ripen than cheeses of cow milk. Both pasteurized and raw milk are used in different districts. Hard cheese made from pasteurized milk has a higher protein level than that made from raw milk.

Rennet is usually obtained from calves or goat kids, slaughtered as required for that purpose.

Soft cheeses are made in most of the countries where buffaloes are maintained. Hard cheeses are made in some centres. In Italy, the bulk of the buffalo milk is made into mozzarella cheese. It is usually and legally mixed with cow milk. A smoked variety, *provola affumicata*, is attracting increasing demand.

Two kinds of cheese are manufactured in the state of São Paulo, Brazil, a soft cheese and a harder, ricotta type.

Salted cheeses are popular in Egypt, Iraq and Yugoslavia. Several kinds of cheese are prepared in Iraq, some of mixed milk, depending on the seasonal supplies of each kind. One is a soft, heavily salted cheese of a curious elastic character. It is marketed in the form of plaited strands. Many kinds of buffalo cheese are sold in Greece.

Some of the soft cheeses made in the warmer regions have very brief keeping quality.

A cheese spread is made in the Philippines from cottage cheese, pimento and dehydrated onion.

Milk powders, baby foods

Freeze-dried and spray-dried milk powders are made from buffalo milk. Considerable work has been done in India and elsewhere on the nutritive value of buffalo milk products, but much more is needed, particularly on its use for baby food.

A product, *khoa,* prepared in India, resembles the milk biscuit recently developed in New Zealand and Australia.

Cream

Several forms of cream are prepared from buffalo milk; they are known by local names and are in popular demand. A heavy scalded cream, *gemir* or *gaimer,* is made in Iraq. It is kept under refrigeration and, with 10 percent added honey or date syrup, is a favourite breakfast dish.

The principal constituents of Egyptian scalded buffalo cream are compared with those of Egyptian cow cream in Table 9.

Table 9. — Comparison of Egyptian scalded buffalo cream with Egyptian cow cream

	Fat	Moisture	Protein
	Percentage		
Buffalo cream	75.0	24.0	0.85
Cow cream	48.5	49.6	1.20

The cow cream was reported to be softer and more difficult to shape.

"Curl cream" is made in Turkey by heating buffalo milk to 90°C for 30 minutes and allowing it to cool to 40 to 45°C in shallow containers. This process is repeated and the product is left until the following morning when it is sufficiently solid to be cut up. It is known as *lule kaymagl* and has a fat content of under 10 percent. Another cream product made in Turkey, and also termed *lule kaymagl,* is rolled into a sausage shape. It has a fat content of 46 percent and resembles the Iraqi *gemir.*

TONED MILK

Whole buffalo milk causes digestive disturbance in some individuals who drink it undiluted. The high fat content may cause some liver damage in exceptional circumstances. Toned milk — buffalo milk diluted with reconstituted skim milk powder — has a slightly higher nutritive value than cow milk and about the same fat content. When skim milk powder is obtainable at an economic price, as a product of butter or ghee manufacture, toned milk can be manufactured at a lower production cost than whole buffalo milk or whole cow milk. The removal of rather more than half the butterfat from buffalo milk, before using it for condensed milk and baby foods, is a common commercial practice in India.

Cow milk is often mixed with buffalo milk in Italy for the preparation of mozzarella cheese. The use of a proportion of cow milk reduces the cost of production of the cheese. The Hansa test can be used to detect the addition of cow milk. A rapid and sensitive ring test has been developed in Madras for the detection of 10 percent or more of cow milk in buffalo milk.

SOURED MILK, CURD, YOGHURT

The rate of acid formation in buffalo milk is higher than that of cow milk. The consistency of the yoghurt made from buffalo milk is better than that of the yoghurt of cow milk, but the flavour is not considered to be so pleasing.

The most popular dairy product in Greece is an almost solid yoghurt made from mixed milks. Yoghurt of buffalo milk is much esteemed in Iraq, Turkey and Yugoslavia.

Soured milk, made from boiled buffalo milk, is a popular food in Iraq. In Java, soured milk, mixed with sugar or honey, is stored in bamboo tubes and eaten with rice.

Most of the buffalo milk produced in Sri Lanka is made into curd, by boiling, cooling and adding lactic acid bacteria. It is ready for consumption after 12 hours. It can be stored in earthenware jars.

A buffalo milk curd, flavoured with sugar, saffron, nutmeg, and charoli or cardamom, and known as *shrikhand*, is made in India. For economic production, it can be made of fat-reduced milk, 3 percent, and 36 percent sugar.

A fermented milk product, *zabadi*, is prepared in Egypt. It can be made of mixed milk.

Flavoured milk shakes are popular in many lands.

Sugared buffalo milk is popular in Lao. In Sumatra, milk is boiled

and then cooled slowly, pineapple juice being added to produce *dadih*, a form of curds and whey.

Buffalo milk sweetmeats

Sweetmeats are made by condensing milk and adding sugar and flavouring. They are popular in Bangladesh, Indonesia and Nepal. *Pastillas de leche* are made in the Philippines with buffalo milk, corn starch and flavouring.

Ice cream

Buffalo milk makes excellent ice cream. It is made in Iran, the Philippines, Sri Lanka and several other countries. The demand in summer in some districts leads to a rise in the local price of milk.

As the buffalo continues to displace the cow in India, the economic disposal of butterfat may become a problem. The manufacture of ice cream may be one possible solution where refrigeration facilities are available.

Fruit or cocoa flavourings are popular for ice cream and yoghurt in some areas.

11. MEAT AND MEAT PRODUCTION

For many centuries buffaloes were bred and kept for work and this led to the evolution of animals of powerful muscular development. Until relatively recent times little attention was given to the exploitation of this potential for quality meat supplies. Most of the buffalo meat was, and still is, derived from animals slaughtered in emergency or at the end of a useful working or productive life. As a result, the meat is generally of poor quality and is often unattractive in appearance. Rearing buffaloes for meat production is still in the early stages of organization but already shows promise of rapid expansion in many countries.

The failure to appreciate the advantages of rearing young buffaloes for slaughter at around 2 years of age is indicative of a prejudice against buffalo meat. In the milk production areas, calves are allowed to die because milk is in demand, but many could be reared economically and kept on range until they attain a weight and condition for slaughter.

It is a tragic fact that the neglect of the meat production potential is greatest in those countries that suffer most from shortages of protein of animal origin.

The famous breeds of beef cattle were developed from working strains. Good meat types of buffaloes could readily be selected from existing stocks, especially in those countries where they tend to become redundant through mechanization of agriculture. Attempts have been made in many regions to create conditions suitable for ranching beef cattle, often with success, but there are vast areas subject to flooding that could be more economically developed for buffaloes. The results in the Amazon delta in Brazil and in the Northern Territory of Australia point the way to planning in other similar areas.

In rice-growing districts, more calves might be reared and transferred on weaning to farms where they could be grown and fattened, possibly in cooperative projects. Diversification of rice land is a policy in some countries. In the Philippines, it has been shown that 0.4 ha (1 acre) of padi land planted with para grass will fatten ten steers in a year and yield twice

as much financial reward as efficient rice-growing. More capital is required and an assured supply of animals is essential.

The wide variation in size and weight of buffaloes in different countries, ranging from 250 to 1 000 kg or more, indicates a considerable potential for selection for breeding. However, it is vital to ensure that improvements in management, nutrition and health protection keep pace with breed development.

Official policies have been implemented in some countries to limit the extent of slaughter and thereby to increase buffalo stocks. These restrictions, however, discourage the rearing of animals for early slaughter and they also lead to illegal killing by crude and wasteful methods in insanitary surroundings. Fortunately, regulations of this kind have been rescinded in several countries. One example of severe limitation of slaughter can be cited. In Thailand, the slaughter of females below the age of 15, and of males under 10, was prohibited unless certified to be cases of emergency, injury, disease, incapacity, intractability or infertility that made future maintenance valueless.

Excellent research programmes on many aspects of meat production are under way at centres in Egypt, Bulgaria, India, Italy, Romania, Trinidad, the U.S.S.R. and Yugoslavia, and trials are planned in many other countries. But there remain many details awaiting study.

Slaughter

The conditions in which animals are rested before slaughter play an important role in the quality of the meat. Accommodation for buffaloes is often quite inadequate. There should be shade, paved floors and showers or spray races. There are several modern, well-equipped establishments in different regions where valuable experience has been gained in the dressing of buffalo carcasses. Such abattoirs could serve as patterns for planning in areas of development of meat production.

In Muslim states, animals are slaughtered by bleeding, without stunning, by methods prescribed in the sacred texts. Throughout the east it is usual to employ Muslims as slaughtermen. Much can be done to provide for permissible means of control of the animal and to minimize suffering. In the Philippines, buffaloes are pithed by a skilful stab between the skull and the neck vertebrae and immediately bled. In Nepal, they are pithed and the head is removed complete; many buffaloes are sacrificed by ritual decapitation with a single stroke of the *kukri*. In Bangkok, a special captive bolt pistol has been designed for stunning buffaloes. The skull is thicker than that of cattle. In some places rifles are used at short range.

In India, regulations controlling firearms prohibit the use of captive bolt pistols in slaughterhouses.

Veal

Buffalo veal is an esteemed delicacy in Egypt and in Italy, where it commands a comparatively high market price. Egyptian buffalo calves slaughtered at 30 to 40 days after birth had average weights of 61 kg and dressed out (offals included) at over 65 percent. Italian buffalo calves at 4 months of age fed on buffalo milk in the bucket had an average carcass yield of 59.4 percent, those fed on cow milk 59.1 percent, naturally suckled males 56.0 percent, and females 55 percent.

Fattened buffaloes

Italian buffalo females at 18 months of age dressed out at 49 percent, males at 49.26 percent. Young Iraqi males, slaughtered at 283 to 376 kg liveweight, gave ratios of 47 to 50 percent. In the U.S.S.R. the females gave higher percentages than the males, 48.7 and 47.8 percent respectively. The average for 433 buffaloes slaughtered in Brazil was 48.7 percent.

Animals with a high degree of fattening finish give higher dressing-out percentages than leaner animals. Fat cattle generally give higher percentages than buffaloes, due to the thicker hides, heavier horns and feet and contents of the digestive tract of buffaloes.

Young fat buffaloes in Yugoslavia attained a satisfactory grade of finish at 300 to 350 kg liveweight, whereas young bulls attained a comparable degree at 400 to 450 kg. Some very high dressing-out ratios have been reported: in Trinidad, 2-year-old buffaloes gave 60 percent; in Australia, 56.9 percent; in Bulgaria, 54 percent; and percentages over 52 were yielded by some animals in Italy and the U.S.S.R.

The capacity of young buffaloes to thrive on coarse fodders is well known, but their fattening propensities under different feeding systems are not so widely appreciated.

Where conditions are favourable — with ample shade and water — buffaloes are efficient converters of feed into meat. They readily adapt to ranching and to feedlots.

Results of comparative feedlot trials are shown below.

Seasonal variation in weight gain was more pronounced in the cattle than in the buffaloes.

Growth rates are considered in the chapter on nutrition (see p. 48).

TABLE 10. — PERFORMANCE OF YOUNG MALE IRAQI BUFFALOES AND MALE NATIVE CATTLE KEPT IN FEEDLOTS IN IRAQ

	Buffaloes	Cattle
Number	165	955
Liveweight at start (kg)	91-226	75-231
Duration (days)	138	127
Average daily weight gain (kg)	0.728	0.544
Carcass weight (kg)	118	102
Dressing-out percentage	47.24	50.45

Low-cost meat production systems operating successfully in Indonesia, Brazil and Australia are described in chapters 17, 22 and 23 respectively (see p. 205, 249 and 258).

Studies in Yugoslavia, comparing buffaloes and cattle, with similar grades of finish, showed that the advantage in favour of the cattle was about 5 percent. In trials in Iraq, the dressing-out percentage for cattle was 3 percent higher than that for buffaloes. Swamp buffaloes in the Northern Territory of Australia gave dressing-out percentages above 51; most of the fat was in the muscle groups with very little under the skin.

Carcass quality

The fat of buffaloes is white and gives the carcass an attractive appearance. Investigations in Iraq showed that the differences in ratio of lean meat, fat and bone of three-rib samples from comparable fat cattle and buffaloes were not significant, although the beef cuts had slightly higher percentages of meat and lower percentages of fat and bone than the cuts of buffalo carcasses. On the other hand, in Australia, in buffalo males compared with Brahmans, both lots under 2 years of age, the ratio for whole carcasses of muscle:fat and of muscle:bone was more favourable in the buffalo carcasses than that in the cattle.

The percentage of lean meat in three-rib cuts of fat Bulgarian buffaloes was 66.74; of Murrahs 67.38; and of crossbreds 61.50. The percentages of bone were 17.64, 16.84, and 19.89 respectively.

In Trinidad, Murrah females, about 4 years of age, were examined by

dissection of tenth-rib cuts. The lean meat ranged from 52.2 to 60.9 percent, fat from 16.7 to 28.4 percent, and bone from 20.3 to 24.5 percent.

A group of Swamp buffaloes slaughtered in Australia yielded an average dressing-out percentage of 55. Muscle represented 36.09 percent of the empty liveweight. The figure for cattle was about 33 percent. The distribution of muscle weight differed mainly in the muscles surrounding the spinal column. The weight of muscle in the expensive cuts was about the same in each species. The fat constituted 10.5 percent of the carcass weight. The carcasses, when chilled, were dark in appearance because of the small amount of surface fat. However, the fat was white and of good firm texture. Cut surfaces of muscle showed a rich red colour, only slightly darker than the muscle of beef carcasses.

TABLE 11. — AVERAGE WEIGHT OF SOME ORGANS AND OFFALS OF CATTLE AND BUFFALOES

	Cattle		Buffaloes	
	Weight	Liveweight	Weight	Liveweight
	Kilograms	*Percentage*	*Kilograms*	*Percentage*
Heart	0.78	0.34	1.38	0.41
Liver	3.28	1.44	4.72	1.41
Kidneys	0.54	0.24	0.90	0.27
Head	8.9	3.90	13.6	4.06
Feet	3.9	1.71	7.9	2.36
Stomach and intestines	47.3	20.72	72.0	21.48
Hide	17.9	7.84	36.1	10.77

Wide variations are found in reports from different sources. In some cases the variations are due to different styles of dressing. For example, tongues and horns may be weighed with heads or separately. Some percentages are shown in Table 12.

The percentage of fat varies with the degree of finish of fattening and may range from 0.5 to 5.0 or higher.

The hindquarters of top-grade Italian buffalo males constituted 42.64 percent of the total carcass weight; of females, 44.45 percent; of castrates,

TABLE 12. — VARIATIONS IN WEIGHT OF SOME ORGANS AND OFFALS OF CATTLE AND BUFFALOES

	Cattle			Buffaloes
	U.S.S.R.	Iraq	Bulgaria	Murrah
	Percentage			
Liver	2.0	1.41	1.12	1.15
Heart	0.35	0.41	0.36	0.43
Head	4.2	4.06	3.87	3.66
Feet	2.2	2.36	1.95	1.99
Hide	11.0	10.77	13.94	12.46

45.07 percent. The proportions of meat:bone in top grade males were 82.3:16.6, females 83.29:16.21, and in castrates 81.96:17.54.

Eight entire male buffaloes fattened intensively in Bulgaria, and slaughtered at 18 to 20 months of age, yielded the averages shown below:

	Kilograms	*Percentage*
Liveweight before resting	289.75	—
Liveweight at slaughter	274.37	100
Shrinkage	15.37	5.22
Carcass weight	140.00	51.04
Hide	31.70	11.53
Head	11.40	4.11
Horns	1.39	0.50
Feet	6.10	2.17
Liver, lungs, spleen, heart	10.37	4.12
Full digestive tract	50.98	18.12

Tissue ratios in five of the carcasses were as follows:

	Percentage
Whole carcass	100
Skeletal muscles	67.42
Fat	16.32
Bones	14.48
Cutting loss	1.17
Kidneys	0.59
Forequarters	100
Muscles	69.86
Fat	12.04
Bones	16.48
Cutting loss	1.16
Hindquarters	100
Muscles	65.04
Fat	20.28
Bones	12.74
Cutting loss	0.77
Kidneys	1.17

In recent trials in the Philippines, carcasses of male carabaos, about 30 months of age, were compared with carcasses of Red Sindhi × Friesian steers of about 36 months. There was little difference in carcass weight, dressing percentage, shrinkage, and trimmings. The buffalo meat had higher points for marbling, and had a higher ratio of lean meat. No difference was detected in flavour, tenderness, juiciness or general acceptability. Buffalo meat had a higher percentage of protein, more pigment and less moisture than beef.

Mention must be made of the recent work of Charles and Johnson (1975) of Queensland University whose earlier observations had shown that buffalo carcasses were well suited to the lean meat market and had a higher dressing-out percentage than those of the *Bos* species. It has now been shown that castration makes little difference to the carcass characteristics of the Swamp buffalo, and that even on high-gain rations

the carcasses will be lean. Average weight gains in four feedlot groups, each of five 200 to 300-kg 11- to 20-month-old steers, fed lucerne hay or pellet rations, are shown in Table 13. Fattening periods were three to five months and slaughter was at liveweights of 300 to 480 kg.

TABLE 13. — PERCENTAGE OF MUSCLE AND FAT AND WEIGHT GAINS

Group and average weight gain	Muscle		Fat	
	Range	Mean	Range	Mean
	Percentage			
0.5 kg/day	70-61	66	9-22	15
0.67 "	70-62	67	12-23	16
0.63 "	66-58	63	13-25	18
0.74 "	70-61	65	11-21	16

The ranges are the maximum and minimum values and mostly correspond to the shortest and longest periods of fattening. These figures suggest that buffalo steers will only become overfat after prolonged feeding to weights well above commercial targets. In fact, excess fat, i.e., over 20 percent, was only produced after a long stay in the feedlot, and in the oldest of the steers.

A comparative study which confirmed the resistance of the buffalo to fattening was made with Hereford, Friesian, Angus and Swamp buffalo steers which were fed concentrate rations from 3 to 7 months. All breeds except the Angus put on the same amount of muscle but differing amounts of fat.

TABLE 14. — MUSCLE, FAT AND TOTAL WEIGHT GAINS

Gain	Hereford	Friesian	Angus	Buffalo
	Kilograms			
Muscle	31	33	12.5	32
Fat	63	19	56	9
Total	141	108	98	87
Kg/day	1.08	0.88	0.72	0.67

The buffaloes finished up with very much leaner carcasses.

TABLE 15. — MUSCLE AND FAT: COMPARATIVE PERCENTAGES

Breed	Muscle	Fat
	Percenage	
Angus	48	39
Hereford	50	35
Friesian	58	23
Buffalo	68	12

Buffalo meat

Buffalo meat is similar to beef in basic properties — structure, chemical composition, nutritive value and palatability. Consumers detect little difference between cooked joints of buffalo meat and beef derived from animals kept under the same conditions and slaughtered at the same age and stage of fattening. On the other hand, where buffaloes are in the minority among improved breeds of cattle kept for the production of prime beef, buffalo meat is less acceptable on the market.

Compared with top-grade beef carcasses, more fat accumulates in the walls of the chest and abdominal cavities of buffaloes, less fat between muscle groups, and even less within the muscles. There is also less marbling. Connective tissue under the skin and around muscle groups is seen to to have thicker layers and looser network.

Cuts across muscles of older buffaloes show a coarser appearance than those of muscles of young buffaloes, a tougher texture and darker colour.

Buffalo meat has excellent qualities as chilled or frozen products and for the manufacture of sausage, hamburger and meat loaf.

Studies in the U.S.S.R. gave the following results of analysis of meat from fat buffaloes, medium grade and lean:

	Buffalo meat grades		
	Fat	Medium	Lean
	Percentage		
Water	64.42	68.87	73.35
Protein	19.19	20.50	22.40
Fat	15.40	9.60	1.15
Ash	1.00	1.03	1.08

Veal of Italian calves fed on buffalo milk and cow milk showed the following:

	Buffalo calves fed on:	
	Buffalo milk	Cow milk
	..... *Percentage*	
Water	71.68	73.15
Protein	21.41	20.37
Fat	5.83	5.35
Ash	1.04	1.01

Studies in Bulgaria and Romania showed that the chemical components of buffalo meat — moisture, fat, amino acids and so on — are the same as in beef but in varying proportions. They confirm the conclusions of research workers in other countries that buffalo meat is a highly nutritive food and is easily digested.

Calories per kilogram range from around 1 300 in lean veal to 2 556 in fat buffalo meat.

THE PALATABILITY OF BUFFALO MEAT

Cooked joints from three carcasses, a Trinidad buffalo, a crossbred Jamaica-Red × Sahiwal steer, and an imported carcass of a top-grade European beef steer were served at a palatability dinner. The 28 diners were people with experience in beef production, butchery or catering, and were not told of the sources of the various joints. All the carcasses were held in cold storage for one week before cooking. The buffalo meat was considered to be best by 14 judges; 7 chose the European beef; 5 thought the crossbred beef the best; and 2 decided that the buffalo and crossbred were equal and better than the European. The buffalo meat gained most points for colour of both meat and fat, for taste and for general acceptability. There was little difference in marks for texture.

In Yugoslavia, meat and liver from an 18-month-old fattened buffalo, cooked in various ways, were compared with those of a young Brown Swiss bull. No difference in palatability was detected regardless of the method of cooking.

On the other hand, trials in the Philippines resulted in slightly higher

marks for flavour, tenderness and juiciness of beef than for the meat of a carabao.

It may be concluded that buffalo meat can be as acceptable on all counts as beef. The prejudice against buffalo meat is due to the general practice of slaughtering old, worn animals and to unsatisfactory methods of dressing, handling and marketing.

Meat products

Several kinds of *pastarma* are highly esteemed in Balkan countries. Thick slices are cut from the big muscle groups, well trimmed, salted for one or two days, washed, compressed and dried in hot air or sunshine. The yield from 100 kg of raw meat is 40 to 50 kg *pastarma.* After ripening it is cut into slices and eaten raw or lightly roasted. One variety is called *gabrovi,* a luxury product. White wine is used in its preparation.

Sausages are made from buffalo meat in Turkey, Greece and other countries. Some kinds of sausage are prepared from dried meat with seasonings. Fresh buffalo meat is used in the Philippines to replace up to 70 percent of pork in sausage, without diminishing the flavour. Little difference was found in sausages made from buffalo meat and beef sausages of the salami and Chinese types, but the buffalo sausages lost slightly on colour. Bologna sausages of buffalo meat were considered to be better than those of beef.

Buffalo meat was found to be just as good as beef for frankfurters.

Meat loaf made of buffalo meat scored higher marks for all characters. Corned buffalo meat was equal to corned beef.

Beef was slightly better than buffalo meat in marinated meat products.

Sun-dried meat — jerked meat, biltong and charque — are popular in many countries. Buffalo meat makes excellent products. The keeping quality of charque is highly prized in Brazil.

Many kinds of food are made from buffalo hides, some of which are described in the chapter on management (see p. 113).

More research is necessary on the industrial processing requirements of buffalo meat. The need for modern installations for dealing with chilling, freezing and packing of meat and meat products in many areas of buffalo development must be emphasized.

The ligaments, tendons and cartilage of buffaloes are suitable for the manufacture of gelatine chip.

The by-products — hides, hair, horns and dung — are considered in the chapter on management (see p. 111).

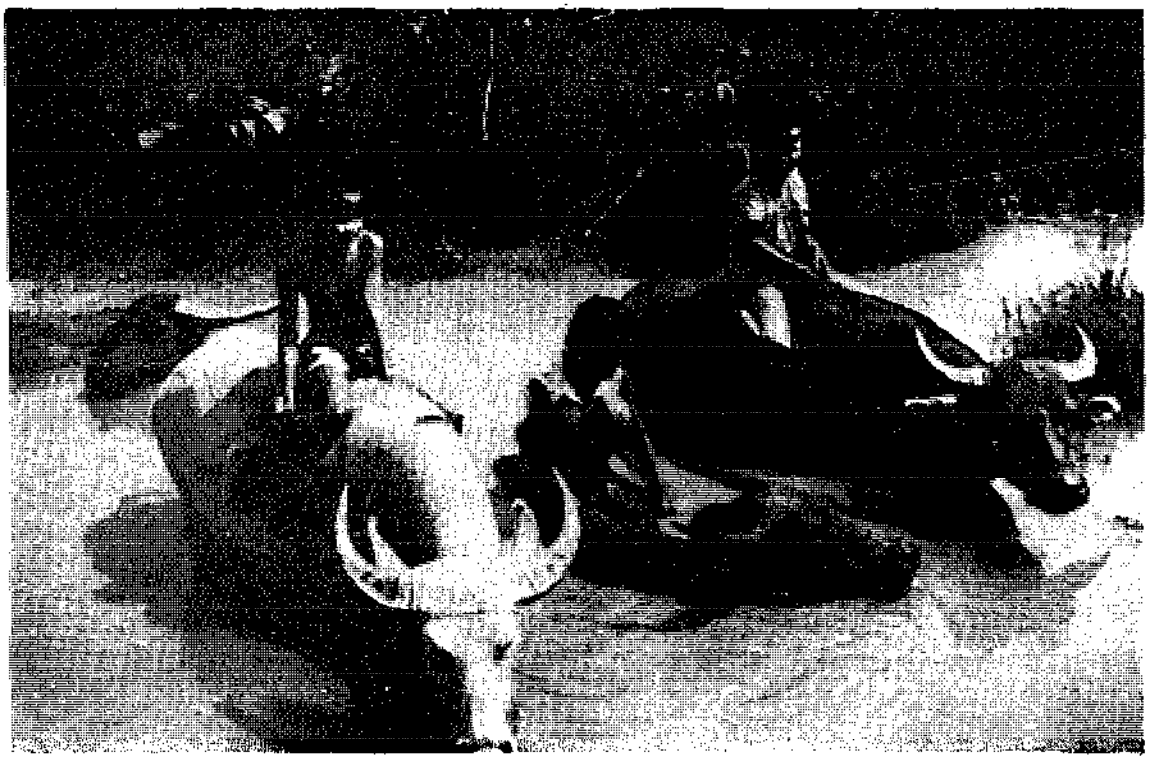
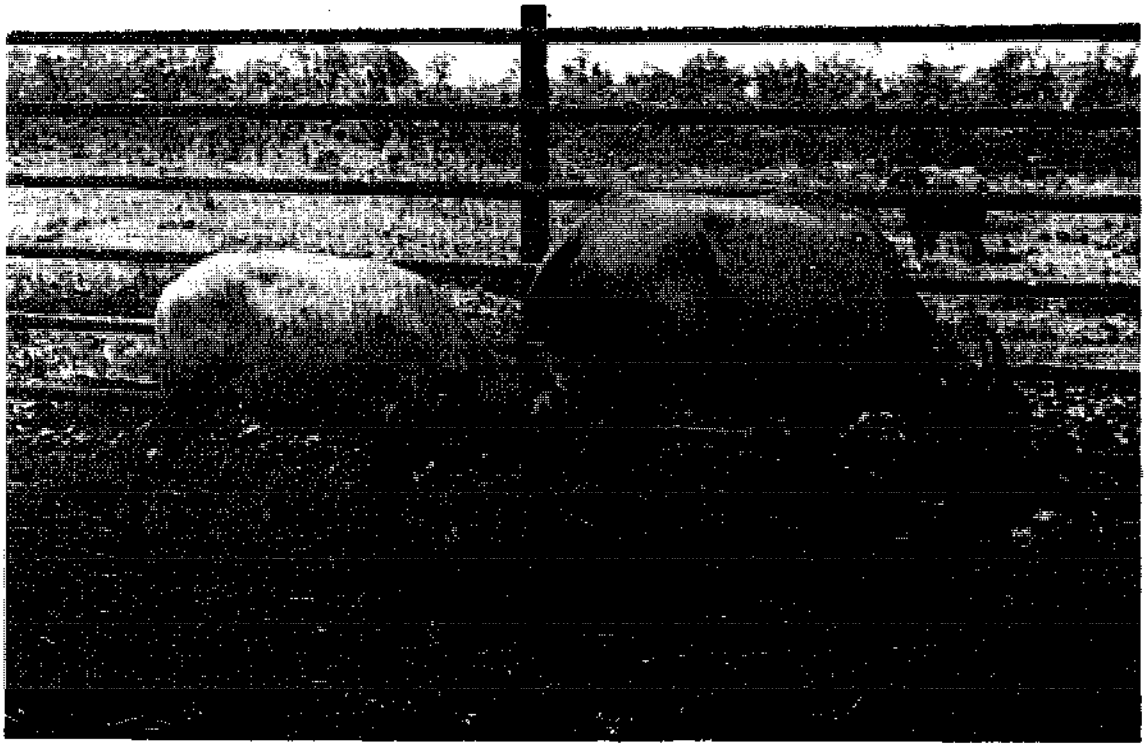


FIGURE 1. — Swamp buffaloes, one an albinoid, wallowing in the charge of children, in Thailand. Note cord halter and pierced nasal septum.

FIGURE 2. — Feral Swamp buffaloes undergoing domestication; calf sucking from rear position. Northern Territory, Australia.



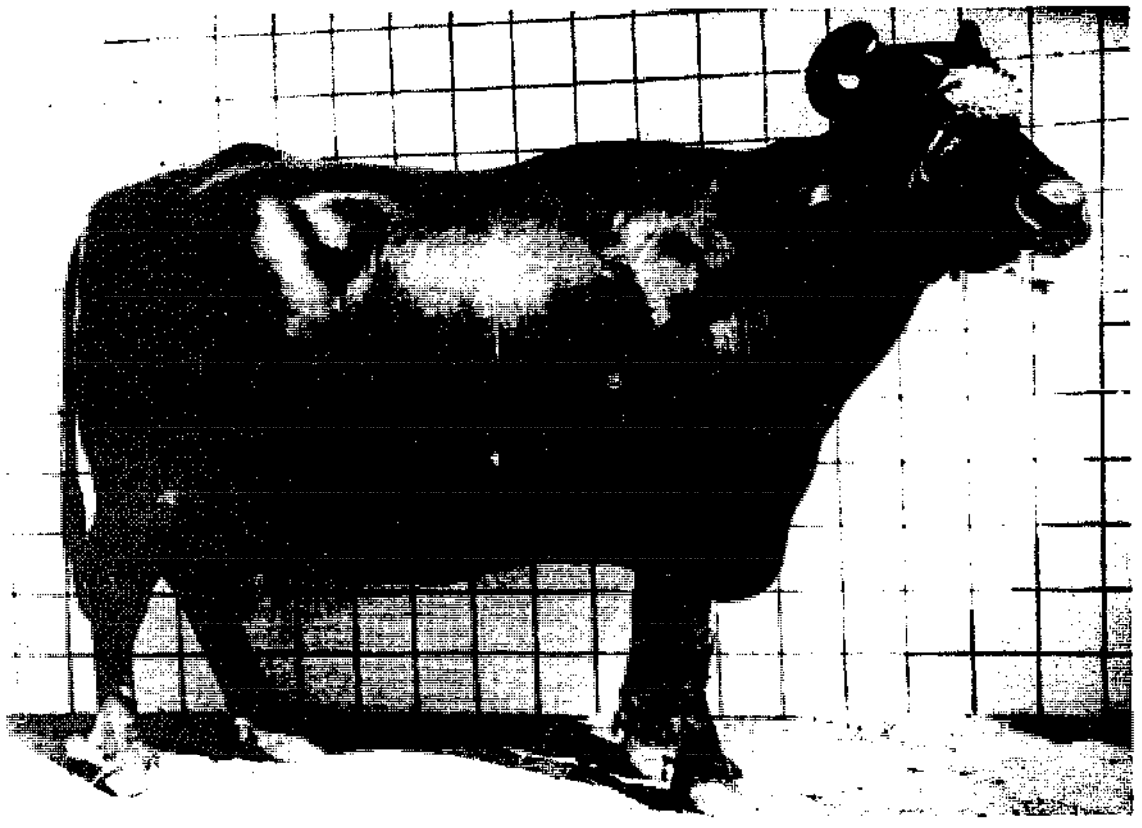


FIGURE 3. - Female Murrah buffalo.

FIGURE 4. - Murrah buffaloes being milked at the Aarey Milk Colony, India. The milk yield has increased by 30 percent through proper feeding and management.

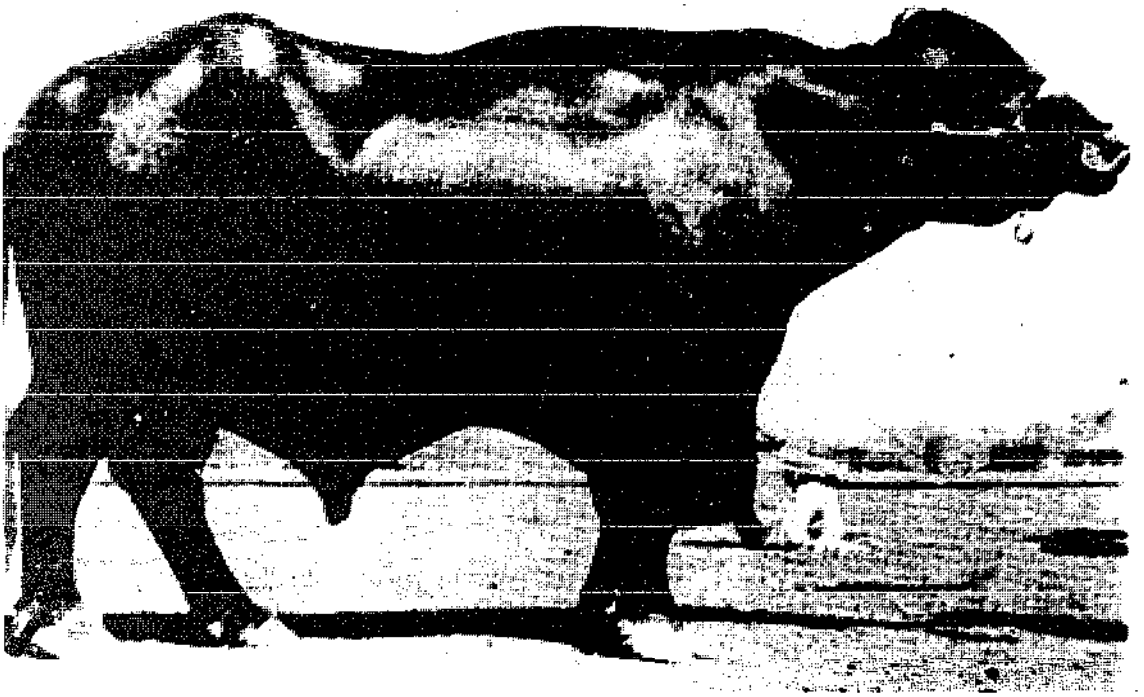


FIGURE 5. — Male Nili-Ravi buffalo.

FIGURE 6. — Brown Nili-Ravi, Landhi "Cattle" Colony, Pakistan.

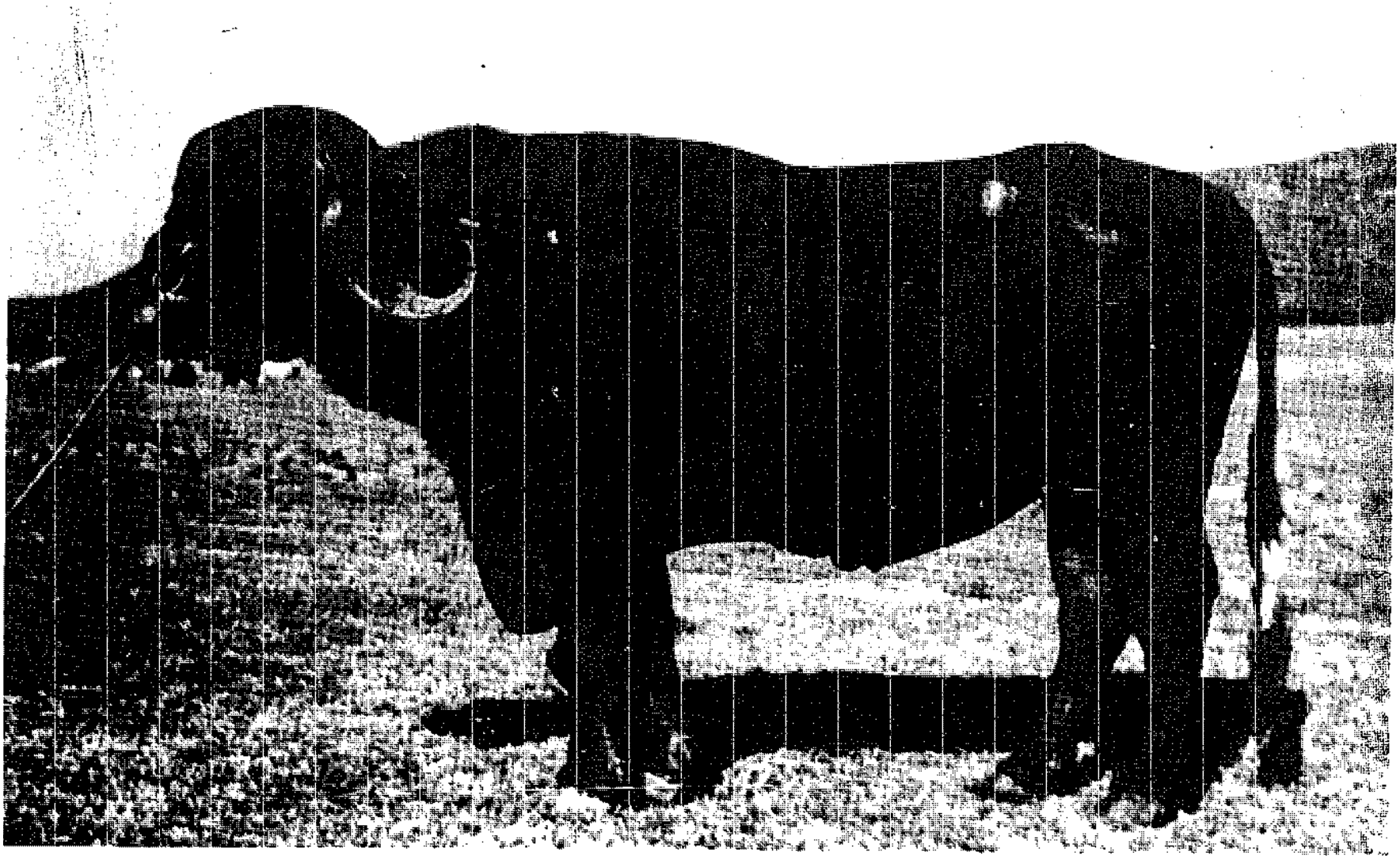


FIGURE 7. — Male Jafarabadi buffalo, India.

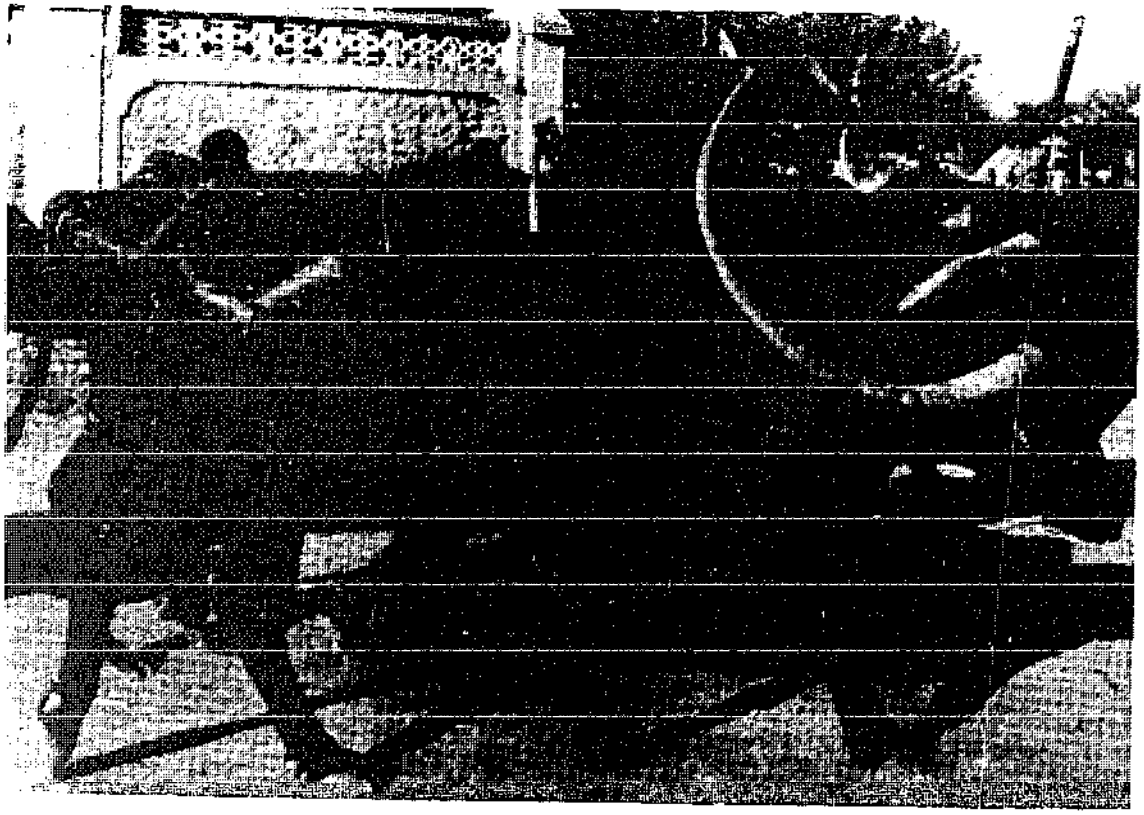


FIGURE 8. — Pandharpuri buffaloes, Maharashtra, India.

FIGURE 9. — Pandharpuri buffaloes wallowing.

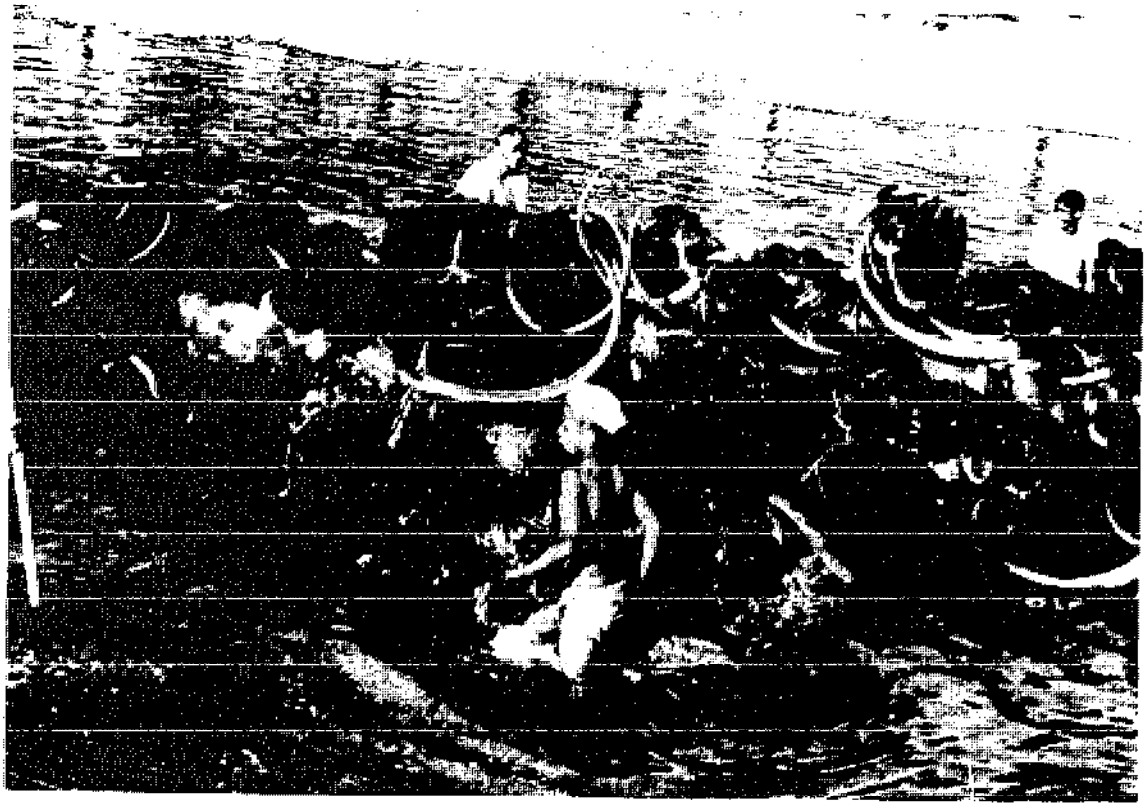


FIGURE 10. Male Surti buffalo.

FIGURE 11. Hand-milking a Surti buffalo.

FIGURE 12. — Nondescript *desi* buffaloes carting cotton. The load is about 800 kg per cart. Note wooden wheels.

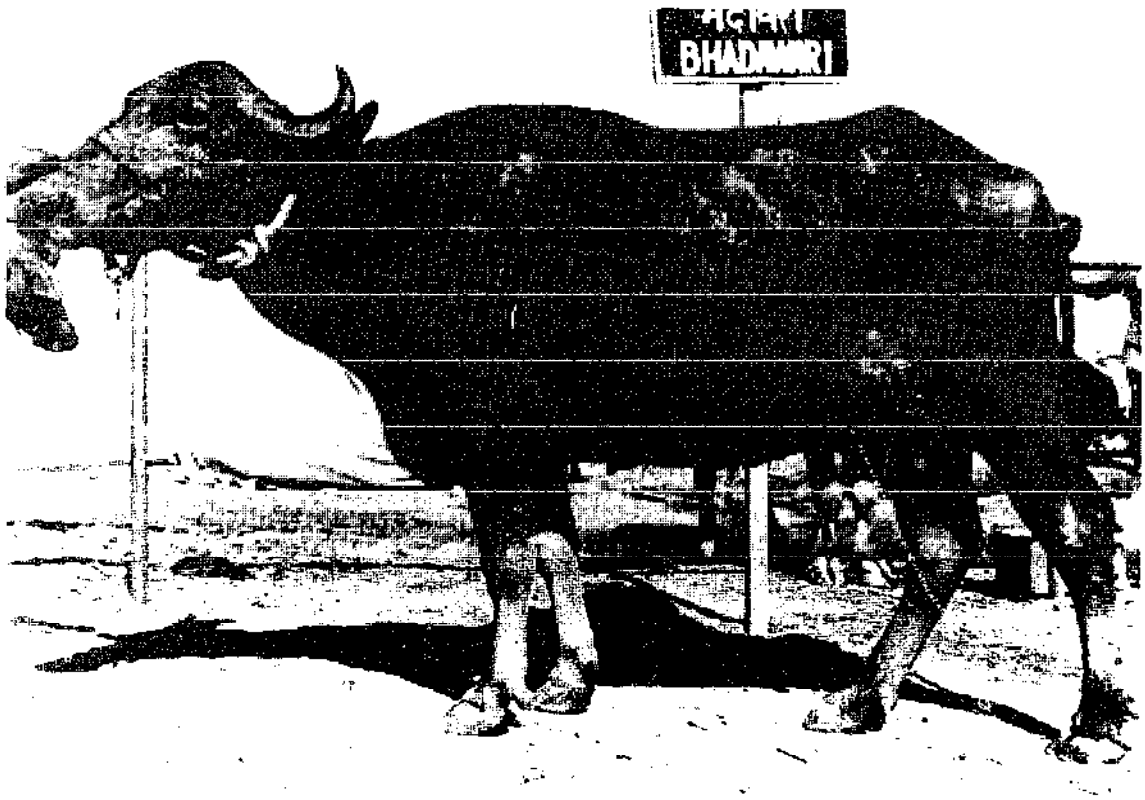


FIGURE 13. Female Bhadawari buffalo.

FIGURE 14. - Piebald Nagpuri buffalo, Mysore, India.

FIGURE 15. — Egyptian buffalo female and calf.

FIGURE 16. — Male Egyptian buffalo.

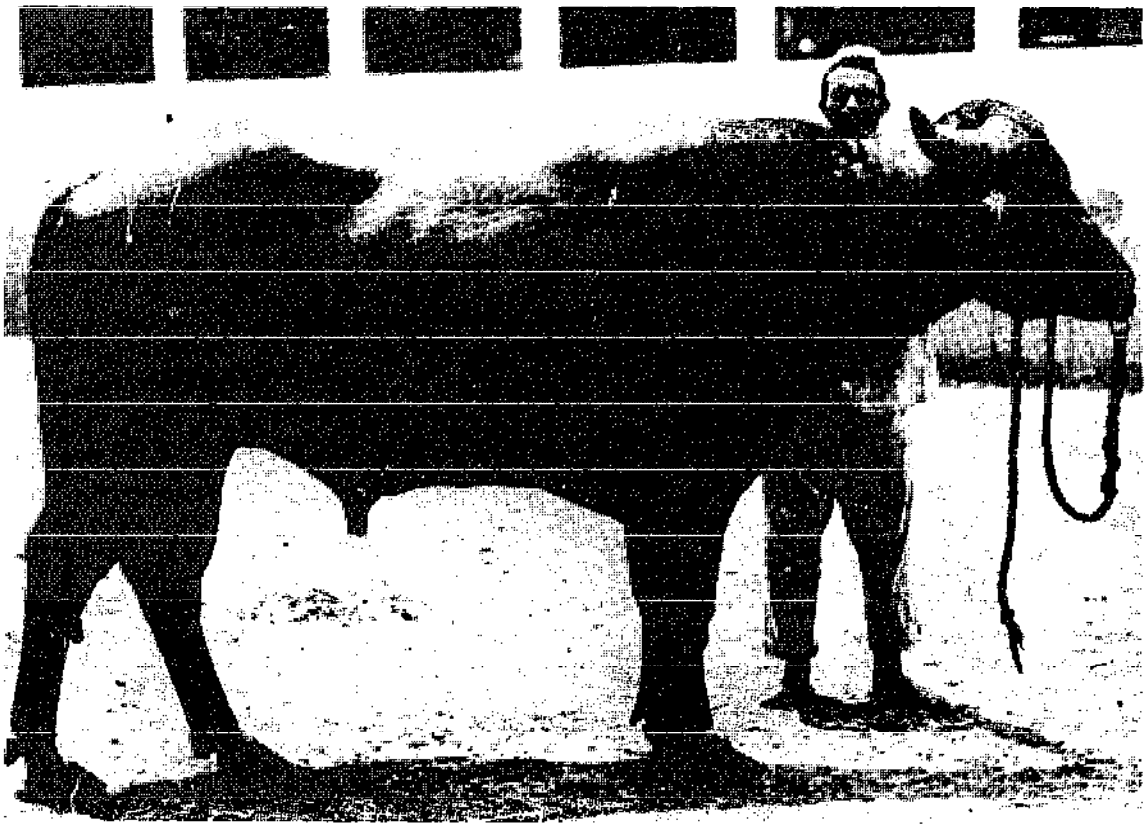


FIGURE 19. — Kosilho, i.e., swamp buffalo on the island of Marajó, Amazonia, Brazil, where they are used for cartage and as riding animals.

FIGURE 20. — Morning milking at Porungaba, Araçatuba, São Paulo, Brazil. The "Preto" buffaloes were introduced some 60 years ago from Italy, where the one-legged stool is common. The calf is present to ensure milk letdown. Note, in foreground, massive scarring which follows dehorning operation.

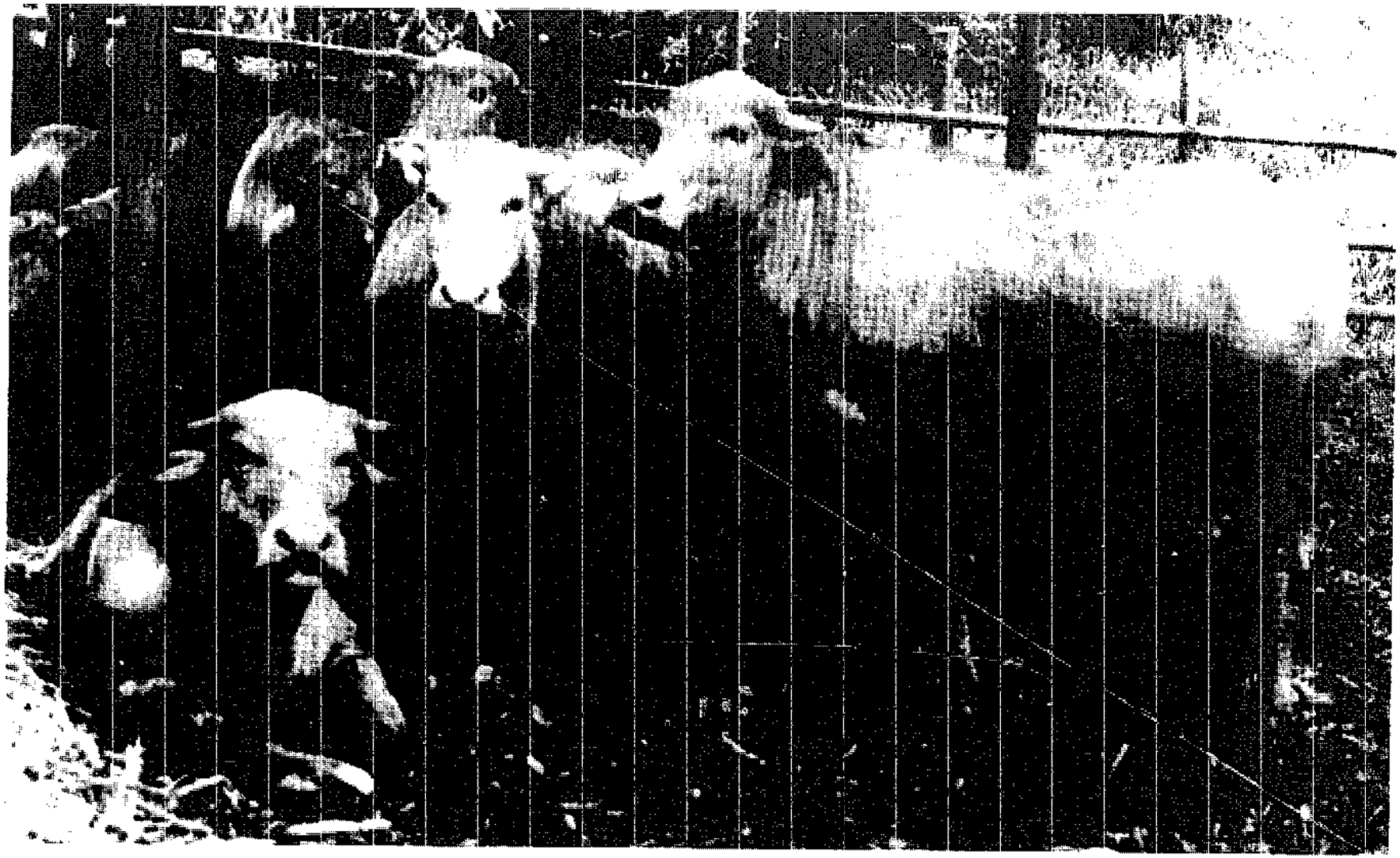


FIGURE 21. "Buffalypso" calves the beef breed being systematically established in Trinidad. Selection factors are weight, early maturing and fertility.

part II - the w :ter buffalo: world distribution

12. THE BUFFALOES OF THE INDIAN SUBCONTINENT

The domestic buffaloes of northern Nepal and those of Sri Lanka are of the Swamp type. In southern India both Swamp buffaloes and River breeds are kept.

In most of the states of India and in Pakistan, buffaloes of the River type have evolved into well-defined breeds. Many of the buffaloes are, however, of a nondescript, mongrel character, and this applies also to those of Bangladesh.

Large consignments of Murrah, Nili-Ravi, Kundi and Surti buffaloes have been exported to many countries to improve local livestock. Other breeds, such as the Jafarabadi, have also been successfully introduced into lands in which buffaloes did not exist until recent times, for example Brazil and Trinidad.

The wild arni, to which the domestic buffalo is closely related, continues to live in the grass jungles of the plains of the Ganges and Brahmaputra, in Assam, in the Terai of Nepal, and in parts of Orissa and of Mandhya Pradesh. The so-called "wild buffaloes" of Sri Lanka may be the feral descendants of domestic buffaloes.

The buffaloes of India

Archaeological evidence of buffaloes and of extinct species has been found in several areas of India.

It is known that 5 000 years ago the people of Mohenjo-Daro had humped cattle, buffaloes, elephants and camels, and the domestic buffalo was highly esteemed in southern India 2 000 years ago. In Tamil folklore it was a symbol of rural prosperity. There is reference to the quality of buffalo milk in the literature on mythology.

Before the development of the present dairy industry, buffaloes were kept throughout India. A typical family would own a pair of working oxen, several buffaloes and the young stock. The pair of oxen is still the

basis of agriculture and much of the rural transport, and the buffaloes still do the work required for rice-growing.

Buffaloes provide the milk with the high fat content that is used for the preparation of ghee. The urban milk supply of Bombay, Delhi, Calcutta and other cities depends on the improved breeds of dairy buffaloes. In Madras, Bangalore, Coimbatore and other southern cities, the crossbred European and Zebu breeds of cattle predominate.

Buffaloes provide much more than half the milk and almost all the ghee consumed in India.

A commendable amount of research has been undertaken in India. Many valuable papers have been published on a wide variety of aspects of buffalo husbandry and health. Abstracts are used in the present publication.

FAO estimates for the number of domestic buffaloes in India in 1974 were 60 million, and for cattle almost 180 million. The buffalo population appears to be increasing at the rate of around 1 million per year. The states with the largest numbers of buffaloes are Uttar Pradesh, Andhra Pradesh and Punjab.

There is a strong demand for replacement females for urban dairies and for herds in the vicinity of the new dairy processing plants. The removal of the best females is causing concern in some states. Rural breeds are being upgraded by the introduction of superior quality males and by the increasing range of artificial insemination services. Because of the reluctance to slaughter, many calves born in dairy herds are allowed to die, and a serious loss of good breeding potential is thus incurred.

It is common practice to stall-feed milch buffaloes. Grazing is wasteful and fodder crops under irrigation produce very high yields of green feed. Some urban dairymen have no land at all and buy all the feed required.

Milk colonies were established to accommodate thousands of animals removed from the cities, where the urban milksheds and animals had become insanitary hazards. Some of the largest milk colonies are the Aarey Milk Colony, Maharashtra, Haringhata, West Bengal, and Madhavaram, Madras.

Before the Aarey Milk Colony was established, the dairies in Bombay comprised about 25 000 buffaloes; at present there are about 15 000 in the colony and 75 000 in greater Bombay. Although there is an improved standard of management, there is, at the Aarey colony, the problem of cost of removal of manure to districts that can make the best use of it. At Haringhata, the situation is better. There is ample land for growing fodder crops and it is being progressively extended.

In some of the states there are farms operated by the departments of animal husbandry or by the universities. Herds of buffaloes are

subject to breeding and management systems of great value to the buffalo world.

In rural areas many farmers keep a few buffaloes, usually tended by the women.

In Gujarat, a migratory system of buffalo husbandry is practised. A milk plant was established to induce the nomadic people to settle but they have shown little willingness to comply.

The all-India average lactation milk yield is about 500 litres and the maximum in a village herd would be about 1 000 litres. For state farms and milk colonies the average ranges from 1 000 to 2 400 litres, and the average length of lactation from 270 to 327 days. Yields of 4 000 litres have been recorded in several states.

Recent investigations showed that although the cost of maintenance of Murrah buffaloes was higher than that of Hariana and Rathi cows, the buffaloes were more efficient milk producers. The overall cost of production per litre of milk was as follows: Murrah, 1.40 rupees; Hariana, 1.75; and Rathi, 1.70. Analysis of costs showed that of the total expenditure fodders called for 39 to 41 percent, labour 18 percent, upkeep of males 5 to 8 percent, plus interest on capital, depreciation, etc.

The standard of nutrition of buffaloes in most rural and urban areas throughout India is very poor. Deficiencies depend on local conditions, such as the availability of green fodders from irrigated land and the cost of ingredients of concentrate feed mixtures. Much useful research on nutrition of the buffalo has been planned as a comparison with dairy cattle. Some of the results are mentioned in the chapter on nutrition (see p. 48).

Most milk-producing herds are fed straw and *kadbis* or chaffed sorghum, with concentrates, mineral supplements and salt. Green fodders include para and guinea grass, lucerne and berseem. Molasses and urea are fed in some establishments.

The effect of heat stress on production and reproduction have also received a great deal of attention in India. See the chapter on the effects of climate (p. 30), and that on reproduction (p. 35).

Recent investigations show that reduced breeding rates are due to heat stress in the majority of cases and that suitable management practices during the hottest months can improve the records. Conception rates were better in buffaloes that were maintained on improved levels of nutrition, although there was little difference in the incidence of oestrus.

Most buffalo calves are born during the rainy season, in August and the autumn. Buffalo females that calved in August had the shortest calving intervals.

The value of good management systems is shown by analysis of the

breeding recor of five military farm herds during a period of 16 years. Of the females, percent had calving intervals of one year.

The expansion of artificial insemination has already been referred to. In spite of technical difficulties some good results are evident. Higher conception rates are recorded following the use of fresh semen; the best results are in winter. Semen quality is at its best during September and October.

Calves born during the first half of the year had higher weight gains than those born in the second half. For selection of buffaloes for weight gain as calves, the ages recommended for weighing are 4 weeks, 12 weeks, and 18 months of age.

In southern India, the injection of vitamin A was believed to help early sexual development. Feeding copper sulphate to milch buffaloes at the rate of 0.5 g daily was followed by a reduction in the calving interval.

The average age at puberty of Surti males was 23 months and the average liveweight was 297 kg. The age at first calving of buffaloes kept in village herds is usually as late as 4 to 5 years. Females of improved breeds kept under good conditions of management calve down at a much earlier age.

The average birth weight of 565 Indian buffalo calves was 29.06 kg, and by 2 years of age they had attained an average of 348.54 kg.

Apart from working in rice-growing districts, buffaloes are not used for draught purposes so much as Zebu bullocks. Oxen are quicker at road work and more resistant to heat stress and the effects of the sun's rays. In the rice-growing areas it is said that a milch buffalo can work three hours a day without adverse effect on milk yield.

The buffaloes of Pakistan

Water buffaloes have been domesticated in the valley of the river Indus from prehistoric times. A seal of the Mohenjo-Daro epoch of approximately 2500 B.C., depicting a male Swamp buffalo, is to be seen in the Lahore museum.

The estimate of the buffalo population in 1974 was slightly more than 10 million, and increasing steadily. The estimated number of cattle was 13 million, and thought to be increasing, but at a slower rate than the buffalo population. In and around the cities, buffaloes have virtually displaced cattle.

The largest buffalo colony in the world is that at Landhi, near Karachi. There are about 40 000 buffaloes and their average per caput milk output is three times that of the cattle of the colony. The estimated total value

of products per head per year for buffaloes is 347 rupees, that for cattle 80.5 rupees.

The buffaloes in the colony have very little exercise and there are no wallows, but they are sluiced down twice daily before milking. The colony comprises many herds and some owners may have up to 250 buffaloes. When it was established, it was planned for Red Sindhi cattle but they are rapidly being replaced by buffaloes, which are found to utilize the available feed to much greater advantage and to yield approximately twice as much milk.

There are, in Pakistan, 18 military dairy farms, all managed with a high standard of efficiency. Some have facilities for pasteurization and others have plants for the manufacture of powdered milk. They supply a daily ration of milk or milk products to every serving soldier.

The cost of whole milk puts it beyond the means of most Pakistanis but toned milk is sold at less than half the price. It is nutritious, having 12 percent total solids but a low fat content.

Intensive selection for high milk yield, early maturity, younger age at first calving and shorter calving interval, along with improved nutrition and management systems are leading to the evolution of breeds of dairy buffalo that are superior to exotic breeds of dairy cow in the Pakistan environment.

The three breeds are the Nili, the Ravi and the Kundi. The first two are almost indistinguishable and are generally considered to be a single breed, the Nili-Ravi. They are described in the chapter on species, types and breeds (see p. 10).

The Nili-Ravi has been found to be the most profitable breed in some large production units. The highest yields, up to 4 000 kg in a lactation, are recorded for individuals of the breed. Averages for government farm herds were 2 000 to 2 700 kg, with 6.9 percent fat.

Some comparative performance data are shown in Table 16.

Of the Nili-Ravi buffaloes in the government farm herds, 39 percent had lactation yields of 2 700 kg or over.

It is estimated that buffaloes produce 63 percent of the milk used in Pakistan. The average butterfat content is around 6.8 percent, but individual animals give very high fat percentages, up to 13 percent.

Kundi buffaloes are smaller than Nili-Ravi but many are excellent dairy animals. Lactation yields of 1 350 to 2 000 kg are common averages. The best individuals have recorded yields of 2 700 to 3 200 kg.

Improved strains of males are bred on government farms and sold to farmers at subsidized prices. Progeny testing has been instituted and there are plans for artificial insemination services.

Extremes of air temperature are regularly recorded in Pakistan. In

TABLE 16. — AVERAGES FROM SEVERAL SOURCES

	Nili-Ravi	Indian cattle
Birth weight	37-39 kg	20-24.5 kg
Weight at puberty	469 "	220-281 "
" " first calving	624-628 "	302-331 "
" " maturity	760 "	313-367 "
Age at puberty	955-960 days	812-930 days
" " first calving	1 366 "	1 166-1 323 "
Calving interval	524 "	413-539 "
Gestation period	308 "	285 "
Daily growth rate	0.5 kg	0.2-0.4 kg
Milk, lactation	2 444 "	1 355-1 760 "
Daily milk yield	4.58 "	4.35 "
Butterfat	6.7 %	4.3 %
Solids nonfat	9.1 "	8.5 "

some districts there are summer temperatures of over 38°C, while in others the night temperature may be as low as 4.5°C. The measures, already discussed earlier, to protect buffaloes from stresses must be adopted.

With good management, buffaloes will breed in the off-season. Vasectomized males are used in some establishments to detect females on heat.

Most of the intensive dairy herds are well managed and high nutritional levels are maintained. Green fodder is plentiful all the year round in the valleys of the Sutlej and Ravi rivers. Sorghum, maize, clovers, alfalfa, turnips and green oats are fed, usually chopped. Concentrates, fed according to milk yield, include cottonseed cake, wheat bran, crushed barley, maize and gram; they may be fed dry or slightly moistened. Rock salt is also provided. Molasses is fed in winter, smaller quantities being given in summer.

Milking buffaloes of small farmers subsist on green fodder and may get a small ration of concentrates during lactation. A high level of nutrition, with adequate green fodder, minerals and vitamins brings on early sexual maturity and regular breeding, but it must be maintained

continuously. Many owners provide salt licks with mineral supplements. Some high-yielding milch buffaloes are given 0.5 kg of a bland oil once a week.

In many districts oxen are preferred for road work. They are quicker in pace than buffaloes and suffer less from heat stress.

Buffaloes are widely used for cultivation of padi fields, for road haulage, water-raising and as pack animals. They are much stronger than bullocks and better workers in muddy environments. Their hoofs are massive, compact and black; they are shod for road work. Road transport is gradually becoming mechanized, but in rice-producing areas changes will take place much more slowly.

Bells and amulets are commonly worn by working buffaloes and by many milking animals as well. A hollow brass ring, containing small pebbles, is often placed round each fetlock, and emits a musical jingle as the buffalo moves.

Both cattle and buffaloes are slaughtered in Pakistan. Beef from cattle is preferred. This is due to the poor quality of buffalo meat on the market, which is usually from old working animals. Meat production has not received the attention it merits. Buffalo veal is not much esteemed and many calves are killed for their skins. Buffaloes castrated as calves, reared well and fattened intensively, will attain a liveweight of 500 kg at 3 years of age. Trials of economic feeding systems are needed. Dressing-out percentages of slaughtered buffaloes are low, because most are old and not fattened.

Owing to the high cost of keeping dry females, owners generally sell them for slaughter after only one or two lactations. Few calves are reared in the milk-producing herds. The demand for replacement stock increases, and the best females are removed from breeding districts.

Outbreaks of foot-and-mouth disease occur from time to time. Deg Nala disease causes losses in some rice-growing areas and is becoming more widespread. Vaccination against rinderpest and haemorrhagic septicaemia is compulsory.

The animal husbandry and veterinary services made available by the Government could be considerably increased with great advantage to many establishments.

The buffaloes of Bangladesh

Prior to 1971 the buffalo population was estimated at 500 000. Since then the country has suffered earthquakes, typhoons, floods and war. It

is thought that the total number has been severely reduced and that there is a deficit of at least 40 000 working buffaloes at the present critical time.

Most of the buffaloes of Bangladesh are of nondescript types, varying considerably in size, conformation and colour. Evidence of Swamp buffalo blood in their ancestry is seen in the numerous specimens that have typical chevrons. Albinoids are also found.

Dairy breeds include the Murrah and Nili-Ravi. They show wide variation in the size and shape of horns; loose horns are common and are considered to indicate good milk yields. Light brown buffaloes are often seen.

Breeding is generally haphazard but fertility is high. There are two calving seasons, January-February and August-September. On government farms the age at first calving is 3 years and the calving interval 13 to 14 months. Many females continue to produce calves until they attain 20 years of age.

During the months of May to July when temperature and humidity are high, very few buffaloes are seen to come into heat. Rainfall brings no improvement.

Daily milk yields range from 5 to 16 litres, with at least 8 percent fat. Buffaloes are milked twice a day and are allowed to wallow for one hour. Small farmers keep a few buffaloes. Some are milked and the yields are usually very low, but good examples are recorded of up to 12 litres a day at the peak of lactation.

The level of nutrition is generally very low, but dairy herds may get padi straw, wheat bran, rice bran, peas or oil cake in addition to grazing.

Buffaloes are preferred for agriculture and for road haulage. Working buffaloes are of the Swamp type, with short horns. Many continue to work until they are 16 years old, some much longer. Males are chosen for work. Quite a number are castrated at about 5 years of age by crude and cruel methods.

Buffalo meat is usually of poor quality and is not in great demand. The rearing of calves and fattening for slaughter at between 1 and 2 years are recommended to produce a high quality product that would overcome the prejudice against buffalo meat.

The general level of nutrition of the human population is one of the lowest in the world.

A sound official policy for improvement of working and dairy buffaloes and increasing their numbers could make a significant contribution to the rehabilitation of the country.

Foot-and-mouth disease is ever present, usually in a mild form in buffaloes. Vaccination programmes, particularly the campaigns to control

rinderpest, attained notable success until they were interrupted by the recent national calamities.

Tail necrosis is prevalent.

Calf mortality may be as high as 60 percent in some herds, the main causes being the roundworm *Neoascaris vitulorum*, and lack of care and hygiene. Many parasites flourish.

The buffaloes of Nepal

Estimates of the number of domestic buffaloes vary widely. The FAO figures for 1974 were 3 831 000 for buffaloes and 6 535 000 for cattle. The buffalo population seems to be increasing gradually.

The large cattle population is maintained almost exclusively for manure which, as fertilizer and fuel, is extremely valuable. The prohibition of slaughter of cattle imposed by the Nepalese civil code, and the heavy penalties for violations, preclude the economic maintenance of dairy cattle on any major scale. Buffaloes, on the other hand, provide milk, meat and agricultural power.

The native buffaloes are small and sturdy; adults weigh 270 to 450 kg. They are of a shorthorn type, dark grey or black, with good hair coats. The predominant Swamp ancestry is indicated by the chevrons seen in many specimens. They have suffered from generations of indiscriminate cross-breeding and now are of a nondescript type, though well adapted to the rigours of the environment.

They are commonly kept at altitudes of 2 500 m and pastured at up to 3 500 m. In the Daulagiri area of western Nepal they are pastured for a few weeks in the summer at approximately 4 500 m.

Large numbers of buffaloes of a mixed Murrah type are moved from India into Nepal, some are slaughtered in Katmandu, and many are kept for breeding. The Murrah type is becoming accepted as the dairy animal. A few Surti buffaloes, and other breeds, have been introduced.

Buffalo breeding in Nepal would benefit from a national upgrading policy, but the essential management skills must be taught. The government livestock stations in the Terai and in Katmandu valley could be used as focal points for breeding units. Trials should be made with Nili-Ravi, Kundi and Surti types. The working buffaloes would be improved by the introduction of good work/meat Swamp types.

Wild buffaloes still persist in some districts but their existence is threatened by the extension of agriculture. The establishment of a national reserve for the wild buffalo is advocated and additional support for the Chitawan national park.

Buffaloes are used for the cultivation of padi land. In the Terai and in the midlands of Nepal they are also kept for haulage work and for milk. The nature of the countryside is such that animal power is essential and mechanization will not make any significant impression for a very long time.

Cord bridles are worn, with the thong through the nose perforation. Nose rings are rarely seen. Few animals are castrated.

Buffaloes produce about twice as much milk as cows in Nepal. Native Nepalese buffaloes yield around 500 kg in a lactation period of eight to ten months, in addition to rearing a calf, estimated to consume 300 kg. Butterfat average is about 7.5 percent. Imported Murrahs yield, on average, 1 200 litres. There is a good market for milk in the towns. Ghee is one of the major exports. Toned milk is sold in some towns. A sweetmeat made from condensed buffalo milk is popular.

The level of nutrition is low. Animals exist on poor rough grazings and straw. Pastures are overgrazed, particularly during the dry seasons, and production is seasonal. The feeding of concentrates is very limited and no fodder crops are grown. Pasture management should be demonstrated and practised, trials of fodder crops and their conservation are needed, the breeding of useless cattle should be restricted by widespread castration. Large areas of land suitable for livestock development are available.

The majority of calves are born from August to October. The age at first calving is from 3 to 5 years. The calving rate is about two in three years, but some may calve every year. Although the productive life may be long, the number of calves produced by a buffalo may be as low as three to six.

Buffaloes do not have the religious protection afforded to cattle and buffalo meat is in good demand. It is estimated that 160 000 buffaloes are imported annually from India for slaughter. They are mostly non-descript Murrah and *desi* types. They trek long distances. Journeys of ten days are quite common and the animals live off the roadside grazing on the way. About 250 buffaloes are slaughtered daily in Katmandu where there are approximately 50 small butcheries. Carcass yields are estimated to be as low as 40 to 43 percent.

Meat may be bought with its part of hide, or hides may be bought separately. They are cooked fresh. It seems to be a characteristic of buffalo meat that it can be palatable and tender when cooked within a few hours of slaughter. Some meat and hides are dried, smoked and stored. Bones are scraped, dried and used as fuel.

Much ritual slaughter and many sacrifices take place in Nepal. Decapitation by a single stroke of the kukri is required. At the great Hindu

festival in October in Katmandu hundreds of buffaloes, goats and chickens are slaughtered.

Production of milk, meat and their products could be increased in Nepal. Improvement of nutrition by all means available is of supreme importance. Selective breeding of animals best suited to the environment, and attention to the control of parasites, especially of liver fluke, should be given high priority.

The establishment of herds of pure Murrah buffaloes at the government livestock farms, to provide quality sires for local stock, was suggested, along with many other recommendations, by the FAO mission to Nepal in 1971.

Rabies causes economic losses and is a grave danger to public health.

The buffaloes of Sri Lanka

Buffaloes were probably taken to Ceylon by the early Sinhalese in their migration from northern India about the sixth century B.C. In recent times there have been numerous importations from India, mostly of Murrahs, with some Surtis and a few Mehsanas.

FAO estimates for the number of domestic buffaloes in 1974 were 716 000; and of cattle 1 673 000. The buffalo population appears to be declining slowly.

The working buffalo is of the Swamp type, a small animal, its liveweight rarely exceeding 320 kg. Colour varies from light fawn, which is the commonest, to jet black; in sunshine the hair may appear to be red or auburn. Animals of this type are distributed throughout the country, but are most numerous in the rice-growing districts. Albinoids are unknown.

The nose is pierced and the halter cord is passed through. Nose rings are not used.

An official system of marking requires a brand on one rump to indicate the district and village and, on the other side, a serial number. Certificates of identity and ownership are issued. Intricate patterns are branded on many animals at the time of castration. They are intended to ward off the evil eye, to prevent loss of condition following castration, and to ensure long life. The practice may have originated in the past as a deterrent to buffalo rustling when many were stolen and slaughtered for the value of the hides alone.

Most males are castrated by crude methods, in spite of the efforts of the efficient veterinary service to encourage the use of the bloodless castrator.

The working buffaloes are used for the traditional cultivation of padi land. In some places the *jijuk* system is still practised. Some owners of large numbers of buffaloes hire out working animals for the season. In the intervals they are turned out in the vicinity of forest land with very little supervision.

During the time of preparation of padi fields for rice planting, the working buffaloes are kept close to their work. They graze the bunds and may be given rice straw, cut grass or banana leaves.

Buffaloes are also used for threshing out the rice by trampling on the sheaves. In the Kandy area, they puddle clay for brick-making; two small buffaloes plod round and round in a circular pit, about 4 m in diameter and 50 cm deep, in wet clay, for about an hour. They may puddle four lots of clay in a morning.

Oxen are preferred for road work.

Few Swamp buffaloes are milked. They yield about 1 to 2.5 litres at the morning milking, the calf being suckled freely during the day and separated at night. Lactation periods are short, rarely exceeding 250 days.

Large herds of Murrah and Murrah × Swamp buffaloes are kept at two government farms. Great variation is noticeable in size, colour, markings, horn shape and tail length. Entire males run freely with the herds. Seasonal breeding seems to depend on the availability of good quality fodder. Periods of shortage and of surplus milk alternate.

The age at first calving is around 4 years and is influenced by the seasonal breeding pattern. The calving rate is two calves in three years, but on one farm the calving interval is only 13 months.

The average lactation yield in one herd is 1 400 kg in 270 days. Concentrates are fed during lactation.

Most of the buffalo meat is derived from old animals at the end of productive or working lives and is inevitably of poor quality. Some males are, however, castrated at 2 years of age and slaughtered at 3 to 4 years. There is a growing demand for meat and production of a good quality product should be increased rapidly.

Buffaloes may not be slaughtered under the age of 12 unless they are certified to be affected with infertility, intractability, incurable disease, lameness or blindness. This restriction impedes the development of a meat industry. Neither buffaloes nor cattle are accorded religious protection but many people are vegetarians or eat very little meat.

Extensive land areas are available in the drier districts which would be suitable for rearing beef cattle and buffaloes. There would appear to be a potential market for buffalo veal.

Vaccination against haemorrhagic septicaemia and anthrax is general and, on the government farms, against foot-and-mouth disease and black-

leg. Brucellosis is known to be present in some herds. Liver fluke disease is not widespread. In some areas the rearing of calves is hindered by heavy infection with roundworms unless regular control measures are taken.

13. THE BUFFALOES OF BURMA AND THAILAND

The buffaloes of Burma

Burma affords a natural site for Swamp buffaloes. Murrahs have been introduced from India over many years and now are believed to constitute about one twentieth of the buffalo population. The rest are Swamp or Swamp × Murrah crossbreds.

The buffalo population was severely reduced during the second world war, but there has been a steady increase in recent years. FAO estimates for 1974 were 1 800 000 for buffaloes and 7 800 000 for cattle.

Herds of wild buffaloes are said to live in the Chin hills but it is not known whether they are truly wild or feral. The gaur or pyaung and the banteng or saing also exist in the hill forests of Burma.

One of the tenets of Buddhism is the prohibition of killing any living creature. Even the use of insecticides may be resisted. Accordingly, many unproductive or diseased animals continue to be a drain on available feedstuffs. Animals cannot be reared for slaughter by orthodox Buddhists.

About 68 percent of all cultivated land is under padi rice. The buffalo is of prime importance in all stages of rice-growing.

Elephants are used for handling heavy timber in the teak forests, but buffaloes are employed for dragging logs on easier ground at loading points or on the banks of streams. Pairs are yoked together and as many as five pairs may be hitched to a heavy log. The strongest males are selected for work. They are usually castrated at 3 to 4 years of age, the weaker males being left to wander freely and sire most of the calves. The nose is pierced and a rope halter with a cord through the nose perforation is worn permanently.

Training for work is a gradual process and may not be completed until 4 years of age. The working hours are, as a rule, from early morning to midday, then the buffaloes rest, graze and wallow, often in charge of children.

The Burmese are not fond of fresh milk or dairy products, apart from condensed milk, which is imported in considerable quantity. Some milk

is sold in Rangoon and other towns, but the price is too high for most families. Local cattle are poor milkers. Murrahs and crossbreds average about 4 kg daily, with up to 15 kg at the peak of lactation. The lactation period is around 240 days. The life span average is 15 years. The first calf is born at 4 years of age, and the calving interval is 14 months. Dairymen are generally of non-Burmese origin and live apart.

Meat, where it is available, is inevitably the end product of a long working or productive life. Many aged animals are turned loose to live out their time. The sources of animal protein are limited and few people can afford them. Slaughtering is done by Muslims; it is generally crude and wasteful.

Veterinary services have been extended and vaccination programmes, especially those against anthrax and haemorrhagic septicaemia, have made good progress. Further efforts to control rinderpest by vaccinating cattle and buffaloes along the frontiers with Assam and Bangladesh are urged. A crippling fixation of the stifle joint is frequently seen in working bullocks and buffaloes. The condition can, in many cases, be remedied by surgery.

Sarcoptic mange is widespread and causes serious loss in calves. Heavy parasite loads borne by livestock have a detrimental effect on growth, production and work capacity.

The general level of nutrition is poor. Much of the grazing land is interspersed with scrub. The ability of the buffalo to thrive where cattle barely exist is often demonstrated in Burma. Disorders caused by mineral deficiencies are suspected; investigation of a possible copper deficiency, for example, is needed.

The dry season in Burma is a serious obstacle to livestock production. The introduction of fodder crops that have been developed in other regions with similar climatic conditions should be attempted. The need for qualified advisory officers to advise owners on practical husbandry and health measures is emphasized.

The buffaloes of Thailand

With the exception of a few local introductions, the buffaloes of Thailand are of the Swamp breed. FAO estimates for 1974 were 5 700 000 for buffaloes and 4 800 000 for cattle.

Within the Swamp breed there are several local strains which are claimed to have special characteristics. These are not well defined and refer chiefly to such features as size, heat tolerance and horn conformation. The differences may be largely the result of varied environ-

mental factors, nutrition and management practices over many generations.

Some of the local strains are *kwai tui* of the central plain, *kwai kam* of the uplands, *marid*, which is supposed to be of Burmese origin, *kwai jawn*, the little buffalo, and many others including *kwai jaam*, *kwai pra* and *kwai glapp*.

Colour, markings and conformation are typical of the Swamp type, size being the essential difference. White or albinoid buffaloes are plentiful, up to 30 percent in the north but only about 5 percent in the central plain and southern Thailand. They are favoured in some districts where they are considered to be more heat-tolerant than dark-coloured animals.

Half of the country's cattle and buffaloes are kept in the northeastern region. From there they are sold as draught animals for the central plain or for export. The numbers in the region may be declining. Approximately 3 000 buffaloes are exported to Hong Kong and Peninsular Malaysia every month. The daily slaughtering rate at the Bangkok municipal abattoir is from 100 to 150 buffaloes, and many more are slaughtered in small district slaughterhouses.

The average liveweight of buffaloes exported for slaughter is gradually declining. In the 1960s it was around 600 kg and at present the range is 400 to 450 kg. The lowest liveweight permitted for export has been reduced from 400 to 380 kg.

For a number of years in the past a government policy of inspection of males, with castration of unsuitable individuals, led to the breeding of big, heavy, powerful buffaloes weighing 700 to 800 kg at 3 to 4 years of age.

In the south, where the climate is favourable and fodder abundant, the buffalo population has been reduced through excessive exports. In other areas too many males are kept because of the traditional preference for males for work. Some could be replaced by females, say three females to two males. Extra feed would be needed for the additional adults and calves. The possibility of cooperative calf rearing should be studied.

Some of the rice land should be used for other crops. Farmers who have land in excess of their own domestic rice requirements should be encouraged to grow cassava on a small area; the residues are useful for feeding to buffaloes. Other crops might be tried. Forage crops can be grown in many places without any reduction in the annual rice crop.

In trials comparing growth rates of Brahman grade heifers with selected buffalo heifers, on native pasture, with rice straw and supplements for one year, the average daily weight gain for buffaloes was 0.34 kg, that of the cattle only 0.29 kg. During the season on luxuriant pasture growth the daily gains were 0.62 and 0.44 kg respectively.

In Thailand, it is a common sight to see a buffalo with two or even

three offspring of different ages still running at its side. Male calves should be weaned before attaining 12 months of age, castrated and removed for fattening under range conditions.

Identification marks are rarely applied unless required for sale or export.

Castration is generally performed by primitive methods, but government veterinarians carry out tasks of that kind in some districts. The castration of males is often delayed until the animal is fully mature and has sired progeny.

Most farmers have a few buffaloes for agricultural work and haulage in the rural areas. They are trained for work at about 3 years of age. There are many instances of working capacity continuing at a useful level long after the normal 10 or 11 years. Both sexes are used for work in rice cultivation. The working season varies from 66 days per year in the north to 146 in the central plain. The cost of keep in the intervals is negligible.

The ideal working buffalo is selected on the basis of evidence of strength and suitability for the work to be done; superstitions also influence judgement. Mechanization is progressing more rapidly in Thailand than in most other countries in the Far East, but it will be a slow process in the remote districts.

The practice of hiring buffaloes for the cultivation season is becoming more widespread. The Swamp buffaloes are often looked after by children when they are not at work. They are docile but may resent the presence of strangers. They defend their calves with courage and have been known to kill tigers.

There are no regular breeding seasons or programmes; calves are born in all months of the year.

Swamp buffaloes are kept for milk production in urban areas and there are also herds of Murrahs and crossbreds. The dairy animals are usually owned by Muslims. With good management and nutrition the Swamp types will give yields of 700 to 1 200 kg in 270 to 300 days. The average yield of the Murrah crossbred is from 4 to 6 litres per day through a lactation period of ten months.

The demand for milk and dairy products is becoming stronger. The importations of condensed and dried milk and butter could be replaced by home production.

Very few cattle or buffaloes are raised specifically for meat. There is a considerable demand for the home market and for export.

The average liveweight of male buffaloes slaughtered in the principal abattoirs ranges from 404 to 534 kg. Most of these animals are retired from a working life. They are generally transported by truck, rail or boat. Considerable losses are incurred by bruising.

The slaughter of male buffaloes of less than 8 years of age is prohibited, and of females under 15 years, unless certified. However, the regulations are largely ignored.

Poultry and seafood are cheaper than meat. Marketing of animals destined for slaughter is inefficient; they often pass through the hands of two or three dealers on the way. Prices in the Bangkok market are unstable and there are no facilities for holding animals when there is a surplus. The risk to the final dealer is reflected in the low prices offered all along the line.

Buddhists do not slaughter animals but some may eat products of those that are dealt with by other people. There is some resistance to the meat of albinoid buffaloes.

Cash crops have priority over fodder crops in most agricultural areas and buffaloes are often restricted to the poorest grazing. There are suitable lands for ranching and government livestock stations might usefully give a lead. Buffaloes of a beef type are being displaced by mechanization; they should be diverted to the development of meat-producing herds. When properly reared and managed, the buffalo makes an excellent meat producer.

Very wide differences in growth rates are reported in the various centres, but young buffaloes grow as fast as, or faster than, cattle in the same local environment.

Carcass yields, at present averaging only about 45 percent, would be greatly improved by the slaughter of younger, fat animals.

Haemorrhagic septicaemia, the most serious health hazard, is controlled by the government veterinary vaccination programmes. Foot-and-mouth disease vaccines are produced in Thailand and the disease is gradually being limited. Rinderpest is kept out by vaccination campaigns along the frontiers with affected countries.

Fluke infections are prevalent, screwworm and lice are widespread, and sarcoptic mange causes the death of many calves. Parasitic conditions are most damaging during the dry seasons when the level of nutrition is lowest.

14. THE BUFFALOES OF MALAYSIA, SINGAPORE AND BRUNEI

The buffaloes of Malaysia

The buffaloes of the three separate parts of Malaysia, Peninsular Malaysia, Sabah and Sarawak are discussed separately.

Peninsular Malaysia

Most of the buffaloes are of the Swamp breed. They have distinct chevrons and large, handsome horns. Some Murrahs have been introduced in recent years and crossbreeding with Swamps has been successful.

Almost 40 years ago, Macgregor studied the buffaloes in what was then the Federation of Malaya. He described the fundamental differences between Swamp buffaloes and the River breeds. Macgregor noted the similarity of the Swamp type to the wild arni and considered that the River breeds are descended from buffaloes which no longer exist.

Little official encouragement has been given to improving the domestic buffaloes or to increasing their numbers, which may be declining slowly.

FAO estimates for the total buffalo population in Peninsular Malaysia in 1974 were 205 000 for buffaloes and 330 000 for cattle.

An efficient system of registration is in operation. Buffaloes are tattooed in both ears. The owner is given an official certificate which records the date of birth, distinguishing marks, and the tattoo numbers. The headman of each district keeps a register of all the buffaloes in his area. Sales and transfers are recorded. It is thought that rustling and contraband movements do not occur.

Buffaloes are widely used for ploughing, harrowing and grading the padi fields, for road haulage and in forestry operations. In Penang they are used for oilseed milling.

Halters are worn and the thong passes through the nose perforation; it is held there by a plug in the right nostril. Buffaloes are seldom castrated and, although fights do occur occasionally, they are normally docile. Fights are pushing matches, with heads down and shoulders and withers in contact; seldom is any damage caused. The struggle goes on until

one runs from the scene, hotly pursued by the victor for a short distance.

In forest districts, where buffaloes fend for themselves in the periods between cultivation seasons, they customarily wear wooden bells that give distinct, musical notes and help the herdsmen to find them. Albinoid buffaloes are common and may make up perhaps 3 percent of the Swamp buffalo population. There is a legend of bad luck associated with the colour and, as a result, they are not very popular. Twins are very rare.

In and around the towns and some villages, herds of milking buffaloes are kept, most of them by Indians. It is estimated that there are about 5 000 milking buffaloes, principally Murrahs. Swamp types are rarely milked. The calves run freely with their dams.

Milk is sold raw, frequently adulterated and some of it is produced in insanitary surroundings. Yields seldom exceed 1 000 litres in a lactation period of 300 days. This is higher than the yield of local cows and the butterfat content is also much greater, thought to be around 7 percent. The Hindus and Muslims esteem the ghee, but a cheaper product is now produced from vegetable oils.

Buffaloes generally graze on inferior pastures and few get additional feed. Cropping programmes should be diversified, and such crops as groundnuts and maize and fodder plants should be given some emphasis. There are considerable areas of land in Peninsular Malaysia that could be used immediately for ranching buffaloes for meat production.

The human population is generally well fed. Fish and poultry are usually plentiful. The level of nutrition of the inhabitants of rice-growing areas, however, is often very low before harvest time. Deficiencies of proteins and vitamins lead to malnutrition even when there is no actual starvation. Buffalo meat and dairy products would be helpful.

A high proportion of the buffalo meat is derived from old working animals, but it is esteemed. The official religion is Islam and pig meat is not eaten. Beef is a luxury. Buffaloes are imported for slaughter, although they could be reared in the country. Ranching under oil palm or rubber and other specialized plantation trees should be investigated. The humid forests, where the seladang or gaur and the banteng formerly lived and flourished but are now almost reduced to extinction, might be used for water buffaloes as in some other countries where feral buffaloes are harvested for meat.

A buffalo may be sacrificed when a house is to be erected, the head and feet being buried beneath the central post. The meat is invariably eaten. Albinoids are not considered to be suitable for sacrifice.

Malaysia enjoys a relatively high standard of animal health. The veterinary services have controlled the major contagious diseases of animals. Johne's disease and parasitic conditions are stubborn problems

in areas of irrigated land or marshland. Lameness in cattle and buffaloes occurs in the rice-growing districts of the state of Kelantan and may be due to a phosphorus deficiency. Mineral licks with salt are beneficial. Chemical studies of livers suggest that copper deficiency may be present throughout the land. If supplements were supplied in some districts an improvement in growth rates might be observed.

Fibrinous pericarditis is found in buffaloes from time to time. It may be caused by thorns of mimosa penetrating the wall of the stomach. Buffaloes will browse on mimosa leaves; cattle rarely do so.

It is a common practice in many areas to clip or shave the hair in order to control lice. Often the skin is massaged with mustard oil or similar preparations to make it supple and shiny. The horns may be similarly anointed.

A large quarantine station is in operation close to the frontier with Thailand to control imports of livestock and prevent the introduction of exotic diseases.

Sabah

Water buffaloes are not indigenous to the great island of Borneo. They have been introduced into the four states — Sabah (north Borneo) and Sarawak of Malaysia, Indonesian Kalimantan, and Brunei.

FAO estimates for the number of domestic buffaloes in Sabah in 1974 were 80 000, and for cattle 23 000. They are all of the Swamp breed, small and sturdy, seldom exceeding 700 kg liveweight. A shorthorn type is not uncommon. Chevrons are usually well defined but some upper chevrons are indistinct; the lower one is often very large and some have forked extremities. There is a superstitious prejudice against forked chevrons but they are useful as identification marks. Rustling is rife and identification is important.

Buffaloes play an important role in the economy of the country. Rice is the staple food of the people of Sabah and buffaloes are used for cultivation of padi fields, for haulage, pack and riding and for powering sugar mills. Buffalo racing is a popular sport.

The *jijak* method of preparing padi fields is still practised. Groups of buffaloes are driven round and round the flooded area to churn up the soil and to press down the weeds. For transport, a light bamboo sled or trevis is often used. Working buffaloes are allowed to wallow for an hour or two during the heat of the day. They are generally broken to work at 2 to 3 years of age but, where they are ranched, they may be selected and trained as late as 5 years. The nose is pierced and a wire or rattan ring inserted. The Hong Kong type of self-piercing nose ring

is becoming popular. Buffaloes are rarely castrated; entires are thought to be better workers than castrates.

Ear notching is the method of identification. Where notches are found to be duplicated the tail may be cut.

Very few buffaloes are milked. A small herd of milch Swamp buffaloes is kept at Tenom. They are milked once a day, giving an average yield of 3 litres per day in a lactation period of about 200 days, in addition to the calf's needs. Salt is given but no concentrate ration.

The "buffalo bank" system is common and leads to local overstocking of pastures. Some young animals are sold for slaughter at around 20 months of age and 200 kg liveweight.

Swamp buffaloes cannot be combined with fish farming; they wallow in the fishponds and break down the banks. Murrah buffaloes, however, prefer running water and can be used in the vicinity of fish farms provided there are running streams available for them.

The first calf is born at around 2½ to 3 years of age and thereafter a calf is produced about every 18 months. Twins and albinoids are unknown.

Many people in Sabah have never eaten meat from cattle but buffalo meat is popular. Several large herds are kept in ranch conditions in well-watered, open forest country. The animals are very timid. When they are needed for work or meat they are lassoed from horseback with a loop of rope on a long bamboo pole.

Coarse salt is given twice a week at the rate of 20 kg for 100 animals. It prevents the buffaloes from becoming completely wild.

Peasant farmers rear a few buffaloes for slaughter at 2 years of age and upward. About three quarters of the buffaloes slaughtered are dressed in government slaughterhouses. Good quality young buffaloes find a ready market in Hong Kong and other centres. Large areas of land suitable for the extension of buffalo breeding are available for development.

Hide foods are not prepared as in many other countries in the Far East, but a soup is made in some localities by prolonged boiling of hides and bones. Hides are fed to pigs in some villages. There is an expanding trade in wet salted hides to Hong Kong and Singapore.

The animal health status is highly satisfactory; even haemorrhagic septicaemia is of minor importance. The roundworm of calves, *Neoascaris vitulorum*, is probably the most damaging parasite, causing diminished growth rate and many deaths. Severe infections of roundworms and flukes are commonplace in adult buffaloes but it is impossible to assess the extent of damage that they cause. Lice are controlled by shaving the hair coat.

Buffaloes play an important part in tribal customs and ceremonies. They are sacrificed at ceremonies for new buildings or at funerals and weddings. A skull and horns may be planted in a field to keep evil spirits at bay. For wife purchase, at least two buffaloes are paid by the bridegroom to the father of the bride.

Sarawak

Sarawak, the "green desert," is largely tropical rain forest. Kampongs and longhouse communities are established on the banks of the rivers. Agriculture is primitive in most places. It is estimated that there are about 8 000 buffaloes, all of the Swamp breed and rather small, up to 400 kg in weight. There are also about 10 000 cattle.

Buffaloes may be seen in small groups grazing along the levees. They do not go into the rivers, except during drought periods, and prefer static water. The rivers flow swiftly and have steep, muddy banks; young buffaloes may be drowned in fast-flowing currents. Periods of drought and flood are frequent.

Females are protected from slaughter unless they are barren, incurably ill, lame, blind or intractable. But laws are often disregarded in jungle country and many female buffaloes of all ages are slaughtered in the kampongs.

Buffaloes are seldom castrated. The majority are kept in a semiwild state and only rounded up when needed for meat or for short stints at the *jijak* method of preparing padi land. Many are merely kept as status symbols and for sacrifice at family ceremonies. Some tribes buy wives with one to six buffaloes. The Muruts kill buffaloes by one stroke of the parang. If one stroke does not sever the head completely it is considered to be an unfavourable omen and the meat is not eaten.

The Department of Agriculture in Sarawak has done much to stimulate interest in the proper ways of using buffaloes. Demonstrations of training, harnessing, ploughing and harrowing are arranged and selected working animals are available at a low price. The veterinary service gives free vaccination, treatment and routine surgery as required and losses have been greatly reduced.

Singapore

Agriculture is intensive and highly specialized. Market gardening is the main occupation of most farmers; pigs and poultry are included in

some holdings. Less than one sixth of the total land area is cultivated and more than half of that is in rubber or coconut plantations. Buffaloes are kept for milk production, most of them by Sikhs. They were introduced from India about 40 years ago.

The buffalo population appears to be static at around 3 000 head. There are some 8 000 cattle.

The buffaloes are mainly Murrahs and nondescript crossbreds. They are of good size, averaging about 750 kg liveweight, and are well tended.

Most of the buffaloes are slate grey or black, many have white stars, socks and tail switch. Light brown specimens are common, some of them with black freckling of the skin. Albinoids are sometimes seen, and walleyes frequently. Horn shapes are very varied: curled, sickle-shaped, and downward-pointing.

No buffaloes are allowed within 16 km of the city. Buffaloes and cattle found straying on the roads are confiscated, slaughtered without compensation, and the meat is given to charitable organizations. Some 800 buffaloes were removed from the city in recent times to a milk colony, where they are regularly washed down and allowed to wallow briefly in a small pond. The Sikh owners are convinced that milk yields decline if wallowing is not allowed. At another milk colony the buffaloes are allowed to wallow for at least two hours each day in a large pond fed with fresh water. They are also washed down twice daily and rubbed with coconut oil.

Some small Murrah herds are kept by the Chinese population.

All milking is by hand, and is done by men. An average yield of a good milch buffalo is about 12 litres a day in a lactation period of 240 days. This is much higher than the yield of local cattle.

The age at first calving is 2½ to 3 years; the calving rate is two calves in three years. One male is kept for 30 females. Twin calves are known but are very rare. The majority of buffaloes have productive lives of at least 12 years.

Feed consists of cut grass, gram, pineapple waste and an occasional ration of concentrates, with unrefined brown sugar. Some salt is also provided.

Buffalo meat is popular in the Chinese communities. Many entire males are imported from Thailand at about 5 to 6 years of age and slaughtered after ten days in quarantine.

The health of the buffaloes is generally very good. Some abortion, tuberculosis and parasitic conditions occur, but no details of the incidence are available. Calf mortality is high and probably averages around 75 percent.

Brunei

Relative to the size of the country, the buffalo population is large and is steadily increasing. FAO estimates for 1974 were 17 000 for buffaloes and 2 000 for cattle.

The buffaloes are of the Swamp breed. The upper chevron of many animals is indistinct or missing. Tails reach the hocks, some are shorter, and some may be cut for identification. Many buffaloes live in a semi-feral state in forest areas. Living in shade they are light-coloured and the bare skin is pink.

A few Murrahs were introduced into the animal breeding farm for crossbreeding trials with local Swamp buffaloes, but the two types remained segregated and did not crossbreed. It is necessary to rear calves of the two types together or to adopt artificial insemination.

The forest herds are regarded as capital assets and prestige symbols. Groups are rounded up for sale or for *jijak* cultivation of padi fields. They are also needed for wife purchase.

Buffaloes are used in timber haulage. When employed in very strenuous duties they are given drenches of beer or rice wine and have a liberal allowance of salt.

Mechanical cultivators are superseding animal power in some districts.

Buffaloes are identified by ear notches and are officially registered. Nevertheless some rustling persists.

Working buffaloes have a pierced nose and the usual halter. Few are castrated.

The age at first calving is said to be around 3. The calving interval is 13 months and the productive life at least 15 years.

Buffalo meat is popular. Regulations forbid the slaughter of females below the age of 7, but enforcement is difficult, and many are slaughtered at wedding feasts and other ceremonies. Methods are primitive and often inhumane. Considerable numbers of buffaloes are imported from Thailand for slaughter, but Brunei could become self-supporting in meat.

Hides are not conserved. In the villages they are usually fed to dogs.

There are few diseases that cause serious losses in buffaloes in Brunei. Parasitic conditions are prevalent, calf mortality is high, mainly due to *Neoascaris vitulorum* roundworms and poor management. Sarcoptic mange, lice and leeches are widespread. The official veterinary service is active in projects to reduce the losses due to parasites. Inflammation of the membrane covering the eye and lining the lids is frequently seen in both cattle and buffaloes. In many cases it is due to irritation by the hooked awns of love grass, *Chrysopogon aciculatus*. Opacity of the cornea of the eye is often observed.

15. THE BUFFALOES OF DEMOCRATIC KAMPUCHEA, LAO AND VIET NAM

The buffaloes of Democratic Kampuchea

During the rainy season in August to October, the river Mekong and its tributaries overflow and flood an area of about 2 million ha. This causes many problems, but not for the buffaloes, which survive and thrive.

FAO estimates for buffaloes in 1974 were 840 000; and for cattle 1 800 000.

The buffaloes are of the Swamp breed. Two strains are vaguely distinguished: a longhorn type, *krabey beng*, of the high forest regions; and a shorthorn type, *krabey leu*, of the plains. There are variations in size but the typical Swamp markings are common to all types, though chevrons are not always clearly defined.

Albinoids are common and there are no popular prejudices against them. Owners do not believe that twinning ever occurs.

Some Murrahs were imported in 1923 for crossbreeding with local Swamp buffaloes, but the experiment was not successful.

Two small herds of Murrahs have recently been brought from India but no crossbreeding has been attempted.

Wild buffaloes are hunted for sport in the open forest areas of two provinces. It is not known whether they are truly wild or the descendants of domestic buffaloes that became feral in times past. They are found in small herds of 5 to 15.

Buffaloes have been associated with religious festivals for centuries. Many are concerned with agriculture and the rise and fall of the water levels. Bas-reliefs at Angkor, of the ninth to thirteenth centuries, show buffaloes in ceremonial procession and also suckling calves. Today buffaloes wallow blissfully in the royal bath under the gaze of the heavenly dancers carved in relief in stylized postures.

Domestic buffaloes are always gently handled. They are usually controlled by a simple rope halter. The nose is pierced early in life but nose rings are not applied. Many buffaloes carry a small metal or wooden bell. They are used almost exclusively as working animals. When they go to work the calves go with them. They are generally

broken to work at about 3 years of age, usually by yoking with an experienced animal.

When not at work they are often tended by children. Rural dwellings are erected on stilts and the domestic animals are stabled below. Both male and female buffaloes are worked; they are allowed ample rest and wallowing periods during the heat of day. The working life is at least twice that of cattle. Many old animals are allowed to live out their lives peacefully when they are no longer capable of work.

Buffaloes are also used for road haulage, timber operations and water-raising.

No attempt is made at selective breeding. Castration is generally delayed until the animal is about 5 years old. It is often done by crude methods and with unfortunate results. The first calf is produced at about 4 years and the calving rate is two calves in three years. Calves may be suckled until they are 12 months old.

Branding, tattooing and horn marking are not used. Registers of ownership are maintained in the provinces. The size, girth, marks and scars, location and type of hair whorls are noted in the certificates of ownership.

There are some illegal movements across the frontiers by nomadic peoples.

Little consideration is given to nutrition. Fodder crops are not grown nor are concentrates fed.

Milking was practised in ancient Cambodia and milk products played an important role in religious rituals. At the present time milk production is practised on a very limited scale. Mixed milk is sold in Phnom Penh. Condensed milk is imported and has a ready market.

Much of the meat sold is derived from animals that can no longer work, so it is of poor quality. Slaughtering is done by Chinese or Muslims. The slaughter of females under 9 years of age is prohibited in most provinces. There is potential for meat production for the home market and for export to neighbouring countries where there is growing demand.

Foot-and-mouth disease, rinderpest and haemorrhagic septicaemia have caused serious losses in the past, more especially when they occur during the season of cultivation of padi land. The veterinary service has steadily improved in efficiency and extends to all provinces. The vaccines required can be produced in the country. Rabies in buffaloes is recorded less frequently than in cattle; cases are usually the result of a bite by a rabid dog in the region of the muzzle. Liver flukes are found in nearly all the buffaloes slaughtered in Democratic Kampuchea. A kind of conjunctivitis, that generally clears up in three or four weeks without leaving

a permanent defect, is often seen in older buffaloes. Sarcoptic mange is a severe affliction of calves in some seasons. Other parasitic conditions do not appear to cause serious problems. Calf mortality may be about 25 percent during the first year. Losses caused by predators are severe in some districts.

Lao

The population of domestic buffaloes had been growing steadily but declined sharply during the war. FAO estimates for 1974 were 1 040 000 for buffaloes and 464 000 for cattle.

The buffaloes are all of the Swamp breed and are kept mainly for the cultivation of padi rice. Some are sold for slaughter in the towns and many are sacrificed in ritual ceremonies in the villages.

Buffaloes are regarded as evidence of wealth. Some are rented out for work during the cultivation and harvest seasons. Payment is made in rice. Buffaloes are also to be seen working on the roads.

In the area along the river Mekong the *bahnar* type of buffalo is prized. It has big hoofs and is particularly suited for work in the padi fields.

Some local peoples refuse to sell their buffaloes to those outside their own community, partly from spiritual conviction and partly because they are so dependent on them for the production of their food. The buffalo spirit ceremony is carried out by all the tribes. An elaborate ritual accompanies the sacrifice of the carefully prepared buffalo offering to the spirit. A sympathetic appreciation of beliefs and practices of rural communities is essential in any attempt to introduce changes in animal husbandry.

Training for work starts at 4 to 5 years of age. The trained buffalo responds to about six different vocal commands. The animals are castrated by ligature of the neck of the scrotum at 9 months of age. The fibre ligature is tightened from time to time and the whole process is a gradual shrinkage of the testicles.

Most of the calves are born in the dry season. It is believed by the rural people that fertility is improved by service while the pair are wallowing.

Very few buffaloes are milked. Sugared buffalo milk is sold in some restaurants in Vientiane.

Buffalo meat is an important source of animal protein for all the peoples of Lao. Following ritual sacrifice, the meat, viscera and hide are cooked in a variety of ways and are eaten. In some villages animals that die from natural causes are also eaten. Little is wasted.

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Viet Nam

FAO estimates for 1974 for the number of buffaloes in the then Republic of Viet-Nam and in the Democratic Republic of Viet-Nam were 501 000 and 1 764 000 respectively. The estimated number of cattle was 853 000 and 899 000.

The major concentration of buffaloes is in the south and central lowlands. The great majority are of the Swamp breed and are used for work, with increasing emphasis on meat production. The size and quality of many of the animals are impressive. This is remarkable considering the practice of corralling them at night and the overgrazing of pastures.

The big buffaloes of the plains closely resemble those of Thailand. Many weigh 1 000 kg or more. In the mountainous area of central Viet Nam the buffaloes are smaller. Conformation, colour and markings are typical of the Swamp type. Chevrons are usually large and distinct.

Albinoids probably form 4 or 5 percent of the total population. There is no prejudice against them and they are thought to work as well as the darker buffaloes. Twinning is very rare.

As a result of the prolonged state of war the economy suffered severe dislocation. Rice production fell dramatically and large areas were abandoned. With the end of war and the introduction of new rice varieties production is recovering.

Buffalo rearing is, in most cases, a family enterprise. Most farmers keep about four buffaloes for agricultural tasks. Breeding is haphazard. Many buffaloes are castrated at the age of 5 or even 6 years.

A halter is worn permanently with a thong through the perforated nasal septum.

The level of nutrition is low. Rough grazing is usual, with aquatic plants in all the floodlands. Additional rations are seldom given.

In addition to agricultural work, buffaloes are used in sugarcane crushing and in forestry operations. Cattle are preferred for road work but some buffaloes are seen pulling carts.

Herds of milking buffaloes, mainly Murrahs and Nilis, are concentrated near the towns and cater to a small consumer market. The demand for dairy products, though limited, is increasing.

Until 1960 the slaughter of buffaloes below the age of 12, except in circumstances permitted by the veterinary service, was prohibited. Now slaughter is allowed, with a tax on those under 10 years of age. There is no tradition of rearing for meat. Since 1955 the number of buffaloes slaughtered has risen steadily, especially in urban areas. There is now a preference for buffalo meat, particularly in the Chinese communities.

The buffalo could make a much greater contribution to human nutrition

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16. THE BUFFALOES OF CHINA, HONG KONG AND OKINAWA

The buffaloes of China

In prehistoric times wild arni ranged over the whole of southern China. There are now no genuine wild buffaloes in the region. Water buffaloes were domesticated in China thousands of years ago. The climate was probably warmer then and bones of buffaloes have been found much further north than the present range. Evidence has come to light indicating that the Shang people kept buffaloes around 1400 B.C. Cattle were, however, more important at that period. In ancient Chinese mythology there was a God of Stockbreeding and a god for each kind of domestic animal. Several centuries before the Christian era one of the Taoist Supreme Triad came to earth to teach men how to live. He was the great master Lao-Tsi, and he departed riding a buffalo westward.

Many superstitions and prejudices have been discarded in modern China. No animals are seen carrying charms, nor are they involved in sacrifice or ritual ceremonies.

Domestic buffaloes were introduced into Taiwan, China, in the sixteenth century.

Including those in Taiwan, there are around 30 million buffaloes in China and the population is growing progressively. The estimated number of cattle in 1974 was just over 63 million. These figures may be too low.

Most of the buffaloes in China are in the rice-growing areas of the south and east.

Until recent times, the Swamp or Shui niu (water ox) was the only breed in China. River breeds have been introduced for crossbreeding programmes. There are about 10 000 Murrah × Swamp crosses in Guangxi Zhuangzu Zizhiqu (Kwangsi Chuang Autonomous Region).

Chinese Swamp buffaloes vary widely in size, conformation, colour and horn shape. They are typically dark slate grey and the sparse hair may be grey or black, with some long, brown hairs. The tan, or "reed-flowered" variant is common; it is of a light grey-brown shade. Most buffaloes have well-defined chevrons but, in a few specimens, they may

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be no more than traces, or the upper chevron may be missing. The lower one may have forked extremities.

The typical buffalo has grey stockings and usually one or two flecks on each side of the face. Many have a fine "moustache." The skin of the lower parts of the body and legs may be bright pink, especially in young animals and in those that are housed. No piebald or spotted specimens are seen. The number of albinoids varies in different provinces, but they are completely unknown in some areas.

Typical horns are thick at the base, triangular in cross-section and sweep back almost in a half circle, tapering to the tip. They become heavily ridged with age but, in China, horn rings are not considered to be reliable indicators of a buffalo's age.

Hoofs are massive, black or yellow-brown.

The typical Chinese Shui niu is a small, heavily built animal, with wide chest, large belly and short legs; it gives the impression of a meat type and is heavier than it looks. Many small buffaloes of about 300 kg are seen in the southern provinces. The biggest buffaloes in the country may weigh up to 850 kg.

Many types have been described as breeds, generally named after the districts in which representative numbers of the type are bred. Their classification as breeds is not justified, since specimens of all the described local types may be found in most of the buffalo provinces.

Some average weights and measurements recorded by the Livestock Research Institute, Nanning, for full-grown adult buffalo types are (in round figures):

Type	Male	Female
Guangxi Zhuangzu Zizhiqu		
Liveweight	428 kg	385 kg
Height at withers	122 cm	110 cm
Ping hui, Hunan province		
Liveweight	495 kg	475 kg
Height	135 cm	127 cm
Jiangsu (Kiangsu)		
Liveweight	624 kg	614 kg
Height at withers	135 cm	131 cm

Selective breeding to arrest the decline in size of buffaloes is advocated. The importation of specimens of the big Swamp types from Thailand or Viet Nam would be a useful step in upgrading the small buffaloes of southern China. The very small animals should be culled.

Some fine examples of River breeds have been introduced from India and Pakistan and crossbreeding programmes are making good progress. Selective breeding for size is progressing at the Nanning institute and at the Livestock farm near Lu Hsu in Guangxi Zhuangzu Zizhiqu. The programmes are coordinated with crossbreeding of Swamp buffaloes with Murrahs and Nili-Ravis. Liveweights of crossbreds show an average superiority over those of local buffaloes of 100 to 120 kg and some individual liveweights of up to 940 kg are recorded.

The crossbred is a handsome, medium-sized animal, black, and with the long tail and white switch of the River breed parent. Chevrons are rare. Horns vary considerably in conformation; some are ugly. Dishorning of calves is recommended.

Other breeds, such as the Surti, Mehsana and Jafarabadi, might well be imported for use in controlled crossbreeding trials.

Male calves not required for breeding are castrated at around 1 year of age, but in rural districts they are left until they are about 4 years old and castrated after the spring ploughing is completed. Castration of mature animals is often performed under acupuncture anaesthesia.

Noses are pierced when the calf is 12 months old. A temporary ring is inserted, and after several weeks the permanent ring is fitted.

The Chinese countryman tends his animals with skill, care and ingenuity. It is customary for a buffalo to have two attendants, one at work while another feeds, grooms and cares for it. The buffalo responds to the voice of the attendant but is nervous when strangers approach.

In China, marking for identification is not a general practice but, should it become necessary, ear notches are cut. There is no system of certification. In Taiwan all buffaloes are registered and certificates record distinguishing marks.

In many areas the buffaloes are able to graze on pasture all the year round; only on the coldest days are they housed. In hill districts they are herded. In the rice-growing areas they are taken in small groups for controlled grazing, or tethered. They are often seen wearing wicker muzzles while being led through rice land.

Water buffaloes make good use of aquatic plants. They submerge completely in sluggish rivers and lakes and can stay under water for as long as two minutes. When they surface they may have a substantial mouthful of water plants.

During autumn and winter, they consume large quantities of rice straw and may get some bran, sweet potatoes, sugarcane tops and cut grass. In cold weather, thin, warm rice gruel is sometimes provided. Before the spring ploughing season bran and boiled vegetables are often fed and, in some localities, eggs and wine may be added. The state supplies salt for the buffaloes of the people's communes. It is generally given with fodder or dissolved in water and sprinkled over straw. Animals at work get extra rations.

The age at first heat is about 3 years. Most heat periods occur during the season August to November, the maximum being in September. The gestation period of the Chinese Swamp buffalo is said to range from 290 to 330 days, somewhat longer than that of Murrahs in the same environment. The calving interval of village buffaloes may be as long as 553 days. Silent heats are often the cause of these delays, but in some cases service is withheld so that calving will not coincide with cultivation programmes. Breeding efficiency of buffaloes in the people's communes could be greatly increased by appropriate management methods. At a research institute farm, calving intervals of 12 months are quite common. There are records of buffaloes calving at 29 years of age but, as a rule, service is withheld after the twelfth calving.

It is reported that about one third of the buffaloes in China are artificially inseminated and that the practice is extending, particularly in the southern provinces. The conception rate is said to be about 60 percent. Insemination twice, with an interval of 8 to 12 hours, increased the conception rate. A claim for an average conception rate of 69.2 percent is made by the A.I. service in Taiwan, China.

It has been estimated that 30 percent of the land is under rice. The system of padi cultivation has changed very little over the centuries. Although mechanization is making some progress, many more working animals are needed at the present time, and it is unlikely that they will ever be entirely replaced. It is a fallacy to regard the use of work animals as a sign of primitive agriculture; they can be the most efficient means of cultivation of land and of transport in rural areas.

Young buffaloes are easily trained for work, usually starting at 1 to 2 years of age, using a light yoke and small implements. They quickly learn to respond to the single rein. In Taiwan, China, on the other hand, young animals walk alongside the dam at work and become trained very gradually.

Much of the agricultural work of buffaloes is seasonal. The average is about six hours per day, six days a week, for about two months of the year. The day's work is interrupted by rest and wallowing periods. The harness used is similar to that seen in other countries of the Far East.

In China, with the exception of Taiwan, buffaloes are rarely used for road haulage. In Taiwan, however, they may be seen at this task all the year round. The feet are protected by shoes made from old tires, or of plastic, or woven straw pads tied on with cords.

The cost of maintaining working buffaloes during the long periods between seasons of agricultural work is very low, the average working life is long, and the animal is self-replacing.

Murrahs in Taiwan, China, are said to be more heat-tolerant than Swamp buffaloes. Mechanization is progressing and a decline in the buffalo population of Taiwan is already shown in the figures reported: in 1960 the estimated number of buffaloes was 324 516; in 1974 it was 127 843. Even so, there are twice as many buffaloes as cattle. The buffaloes released from work on the roads might be kept on in ranches and bred for meat production.

Buffaloes are also used for milling and water-raising.

Research undertaken at the Nanning institute shows wide variation in the work capacity of different types of buffaloes, depending on the size and weight of the animal. Capacity is also affected by the system of husbandry, working hours and rest periods and the kind of equipment used. Investigations at the Hengchun breeding centre in Taiwan, China, showed the maximum loading power of an adult buffalo female to be 869 kg (240 percent of the body weight) and the maximum traction power 370 kg (113 percent of the body weight).

Milk and dairy products have not been important items in the diet of the Chinese people in the past. There is, however, a growing interest in the production of milk for urban supplies.

Few Shui niu are milked, although there is a surprising potential and many useful milkers could be selected from among the large numbers available. A few herds of Shui niu are kept near towns and there are herds at the experimental institutes. An average daily yield of 2.15 kg plus the calf's intake has been recorded, with butterfat at 11 to 12 percent.

Murrahs at the Nanning institute gave average yields of 1 387 kg in 240 days; individual yields of up to 3 200 kg have been recorded. The Swamp buffaloes averaged 500 kg. Other reports give average yields for native buffaloes as 751 kg in 300 days, the best being 1 040 kg, with a fat content of 9.89 percent. The average for purebred Murrahs was 2 221 kg, the highest individual yielding 2 355 kg, with a fat percentage of 7. For crossbred Murrah × Swamp buffaloes the average was 1 658 kg, maximum yield being 2 527 kg, and fat content 8.87 percent.

A type of Shui niu bred in Zheziang (Chekiang) province and known as the Wen chou buffalo is stated to yield an average of 774 kg in

305 days. The best individual yield was 1 059 kg, and the fat content was 9.5 to 10.5 percent.

Milk production and consumption could be encouraged in the people's communes, but progress is bound to be slow. Ice cream is popular. The rich milk of buffaloes makes a very attractive product and there might be an industrial future for production on a wider scale.

Buffaloes are not reared specifically for meat production in China at the present time. Buffalo meat is generally derived from old working animals. It is sold fresh and is tough and unattractive. Beef and pork are preferred and attract higher prices.

Carcass yields are low, from 38 to 42 percent. Buffaloes from south China slaughtered in Hong Kong have an average carcass yield of only 37 percent, but that of cattle from the same provinces is even lower, 36 percent. The average liveweight of buffaloes from China is 330 kg, while that of buffaloes from Thailand is almost double that figure.

In Taiwan, China, the slaughter of females below the age of 12 is prohibited, except for barren, intractable or casualty cases. The average carcass weight of the Taiwan buffalo is 206 kg, that of cattle only 173 kg.

In 1974, 45 000 buffaloes were exported to Hong Kong with 55 000 cattle and 2 140 000 pigs. The buffaloes and cattle are generally poor culls. There is an outstanding opportunity to improve quality, quantity and economic benefit. The pig industry has made great strides.

Hand-fed Murrah calves at the Nanning institute attained an average liveweight of 120 kg at 7 to 8 months. Another report gives a liveweight average of 300 kg in ten months for purebred Murrahs, and for crossbred calves 265 kg. The average liveweight of Murrah × Swamp crossbreds at maturity was 582.8 kg for males and 458.8 kg for females.

Hides are made into many attractive and durable articles. There is an efficient leather industry. Horns are also made into useful and ornamental objects. Manure is carefully treated and used as fertilizer for the land. One buffalo produces a sufficient quantity to keep about 0.067 ha of land in good condition.

The development of livestock and the protection of animal health go hand in hand in China. Responsibility lies with the Bureau of Animal Husbandry and Veterinary Medicine of the Ministry of Agriculture and Forestry. Each province has its organization. Animal husbandry, animal health and quarantine stations are established wherever they are needed. Campaigns to control infectious diseases have been remarkably successful. Rinderpest has been eradicated. Prior to Liberation it caused devastating losses in working animals and, as a result, famine for millions of people in China.

Foot-and-mouth disease has been brought under control and almost

eliminated. Reintroduction is prevented by zonal vaccination along the frontiers at risk. Complete eradication will, it is claimed, be achieved within a few years. Other diseases that are being dealt with, and which will be eliminated eventually, are hog cholera, swine erysipelas, pasteurellosis, sheep pox and Newcastle disease of poultry.

Routine vaccination against haemorrhagic septicaemia has reduced losses to a very low level.

Cases of bloat occur frequently in the spring. These and other digestive disturbances are treated with herbal remedies. Sarcoptic mange is cured by washes made from herbs. Tung oil is used to kill lice and mange mites.

Emphasis is given to cleanliness and hygiene in rural areas as well as in the cities. Many of the afflictions that are spread by vermin and insects are gradually being eliminated. A campaign to reduce the populations of the snails that are intermediate hosts of the schistosome parasites of man and animals has made remarkable progress. Ticks and tickborne diseases are on the way out.

The training of medical auxiliaries, known as "barefoot doctors," has proved to be highly beneficial. This has been extended to the animal husbandry and health services, which are now combined. The young practitioners, who are able and dedicated, are known as "barefoot vets," though they are not, by western definition, veterinarians, nor do they go barefoot. Three levels of veterinary training are offered: a college course of three years, a professional school course of 18 months with emphasis on practical application, and short-term courses for trainees with practical experience in animal husbandry in the communes. In addition, there are opportunities to attend refresher courses, lectures and discussion groups. The question of providing for postgraduate studies is being considered.

Efforts are being made to combine traditional medicine with modern techniques. Over 2 000 plants are used in herbal remedies, and also such items as ground pearls, powdered buffalo horn, turtle meat, snake gall, tortoise-shell and freshwater mussels.

The practice of acupuncture is traditional. More than 1 000 acupuncture points are recognized. The insertion and vibration of the needles at determined points produce specific reactions as, for example, anaesthesia or increased liver function.

Acupuncture anaesthesia for surgery in large animals is reported to be effective in 88.6 percent of subjects and to be particularly useful in castration. Stainless steel needles of varying length, up to 10 cm, are used. After insertion, they are vibrated either by hand or electrically, using a 5 to 10 volt battery and a 50 to 100 cycle transformer. If the anaesthetized animal shows signs of discomfort, the rate of oscillation is increased

slightly. The effects of acupuncture continue for at least an hour after removal of the needles.

Buffaloes are said to respond better than cattle to acupuncture treatment, but for anaesthesia the frequency of oscillation of the needles needs to be higher to be effective.

The buffaloes of Hong Kong

The rapid expansion of the human population, housing, roads and commercial establishments have reduced the agricultural land to only 13 percent of the total area of Hong Kong. Production losses have been offset to some extent by more intensive methods and by the development of marginal land. Although the yield of rice per hectare has increased threefold, its production continues to give way to intensive vegetable gardening.

The number of buffaloes has declined surprisingly slowly in recent years. There are now about 2 000 buffaloes and 11 000 cattle.

The buffaloes are of the Swamp breed. They are kept almost exclusively for work, with meat as a by-product. They are small, sturdy, docile animals with the typical colour and markings of the breed.

The domestic buffalo is a valued possession and is treated with kindness and consideration. A simple cord halter is worn, with a single rein or tethering rope. Many kinds of nose rings are seen, and also many disfigured muzzles. The working lifetime is 15 years or longer. Intervals during the working day are allowed for wallowing, usually in a mudhole made by the buffalo. Castration is rarely found to be necessary. Males run freely with the females. Oestrus occurs at night or is silent.

Approximately 80 000 buffaloes are imported annually for slaughter. They are brought from China, Indonesia, Thailand and Democratic Kampuchea with smaller and fluctuating supplies from Lao, Australia and some other sources. Imports from Viet Nam have been interrupted because of the rinderpest situation there. Many different types can be seen in the lairages; from the small buffaloes of the southern provinces of China, which seldom weigh more than 340 kg, to the heavy, muscular type from Thailand with an average liveweight of 600 kg. There are many poor culls of mongrel character. They are all entire or castrated males.

There are two modern abattoirs in Hong Kong as well as a large animal quarantine station. Buffaloes are stunned by a modified captive bolt pistol. Dressing-out percentages are about 37 for the south China buffaloes and 50 for those from Thailand and Indonesia. Losses of up to

10 percent have been recorded in consignments transported by sea in stormy weather, but in fair conditions little damage is incurred.

Buffalo meat is popular in the Chinese community. It is sold at the same price as cattle meat. There is no process of cooling and maturing before sale.

The buffaloes of Okinawa

Approximately 300 buffaloes are kept on Okinawa island and the small adjacent islands, and there are about 845 on the islands of the Yaeyama region close to Taiwan, China.

They are kept for cultivation of padi fields and most farmers own at least one buffalo. Mechanization is gradually replacing draught animals. Small cultivators made in Japan are now used in many padi fields.

Buffaloes are also used for carting produce. The nose is pierced and a thong with plug applied. The single rein is the only means of control.

17. THE BUFFALOES OF INDONESIA, EAST TIMOR (FORMER PORTUGUESE TIMOR) AND PAPUA NEW GUINEA

Indonesia

Conditions are eminently suitable for water buffaloes in considerable areas of Indonesia. The annual floods in some localities are prolonged and other species of domestic livestock cannot be maintained in such places without great risk and attention. Swamp buffaloes are kept throughout the archipelago, mainly as working animals.

FAO estimates in 1974 for the number of buffaloes and cattle were 2 870 000 and 6 720 000 respectively.

Most of the buffaloes are kept by smallholders as working animals but there are also large herds living in a semiwild state and maintained mainly as prestige symbols. Some farmers own as many as 500 buffaloes, regarding them as a secure investment, the "buffalo bank" system. Batches are rounded up as required for sale or work.

There are wide variations in the size and colour of the buffaloes in different parts of the archipelago. The Toradja people of Sulawesi breed black and white spotted buffaloes known as *tedong bonga,* selected for strength and colour. They are never castrated. Many variations of the type are to be seen; white heads, piebalds and walleyes are common. Such animals are used for work, whereas the true *tedong bonga* are kept for fighting and ritual ceremonies. There are about 1 000 of these very valuable animals. They are massive, muscular and weigh up to 800 kg.

Murrah buffaloes were imported more than 50 years ago to provide milk for European planters. There are about 2 000 in north Sumatra, maintained exclusively for urban milk supplies. Very little crossbreeding has been attempted.

Buffaloes usually work in pairs. They are preferred for wet and heavy land, whereas cattle are favoured for the dry and lighter soils. The nasal septum is pierced by a bamboo spike at about 3 years of age and a simple cord halter is fitted.

Two buffaloes are required for the work involved in the cultivation of 1 ha of irrigated padi land. Ploughing, harrowing and grading are usually

done in the morning and the buffaloes then graze and wallow during the hotter hours. A report from another source states that a working pair can cope with an area of up to 5 ha. The majority of farms in the rice-growing areas are very small, many less than 1 ha. Owners of large herds hire out buffaloes and implements.

The small, agile Bali cattle — the domesticated breed of the wild banteng — are used for harrowing and grading the light soils of central Bali. They are more resistant to heat stress than buffaloes.

Buffaloes are used for road work in east Java. Entire males pull heavy, two-wheeled vehicles, usually attractively decorated.

The animals are shod with *trompahs* cut from old tires. They work through the night, at a steady 3 km per hour, taking produce to market. They are not allowed into the town, so they are outspanned at the boundary, fed, rested and sluiced. A small bell hangs from the buffalo's neck or from some part of the vehicle to give warning. Albinoids are not favoured, since it is believed that they work better by day than at night.

Buffaloes are also used as riding and pack animals. They were used in deer hunting in the last century. As many as 30 hunters, mounted on buffaloes, would hunt together in west Java. The deer carcasses were carried back on the buffaloes.

Sleds are occasionally seen in parts of Indonesia, but not so commonly as in Thailand and Malaysia. Buffaloes are also used in sugarcane and rice mills, but the use of animal power for such purposes is declining. They are, however, still employed in forestry operations for hauling heavy logs.

Buffalo racing is a popular sport in Bali; the animals run in pairs pulling a light cart. Only males are raced and the best are highly valued. They are given special rations which include bran, maize, rice and sometimes eggs and honey.

A traditional system of meat production practised in south Kalimantan is of particular interest. During the rainy season, November to April, vast areas are flooded and become covered with aquatic grasses and water hyacinth. Herds of around 150 buffaloes are kept, many in cooperative organizations, with a total for the area of about 10 000.

During the dry season platforms are made of hardwood logs high enough to keep a surface above the level of floodwater. At that season the buffaloes graze natural pastures. In the wet season they are corralled at night on the platforms; at sunrise they go down the ramp and graze while wading or swimming. They are herded by boys in small boats and are returned to the platform in the evening. Females with young calves stay on the platform for six to eight weeks after calving and are fed on cut grass. Calves remain on the platform until about 6 months of age.

Males are sold at about 2 years of age, when they weigh around 300 kg. Old females are sold at the end of their productive life; they weigh approximately 600 kg.

Insufficient numbers of buffaloes and of capital limit the expansion of this low-cost meat production system.

A similar system is seen in operation in the Amazon region of Brazil. See the chapter on water buffaloes in the Americas (p. 246).

In some parts of Java and Sumatra, buffaloes are kept partly to provide protection against tigers, which they attack quite fearlessly.

Where working buffaloes are castrated, the usual crude methods are used. As a result of the efforts of the government veterinary services, efficient and humane procedures are becoming general. The instrument known as the *pasuruan*, a kind of bloodless castrator, is one of the practical improvements on the old equipment. It can be made by the local blacksmith.

Identification systems vary from district to district; there is no standard.

Apart from a few isolated localities, no attempt is made at selective breeding, but some selected males are made available by the government services. Castration of undesirable males would help to improve local stock.

Fertility is generally satisfactory. Twinning and calving difficulties are extremely rare.

The nutrition of buffaloes receives little attention in Indonesia.

Milk production for urban supplies is largely in the hands of people of Indian origin. Indonesians are not inclined to enter the market. A few buffaloes are often kept in herds of dairy cattle to raise the fat level of the milk.

Murrahs give average yields of up to 7 litres per day in a lactation of up to 11 months. They are, as a rule, in poor condition, badly nourished and inefficiently managed.

Swamp buffaloes are milked in many places, generally once a day, and the calf sucks freely during the day. Yields are low, rarely exceeding 2 litres a day, with fat content at 7 to 8 percent.

Mixed cow and buffalo milk is sold in a few towns. A kind of soft cheese is made in the villages, and it is a beneficial addition to the diet of the inhabitants. A clotted milk product, with sugar or honey, known as *dadih*, is stored in a bamboo tube and eaten with rice. In the Toradja district of Sulawesi, a palatable soft cheese is made. The curdling agent is derived from a local plant instead of rennet.

A sweetmeat called *gulapuan* is made by condensing buffalo milk and adding sugar. Another product is made by boiling the milk and adding pineapple juice as it cools slowly. It is known as *tahu*.

Ghee is made from buffalo milk and is used for cooking, especially by the Muslims and Hindus.

Buffalo meat is eaten in all parts of Indonesia. It is derived from animals that are no longer able to work, except in the case of limited supplies from animals slaughtered for other reasons. Raising buffaloes specifically for slaughter is not practised but, when animal health conditions permit and shipping is available, there is a considerable export of buffaloes to Singapore and Hong Kong for slaughter. Large areas of government-owned land in Sumatra and Kalimantan are eminently suitable for ranching buffaloes for meat production. The possibilities in south Sulawesi are outstanding. Pasture improvement would not be difficult.

Only castrated males may be exported. The slaughter of buffalo females below the age of 6 is prohibited. They must have all eight permanent incisors and at least three horn rings.

Slaughter is generally by the Muslim method. Ritual killings are practised at family feasts and on other occasions. A prejudice against the meat of albinoids leads to the slaughter of those animals at an early age. Meat of buffaloes and of cattle command the same market price.

Blood is collected and sold. Strips of fresh buffalo meat rubbed with blood and sun-dried are prepared in Bali. The lips of buffaloes make a special delicacy known as *djingur*. A cooked hide food, similar to pork crackling, is enjoyed by all communities. It is known as *kerupik kulit*.

More use is made of buffalo horns in Indonesia than in most other countries. A great variety of useful and ornamental articles is fashioned, usually with a horn motif, and highly polished. Great carved wooden buffalo heads bearing natural horns decorate the homes of the Toradja people to keep evil spirits at bay. Buffalo horn amulets are worn to give strength and protection to the wearer.

There is a leather industry, producing heavy buffalo leathers. Many hides are exported, mainly to the Netherlands. A considerable industry in central Java is engaged in the production of figures and puppets for traditional shadow plays, the *wayang kulit*, of epic stories, tradition and folklore. Hides from buffaloes of Sulawesi, affected with sarcoptic mange, are preferred because the leather is thought to be thicker and stiffer.

All the epidemic diseases and parasitic conditions that afflict buffaloes in the Far East are reported to occur in one part or another of Indonesia. Losses are sometimes heavy in affected areas. The veterinary service is staffed by fewer than 200 veterinarians scattered throughout more than 3 000 inhabited islands, and they are faced by many problems. An extension of the service, with the production and use of greater quantities and a wider range of vaccines and medicines for livestock would encourage the expansion of livestock development.

The other species related to cattle and buffaloes and still existing in Indonesia are the Bali cattle, mentioned above (see p. 203), and the anoa, the dwarf buffalo or wood ox, of Sulawesi. The anoa is protected by law but as its flesh is very tasty, it is much sought after and may be in danger of extinction.

Complicated traditional rules and customs guide the lives of the rural peoples of Indonesia and they often call for the participation of buffaloes. An immense folklore involves the buffalo and a vast range of religious and magic practices govern the lives of the inhabitants. A few examples are cited below.

The women of Sumatra wear headdresses that duplicate the shape of buffalo horns as a memorial to a buffalo of their mythology. A carved buffalo horn amulet, holding magic herbs, may be worn by a man who has to travel through the forest at night.

Many sacrificial rituals involving buffaloes are celebrated to cause rainfall and to ensure good growth of the rice crop. Buffaloes may be slaughtered at family events of all kinds. Albinoid buffaloes are not selected for these festivals since their flesh is thought to cause skin disease; yet, in some localities, it is prescribed for medicinal purposes. The head of a sacrificial buffalo is buried under the foundation of a new house in Bali.

The dead are often cremated in wooden sarcophagi carved to represent buffaloes. The Hindu god, Yama, Lord of Death and Hell, must be placated; he is represented as riding on a buffalo. The death of a wealthy man may call for the slaughter of so many animals that years may elapse before the number of working animals required for the land is fully restored.

There is a lake in the north of Bali on which there is launched, as occasion demands, a large bamboo raft carrying a dark-skinned buffalo and its attendants. The buffalo is weighted and sacrificed by drowning. The ritual is ordained when prosperity is depressed or when rain is urgently needed.

Wife purchase by buffalo is still quite common. Many buffaloes are considered to be very lucky, by virtue of some special characteristic of the horns, or of the colour and type, or of the hair whorls. Such animals go first into the padi field to ensure good crops; they also receive special treatment.

Buffalo milk may be sprinkled on newly planted rice as a fertility rite. People of Indonesia, as in many other countries, believe that buffalo meat and milk have aphrodisiac qualities.

Emphasis must be given to the importance of the study of age-old customs in relation to plans for improving animal husbandry methods.

East Timor (former Portuguese Timor)

The people of Timor are dependent on rice-growing and buffaloes are essential to their welfare. There are approximately 128 000 buffaloes and 85 000 cattle at the present time. Horses, pigs, sheep and goats are also kept.

The buffalo population was severely reduced during the second world war, and restrictions were imposed on slaughter for some years. When numbers increased to what was considered to be the normal level, the ban was lifted. In recent years there appears to have been a fluctuating population with, on the whole, a slow increase.

The buffaloes are all of the Swamp breed. Many are big animals with good conformation, colour and markings. Normal weights are estimated to be from 800 to 900 kg, while specimens of 1 000 kg and over are not unusual.

There are no colour preferences. Albinoids are numerous, perhaps 10 percent or more, piebalds and skewbalds may frequently be observed, and a red coloration of the skin and hair is seen in some animals that show the same tinge as that of the "ginger buffaloes" of the Northern Territory of Australia. Large chevrons, well marked, are usual. Walleyes are common. Horns are massive in most of the mature animals and the classic moon shape is often noted. Tails rarely reach down to the hocks.

A heavy, stocky, short-legged strain is common. Breeding is haphazard and its occurrence seems to be by pure chance. It appears to be a good meat type that would probably breed true.

Both males and females are used for work in the padi fields. Males of a quiet temperament are kept entire; the less tractable are castrated at 4 to 5 years of age. The nasal septum is not pierced and neither rings nor bridles are worn. Few are marked for identification and there is no system of registration.

Working hours are limited to the early morning; thereafter the buffaloes spend the time grazing and wallowing. The cultivation of the padi land is by the *jijak* method.

Some working females are milked. The average yield is about 2 litres in addition to the calf's intake. The daily yield at the peak of lactation may be as high as 4 litres. Milk is used in liquid form and as a hard cheese.

The age at first calving is around 2 years and the calving rate is two calves in three years. Twins are unknown.

Buffalo meat is popular with the tribal peoples but less so in the capital town, Dili. Animals of all ages are slaughtered, but much of the meat comes from the old working buffaloes. Cooked hide delicacies are very

popular. After prolonged boiling the hide is cut into strips, sun-dried and, when required, cooked in deep fat or oil.

Haemorrhagic septicaemia is the major health menace. Cattle and buffaloes are vaccinated at the beginning and end of the wet season by the veterinary service at numerous gathering places, equipped with solidly constructed pens and crushes. East Timor is said to be free from foot-and-mouth disease, rinderpest and rabies. Neither tuberculosis nor brucellosis has been confirmed in buffaloes, but tuberculosis is common in human beings and in pigs.

The buffaloes of Papua New Guinea

Several small herds of buffaloes were established at intervals since 1906 by introductions from Indonesia and the Philippines and, in recent years, more have been brought in, sometimes by air, from Australia. They are all of the Swamp type. Plans have been formulated for the expansion of the buffalo population to around 6 000 within three years.

A government herd of about 600 is maintained and the Department of Agriculture, Stock and Fisheries also has an experimental herd. Several small herds are in private ownership and there are some feral and semiferal herds. A few feral buffaloes have been tamed and added to domestic herds.

Reports of trials at the experimental farm show that the buffaloes matured earlier than the cattle, the calving rate was higher and the calving interval shorter. The environment was more favourable for buffaloes.

There was a marked response to feeding mineral supplements. The feeding of trace elements, particularly phosphate, with salt is recommended.

A few comparative data are shown in Table 17.

The average liveweight of buffaloes at 4 years of age was 98 kg more than that of Brahman cross cattle.

A further advantage is that the buffaloes are easier to handle than the cattle. Crushes must be made wider for buffaloes, unless they are polled.

Three natural poll buffaloes have recently been reported, and there are cases of others in the past. Two first-calf poll heifers, one black the other white, each with a horned calf of the dam's colour, were seen. In addition, a natural poll male calf has been examined. It was thought to be sterile. They were to be collected for observation and breeding trials.

Screwworm could become a serious problem, but it has been observed that buffaloes have some degree of resistance and rarely suffer as severely as cattle.

TABLE 17. -- COMPARATIVE PERFORMANCE OF WATER BUFFALOES AND CATTLE

Averages	Swamp buffalo	Brahman cattle
Daily weight gain (kg)		
Unweaned calves	0.43	0.52
Weaned calves	0.28	0.25
Liveweight at 3 years of age (kg)	384	286
Age at first calving (in months)	43	37
Weight at first calving (kg)	418	335
Percentage calved (46 months of age)	80	97
Percentage calved, second calving (52 months)	59	16
Calving interval (days)	414	528
Calf mortality	20	10

Many clinical cases of bone and joint disorders are reported. There is a general deficiency of phosphorus in the soil and pastures.

The inhabitants of Papua New Guinea have never been accustomed to large animal husbandry, but they are attracted to the buffalo and to its work capacity. Because of its wallowing habit they regard it as a large black pig. There is no prejudice against eating buffalo meat and there would seem to be a bright future for rearing buffaloes under range conditions in such areas as the east Sepik.

18. THE BUFFALOES OF THE PHILIPPINES AND GUAM

The buffaloes of the Philippines

The native swamp buffalo is known as the carabao, with the feminine form caraballa. It is thought that Malay immigrants of the period 300 to 200 B.C. introduced buffaloes and horses. Chinese colonizers may have brought buffaloes later. The native type is sometimes referred to as the Shanghai buffalo. Early in the present century there were importations from Cambodia for work in sugarcane plantations. They were also used for the production of rinderpest serum. A descendant is called a Cambodian carabao. It is very similar to the native type but is larger and has bigger horns.

Murrahs were first introduced from India in 1917 and there have been many importations since then. A few representatives of the Nili breed have also been acquired.

The present population of buffaloes is approximately 5 million; that of cattle 2 200 000.

Native carabaos are widely distributed in all the larger islands of the 7 100 that make up the Philippine archipelago. They are smaller than the Cambodian carabao and the Indian breeds. Mature males weigh from 420 to 500 kg, females 400 to 425 kg. Height at withers of the male ranges from 127 to 137 cm, and of the female from 124 to 129 cm. They have the low, wide and heavy build of draught animals and sufficient flesh to provide a reasonable yield of carcass meat.

The colour of the carabao varies from light grey to slate grey. Chevrons are common. Albinoids are present in the proportion of about 3 percent of the buffalo population. They have white or yellowish hair on a pinkish skin but the eyes, hoofs and mouth are dark and the skin may be speckled. The horns are sickle-shaped or curve backward toward the neck.

The native carabao is more docile than the other types of buffalo or cattle of the Philippines. It is the mainstay of agriculture but is slow-moving and not so resistant to extremes of climate as the Zebu cattle.

The Cambodian carabao is similar to the native type. The typical male

weighs, on average, 673 kg and measures 141 cm at the withers. Purebred Cambodian carabaos are kept on only two islands, but specimens with that blood are seen in many other parts of the Philippines.

There are about 45 000 Murrahs widely distributed. They are rather smaller than the original foundation importations. The udder is well developed. The upgrading of the native strain by crossing with the Murrah is a long-range project. The cross between the caraballa and the Murrah male yields, on average, 3 to 4 litres of milk daily. The carabao × Murrah may well become the main source of milk supplies in the Philippines. Male crosses are better than native carabaos for work; they have more stamina and are more resistant to the effect of sunshine.

The carabao is used for cultivation of padi fields, for maize and sugar-cane land and for threshing, milling, logging and rural road haulage.

A buffalo festival is held in Bulacan at the feast of San Isidro, the patron saint of agriculture. Buffalo races are a popular attraction to the gathering.

The average size of the holdings is about 3.5 ha and most farmers keep a couple of carabaos for work and milk. They are the greatest cash asset of the rural people.

Mechanization of agriculture, though inevitable, is bound to be slow. Future emphasis must be on production of milk and meat to satisfy the growing demand of the human population.

Buffaloes on small farms are not usually housed; they are often tethered when not at work. Guinea, para, napier and alabang cross grasses and forage crops are grown, but pastures are generally overgrazed during the dry seasons. Commercial milk producers rear calves on the bucket. Roughages and concentrates may be fed as early as 4 weeks of age; milk feeding stops at 4 months.

The common pattern of rice-growing on irrigated land is one crop of rice during the rainy season followed by fallowing or a short-term crop such as mung beans. Forage legumes may be grown and fed to buffaloes along with weeds removed from the padi fields. The more progressive farmers average two crops of rice per year. Grains are rarely grown for animal feeding. Mineral supplements do not form part of the rations.

The age of puberty in the carabao ranges from 20 to 35 months, depending on management, season, and level of nutrition. Murrah pure-breds are rather slower in coming to sexual maturity. Signs of heat in the caraballa are more obvious than in other types of water buffalo; they are similar to those shown by the dairy cow.

Most breeding activity is noted during the cool and wet months but, with good management, the caraballa will breed at any season. The average duration of the heat period is less than one day. The average

age at calving for the first time is 43 months, the calving interval 17 months.

The national artificial insemination services give free attention to herds in the vicinity of centres. Frozen Murrah semen has been used, with an average number of inseminations per conception of 2.3. Trials are proceeding for the control of oestrus by the injection of hormones and on synchronized calvings.

There are many records of fecundity and longevity. Two caraballas at the college of agriculture had 9 and 10 calves, respectively, within a period of 12 years. The caraballa's milk yield is from 1 to 1.5 litres at the morning milking, the calf sucking freely during the day. The high butterfat content of caraballa milk is well known; it is around 9 to 10 percent.

Buffalo milk is preferred to cow milk, especially by rural people. It is widely used for a soft cottage cheese and as the basis of popular sweetmeats called *pastillas de leche* and *yemas*.

The branding of buffaloes and cattle is required by law. The owner's mark is on the right hip, that of the district on the left. They reduce the value of the hide.

The buffalo population declined during the second world war to a critically low level, then a ban was imposed on slaughtering and it led to a gradual recovery. Slaughter of buffaloes over 3 years of age is now allowed, subject to a permit system. The number of buffaloes slaughtered in the Manila abattoir increased until, in 1974, the total reached 66 116. The number of cattle slaughtered was 42 625.

Average carcass weights were 170 kg for buffaloes and 150 kg for cattle. The well-reared and fattened carabao produces meat of good quality and compares favourably with the beef of cattle.

Some buffaloes are fattened in feedlots. Large herds of up to 800 are kept under ranching conditions. There are many semiwild buffaloes. An extension of these systems of management wherever suitable conditions prevail would make a significant contribution to meat supplies and to the economy of the land.

Hides form the basis of a major leather industry and of several popular foods. The dung is a valued fertilizer for crops.

Outbreaks of anthrax occur quite frequently in well-defined areas. Buffaloes appear to be more susceptible than cattle. Between 1923 and 1968 more than 600 human cases of anthrax were confirmed and 240 people died. Infection was almost always the result of contact with meat, mostly of carabaos, dealt with in a clandestine way.

Liver fluke is a major problem in most parts of the Philippines. Of the animals slaughtered and inspected, 70 percent of the buffaloes are infected and only 50 percent of the cattle. *Leptospira, Schistosoma* and

Capillaria infections are widespread; they are closely associated with the watery environment.

Finally, a note on the tamarao, the wild dwarf buffalo, *Bubalus mindorensis*, found only on the island of Mindoro and hence also called the Mindoro buffalo. It is a small creature, 100 to 120 cm high at the withers. Pairs and small family groups keep to the deepest forest during daylight hours and come out into open areas to feed at night. They do not wallow and appear to avoid water. They are in danger of extinction unless effective conservation measures are quickly enforced. The life span, in the natural state, is said to be about 20 years, but in captivity the average is from 3 to 5 years.

The buffaloes of Guam

There is a small population of Swamp buffaloes in Guam, in the Mariana islands, which are under U.S. trusteeship. They are called carabaos and it may be presumed that the original stock came from the Philippines.

They are used for pulling carts and for cultivating padi fields. As in the Philippines, carabao races and other sports are very popular. A few are milked and the milk is highly esteemed.

Meat is a by-product and little is sold. Hides are made into good quality leathers.

Feral buffaloes live in the jungles. Some years ago two males and four females were captured and sent to the San Diego zoo, California, where they adapted well.

19. THE BUFFALOES OF ASIA AND THE NEAR EAST

In Asia, west of Pakistan, populations of buffaloes are distributed in areas of Afghanistan, Iran, Iraq, Turkey, Syria, Jordan and in Russian Transcaucasia and north Caucasus. The Egyptian buffaloes are considered in the chapter on the water buffalo in Africa (see p. 236).

The types of buffaloes bred in these countries are basically similar, not only to each other but also to those of India and Pakistan.

The buffaloes of Afghanistan

Domestic buffaloes are kept in well-defined areas, such as in Baghlan in the north, around Kabul and Jalalabad in the east, and along the north-east frontier with Pakistan. FAO estimates for 1974 of the number of buffaloes were 33 000, and believed to be increasing. By comparison, the number of cattle was estimated at 3 550 000, many of them kept by nomadic peoples.

The original introduction of buffaloes was probably made by Arabs and Turks in the seventh century A.D. Many are still brought in from Pakistan, either legally or as contraband.

Most are nondescript types, with some Murrah, Nili-Ravi or Kundi characteristics. Black-skinned buffaloes are favoured, but brown-coloured specimens are quite common. Animals with white markings and with walleyes are numerous.

The areas are arid and the buffaloes get little chance to wallow. No bells or amulets are worn. Buffalo horns may be seen mounted high up on the walls of the fort-like villages to avert the evil eye.

Around Kabul, buffaloes are used for ploughing and for draught work.

A dairy herd is established at Baghlan, but elsewhere few buffaloes are kept for milk production. Village buffaloes are said to yield up to 6 kg a day. The milk is not so popular as either sheep or cow milk. The age at first calving is 4 to 6 years. A buffalo that has not calved by 7 years of age is sold for slaughter.

Many are slaughtered by local butchers. There is a large military

abattoir at Kabul, with a year-round entry of buffaloes, sheep and cattle, the largest numbers during the summer months. They are slaughtered in accordance with the Muslim ritual. Meat is frozen until needed. The estimated carcass weight for buffaloes is from 210 to 250 kg, dressing out at about 45 percent.

Most people need more protein foods; few, apart from the privileged classes, eat meat. There appears to be an awareness of the importance of the buffalo in improving supplies of meat. The rearing of more animals in village herds for early slaughter might well be encouraged, but the need to import from Pakistan is unlikely to decline for many years.

The buffaloes of Iran

Reliable figures for the total buffalo population are not readily available and estimates from different sources vary widely. FAO estimates for 1974 were 460 000. A decline from well over a million in the 1930s to less than 250 000 in the 1960s is explained by excessive slaughter during the second world war. Numbers have been building up steadily since then. By comparison, the estimated cattle population is 5 760 000.

Domestic buffaloes were probably kept in Iran many centuries before the Christian era. It is known that there were buffaloes in the Indus valley to the east and in Mesopotamia to the west. In 538 B.C. the Medes and Persians overran the Iranian plateau. They may have used buffaloes. The expansion of Islam spread buffaloes to many lands and it may be assumed that they were taken to Iran by the seventh century A.D. Murrahs have been imported from India in recent years. Nili-Ravi characteristics can be noted in many of the nondescript buffaloes in the vicinity of Tehran.

Buffaloes are kept chiefly for milk production. A few are to be seen engaged in road haulage and in threshing barley. Little official support is given to measures for improving the quality of buffalo stocks. There is an obvious potential for increased milk and meat production.

Milk yields are higher than those of local dairy cows. Considerable areas along the rivers are more suitable for buffaloes than for cattle. The average daily yield is about 6 litres in a lactation of approximately seven months, with butterfat content at 9 percent. Some high individual milk performances are recorded.

Khuzestan is a good area for fodder crops. There are around 76 000 buffaloes in the area, and milk yields are said to be as high as 15 litres per day. The animals are given 9 kg of a mixture of rice bran and rolled barley per day, with 12 kg of chopped straw and the same weight of alfalfa.

Buffaloes are also kept on mountain pastures in west Azerbaijan, where they graze with cattle up to the snowline.

Much of the buffalo milk is used for the preparation of ghee. There is a good market for ice cream in summer and this causes a rise in price. Fresh milk is not popular, owing to its short life in local conditions. Soured milk, yoghurt or *mast*, cheese, butter and buttermilk are all made in various localities. One or two buffaloes are often kept in herds of dairy cows to increase the butterfat content of the milk in bulk.

There are no official restrictions on the slaughter of buffaloes in Iran. Methods are usually crude and wasteful. The number of buffaloes slaughtered has increased in recent years but the average carcass weight has declined. The heaviest animals are reared in the highland area bordering the Caspian sea.

The buffaloes of Iraq

Wild buffaloes may have lived in Mesopotamia in prehistoric times. There may have been movements of domestic animals from the Indus valley in the pre-Christian centuries. But it is thought that they were first introduced from India at the time of the Abbassid Muslim empire. At the present time it is possible to find specimens with chevrons, indicating an ancient Swamp ancestry or else a more recent infusion with blood of the Surti breed.

The Iraqi buffalo presents many unique features, but there is no justification for its classification as a distinct breed. Albinoids, piebalds and roans are quite common, especially in the marshes of the southern part of the country. These colours are not favoured, except in the Basra area, where albinoids are much esteemed. There is no prejudice against them but they are believed to be deaf and to suffer more distress than other buffaloes in cold, wet weather. Clear chevrons are highly favoured.

There is usually a pronounced beard below the jaws. Young buffaloes have shaggy coats with long, brown hairs predominant. The skin of the inner surface of the upper part of the legs is generally a pale pink colour. Many have a well-marked flap at the navel. White markings are common. Tails are long, reaching well below the hocks.

FAO estimates for the number of buffaloes in 1974 were 309 000. Of that total about half are in the marshes of southern Iraq. The population is growing and it is probable that estimates are too low. The cattle population is estimated at 2 059 000.

Buffaloes are the main support of the Ma'dan, the marsh Arabs. Of all domestic animals only the water buffalo could exist and be productive

in the marsh environment. Marsh Arabs are the dairymen of the urban districts. Buffaloes are also kept by the people of the riverside settlements.

The giant reed is the most important plant. Its young shoots form the bulk of the fodder, the smaller stems are made into mats which have a ready market, and the main stems are used in the construction of the huts and also for fuel. Many other useful aquatic plants abound. None is known to be poisonous.

Dealers and dairymen from Baghdad and other urban centres prefer to buy their replenishment stock from the marshes. Removed from the stresses of the environment and fed on a higher level of nutrition, the buffaloes respond well, and good milk yields are anticipated.

The marsh Arabs select their breeding males with care from the best milking dams, paying due attention to the conformation of the udder. Only males selected for breeding are retained. No castration is needed. The fertility rate is satisfactory, although the first calf may not be born until the dam is 4 or 5 years old. It is not unusual for a calf to be produced every year, and 15 calves in a lifetime is not an uncommon record.

Marsh buffaloes are very wary of strangers and are difficult to handle for vaccination or dosing. They are not ringed and are unaccustomed to haltering. The control of contagious diseases and parasitic conditions is extremely difficult. Haemorrhagic septicaemia causes heavy losses. Foot-and-mouth disease virus is never long absent, but the buffaloes have considerable resistance and outbreaks are relatively mild.

The early morning air of the marshes can be chilly, even in the hot season, and the buffaloes do not usually begin to wallow until they feel the sun's warmth.

Around 3 000 milking buffaloes are kept in the Basra district. Many are large animals, weighing about 900 kg. Chevrons are seen more frequently here than in other areas, perhaps the legacy of the buffaloes that were imported during the first world war.

Good specimens at the height of lactation yield about 13.5 litres at two daily milkings. Lactation yields in well-managed herds range from 1 500 to 1 800 litres. The length of lactation periods varies widely with the management practices in different areas; in the marshes it is often only five months but in the urban dairies the average is eight months. Some exceptional yields by milch buffaloes in the Basra area are as high as 22 litres at their peak.

The communities of former marsh dwellers near Baghdad have large communal wallowing tanks built of bricks and mortar; the water is static and becomes heavily polluted. They are only used in summer. In other urban herds the buffaloes are hosed down or sluiced two or three times daily. Housing is often primitive, with earth floors and matting

roof. Swarms of flies are discouraged by smudge fires of dung cakes and straw.

Milking buffaloes are given concentrates, in many cases more than required for their yields. An average ration would be cottonseed, up to 1 kg; crushed barley, 3 kg; wheat bran, 2 kg; rice bran, 1 to 2 kg; along with alfalfa 10 kg and chopped wheat straw in quantity. Other feedstuffs used in various localities include rice hulls, dates, sugarcane tops, molasses and bagasse.

Evidence of deficiencies is seen in the avid way in which the buffaloes take salt, in nibbling and licking each other's hair and in nibbling the pitch coating of canoes, which have to be moored far from river banks.

Areas of green barley are grazed by buffaloes. Some cases of bloat occur when they first go on to the crop. Calves running with the dams on pasture are often fitted with a device to prevent sucking and they begin to graze at an early age.

Infertility in both sexes causes considerable loss of production and more investigations are needed. Mastitis is prevalent in high-yielding buffaloes. Calf mortality varies from district to district and may be as high as 50 percent. Buffaloes carry a heavy load of parasites of many kinds. Although they may show no sign of ill-health, production must of necessity be diminished and feed utilization becomes less efficient.

Meat production potential is largely ignored. In rural areas male calves are slaughtered, the veal eaten by the family, or given away. More calves should be reared. At a state farm near Baghdad young buffaloes and cattle are fattened in feedlots on green fodder. They are bought as calves and slaughtered at about 15 months of age, at an average live-weight of 120 kg.

Results of recent feedlot trials are shown below:

Averages	165 male Iraqi buffaloes	975 male native cattle
Period of feeding (days)	139	127
Daily weight gain (kg)	0.728	0.544
Carcass weight (kg)	118	102
Dressing-out percentage	47.24	50.45

Buffaloes are not used for work in Iraq. Owners lavish every care on their buffaloes and have many superstitions about them. It is claimed that they have powers of reasoning. Each is given a name and will respond to it. It is said that they will intervene should the owner be

attacked. Males show preference for favourite females and, it is believed, refuse to serve their dam.

The buffaloes of Turkey

In spite of the lack of official encouragement, the domestic buffalo maintains its popularity among peasant farmers. Figures for the number of buffaloes in Turkey during the last 30 years show considerable fluctuation. There is probably a slight but variable decline in both buffalo and cattle populations. FAO estimates for 1974 were 1 023 000 for buffaloes, and 12 408 000 for cattle.

Buffaloes are bred in most parts of the country, with the greatest concentrations in the coastal north, the northern part of central Anatolia and in Thrace.

The typical Turkish buffalo is a small, stocky animal; it has a rather nondescript appearance. It is a shorthorn, like the Mediterranean type, but with a much smaller frame. The animals are usually in lean condition and may weigh only 150 to 300 kg. Most are black with few distinguishing marks. They have long hair and beards are common. No chevrons are seen and albinoids are unknown.

Buffaloes may have been taken to Turkey originally during the spread of Islam, although some archaeologists claim to have found evidence of their presence in the area many centuries earlier.

Agricultural methods are generally simple with much reliance on hand labour and animal power. Mechanization advances very slowly. Nutrition is at a low level for most families and their livestock. Pastures are often severely overgrazed, and few forage crops are grown. The climate is severe and rainfall scanty. Buffaloes are housed in winter in many districts. They are rugged in cold weather. Warm water may be given to drink and they are sometimes rubbed down with linseed oil.

Many buffaloes are kept exclusively for work in agriculture or on the roads for ploughing, pulling carts or wheeled water tanks. Most of them are males castrated before they are one year old. Some males are left entire until they have been used for breeding. The bloodless castrator is the instrument generally used. For road work buffaloes are shod with flat iron plates. Nose rings are not applied.

Working buffaloes get little feed apart from rough grazing with some straw and, occasionally, maize leaves or a handful of oats.

Buffalo gun teams were used to haul heavy artillery during the war of independence and in earlier campaigns.

Breeding is generally quite haphazard and matings are not recorded.

Many females are nervously aggressive during heat periods and tend to wander until settled by conception. Silent heat is not known to occur. Artificial insemination is not applied to buffaloes in Turkey, although fairly widely used for cows. Twins are unknown.

Records kept at the research station at Afyon give the following averages:

Age at first service	20-24 months
Lactation, maximum	1 603-1 715 litres
" minimum	186-442 "
" period	245 days
Butterfat content	8 %

The age at first calving of buffaloes in village herds is around 3 years. It is claimed that service intervals are quite short, yet there are reports of many long calving intervals. The maximum daily milk yield is about 8 litres although individual yields of up to 12 litres have been recorded. Butterfat percentages of up to 12 percent have been reported.

Better nutrition is needed to improve the breeding and production performance in most districts.

Some good Romanian buffaloes were introduced about 50 years ago; a small herd is still maintained at the state farm at Karacabey Hara. They are black, with white stars, long tails usually reaching to the ground, and with white switches. The average liveweight of mature specimens is about 800 kg. Lactation yields range from 700 to 1 100 litres. In an average lifetime they produce 12 calves. Some live to 27 years of age.

A popular dairy product is "curl cream" made by heating buffalo milk, cooling in trays, reheating and finally cutting up next morning. Another type is sold in sausage form.

Most buffalo meat is derived from old animals. There are no official restrictions on slaughter. Buffalo meat must be labelled and kept separate from other meat. Carcass weights are declining. Dressing-out percentages are low, not more than 42 percent.

A popular sausage is made from buffalo veal mixed with beef and mutton.

In some areas sugar-beet pulp is given to fatten buffaloes which are generally housed for the feeding period. They may also be fed a little ground maize, bran, straw and molasses.

Haemorrhagic septicaemia sometimes causes serious losses during the

winter months. The veterinary services vaccinate twice a year. Liver fluke infestation is widespread. An infusion of tobacco, with vinegar and salt, is used to control skin parasites. Warbles are commonly seen in cattle but never in buffaloes.

Many nomadic gipsy families travel around with a few buffaloes. Amulets are carried by some buffaloes. Blue beads or a small pouch containing a verse from the Koran are considered to be a protection against disease and accident.

The buffaloes of Syria

About 1 000 domestic buffaloes are kept in the marshy areas of Syria. The population is gradually declining. The estimated numbers of cattle and camels are, respectively, 539 000 and 6 000. They are rather large animals, kept for milk and for work.

The buffaloes of Jordan

A few buffaloes were introduced from Syria 30 or 40 years ago and they flourished in the marshes of the Azraq area. There are around 400 at present, some kept for milking, others in a semiwild state. They are owned by many families and are identified by markings. Some stay in the marshes, grazing on aquatic plants and wallowing in lakes. They return in the evening to be milked and housed for the night. They are not used for work.

The skin is black, with long, black hair. The fertility rate is very high. Most calves are born in August. In winter, they are well cared for and given berseem, straw and a fodder plant, *halfa*.

The feral buffaloes are shot when required for meat.

Barren females are slaughtered and dressed. Buffalo milk is highly esteemed. A cream cheese called *laban* is popular.

Outbreaks of foot-and-mouth disease occur from time to time Vaccination of the feral animals is not possible. Foot infections, liver fluke and mange are the most troublesome conditions.

The buffaloes of Israel

Buffaloes were formerly kept in the river swamps near the coast and in the marshes of lake Huleh in the north. With the draining of these areas, the buffaloes have disappeared.

The buffaloes of the U.S.S.R.

The number of domestic buffaloes in the U.S.S.R. is reported to be 433 000. The population is increasing. Characteristics and performance of the Caucasian buffalo are briefly discussed in the chapter on species, types and breeds (see p. 19).

The buffaloes are found in the part of the country between the Black sea and the Caspian sea, especially in Dagestan, Azerbaidzhan and Georgia. The Lenkoran plains of Azerbaidzhan are contiguous with the provinces of Iran — Azerbaidzhan and Mazandaran — where many Iranian buffaloes are bred.

A great deal of research on buffaloes and their products has been undertaken in the U.S.S.R. and much useful information has been published.

20. THE DOMESTIC BUFFALOES OF EUROPE

Buffaloes are bred in the Danube valley in Bulgaria, Romania, Yugoslavia and Hungary, as well as in Albania and central Greece. There are around 100 000 in Italy. Those in Thrace are part of the general population of Anatolian buffaloes of Turkey and are very similar in type.

They are known by the names of the countries in which they are maintained and may also be designated Mediterranean buffaloes or Balkan buffaloes. They are of the same general conformation, varying chiefly in size. The buffaloes of Greece, Albania and Yugoslavia are considerably smaller than those bred in other European countries.

The buffaloes of Bulgaria

It is not known when buffaloes were first introduced into Bulgaria or where they originated. In 814 A.D. Byzantine prisoners were exchanged for buffaloes. In 1206, when the Crusaders captured the town of Veroi, they took much booty, including cattle and buffaloes. The Turks, in their invasions to the west, used buffaloes to pull the heavy battering rams, equipment and food supplies. During the seventeenth and eighteenth centuries, caravans of hundreds of buffaloes transported all kinds of merchandise throughout the Danube and Black sea region. Caravan songs and folklore still express the affection and gratitude felt for the animals. The Bulgarian army used buffaloes as draught animals during the first world war.

The peak of the buffalo population was reached by about 1920, when there were probably more than 400 000. Since then there has been a fairly rapid decline due partly to the emphasis on mechanization of transport and agriculture. However, a significant increase has been noted during the last few years. The buffalo population in 1974 was reported at 67 000, and that of cattle at 1 454 000.

Emphasis in the past was given to the breeding of strong, muscular working buffaloes. Nevertheless, some dairy herds evolved, and the present

Bulgarian type is a multipurpose farm animal, used for work, milk and meat.

Milk yields are not generally high, mainly because the buffaloes are expected to thrive from calfhood onward on coarse forage without succulent and concentrate supplements. Those kept on state and research institute farms have higher yields than those in cooperative herds. Short lactation periods also limit production.

The range of annual yields of 8 750 buffaloes in all parts of the country was from 425 to 1 169 kg, with an average of 670 kg. Buffaloes on state and cooperative farms in northern Bulgaria gave an average, in 712 lactations of 300 days, of 1 315 kg. At the Vrani Kon state farm the average was 1 537 kg, with butterfat content at 8 percent. Some exceptional individual performances are recorded: one buffalo, at the V. Kolaruov state buffalo farm, gave more than 4 000 kg in a lactation of 354 days, with 8.45 percent fat; 11 selected females averaged 2 276 kg and, later, 40 had an average yield of 1 680 kg, with 8.12 percent fat.

Some performance details are shown in Table 18.

TABLE 18. — MILK PRODUCTION AND DURATION OF LACTATION OF BULGARIAN BUFFALOES

Farm	Lactation sequence	Average lactation yield	Average duration
		Kilograms	*Days*
Institute of Animal Breeding, Shumen	1st	1 335	302
	2nd	1 536	279
	3rd	1 614	267
	4th	1 746	295
	5th + +	1 711	282
Vrani Kon state farm	1st	1 190	305
	2nd	1 346	275
	3rd	1 450	280
	4th	1 410	275
	5th + +	1 371	270

The milk production potential is obviously high and could be developed by selective breeding for high yield and long lactation period along with better nutrition and management. During the past 20 years, many Murrah and Surti buffaloes have been imported from India and an extensive programme of crossbreeding has been established at the Institute of Animal Breeding, Shumen.

Selection in the past aimed at high butterfat content and, as a result, the percentages and wide variation in individuals are valuable breeding assets.

Studies have been undertaken in Bulgaria on the composition and physical properties of buffalo milk and have shown its value in the elaboration of many dairy products.

Few of the buffaloes slaughtered are young and fattened, and the meat on the market is generally of poor quality. The meat of young, well-fattened buffaloes has been found in no way inferior to that of cattle, and in some respects it is better. In palatability trials of cooked joints, ten experienced judges considered the buffalo meat to have better flavour than the beef, 11 detected no difference, while opinions on tenderness were almost equally divided.

Comparative trials with yearling native buffaloes and cattle showed the following:

1. Both species can be fattened at 12 to 14½ months of age on fodders with small amounts of concentrates.
2. Daily weight gains of the buffaloes were slightly lower than those of the cattle, but the number of feed units per kg weight gain was practically the same in both species.
3. There was no difference in the meat:bone ratio of the two groups.

In another series of trials with young buffaloes the results were as follows:

1. The number of feed units required per kg weight gain increases as the animal grows heavier.
2. As the body weight increases, the proportion of meat increases and the increase is relatively greater than that of the by-products.
3. No difference was detected between the weight gains and feed units required by castrates and entire males fattened up to 400 kg liveweight. The castrates carried more fat while the entires had thicker skins.

Differences in other carcass characters were negligible.

Murrah × Bulgarian buffalo crossbreds made 28.6 percent higher average daily weight gains than young native Bulgarian buffaloes and their forage conversion rate was better. On the other hand, the Bulgarian buffaloes gave slightly higher dressing-out percentages.

In trials comparing the fattening of young buffaloes and cattle, no appreciable difference was found in the ratio of quality cuts, in meat quality, or in chemical composition. Buffalo meat products in the form of dry salami and salted meats were given higher credits for consumer appreciation than those made from the meat of cattle.

The economics of production studies in Bulgaria have revealed many interesting facts, a few of which are noted here. Two buffaloes have the work capacity of three oxen; where conditions are favourable, buffalo females give higher economic returns for capital invested than cattle; the cost of producing buffalo milk is lower than that of cow milk; fodder wastage by buffaloes is much less than that by cattle; and it is claimed that one buffalo can be kept on the leftovers of 15 cows.

The buffalo centre at Shumen has a continuing programme of research and has made outstanding contributions to buffalo development.

The buffaloes of Romania

Buffaloes were first moved into Romania by the Turks in the fifteenth and sixteenth centuries and were perpetuated by the Muslim communities, in which they continue to maintain the affection of their owners. Although the buffalo population declined, it is still surprisingly large and appears to have been increasing in recent years.

FAO estimates for the number of buffaloes in 1974 were 218 000. An unofficial estimate of the number of cattle was 5 679 000.

More than 40 percent of the buffaloes are kept in the region of Cluj. No buffaloes have been imported or exported for many years.

Romanian buffaloes are black or slate grey, of the shorthorn, European type. They are triple-purpose animals with varying emphasis on milk, work and meat.

Very little published information is available on performance records. However, a few details are shown below:

	Range	Average
Gestation period	311-331 days	318 days
Milk yield	889-1 010 litres	
Butterfat		7.29%
Lactation period	139-369 days	243 days
Carcass percentage	40-57	

The buffaloes of Yugoslavia

Domestic buffaloes were introduced during the years of Muslim expansion into Europe. The population declined but now shows signs of an encouraging recovery as the potential for meat production becomes more widely recognized.

The number of buffaloes reported in 1974 was 62 000; that of cattle 5 681 000.

The buffalo is the typical domestic animal of the small farm, of which there are many in Yugoslavia. The high butterfat content of the milk is appreciated by the Muslim communities in which ghee is used for cooking in place of the forbidden lard. Buffaloes are also popular because they thrive on rough pastures and live long, productive and working lives. Numerous instances of buffaloes living 40 years are well authenticated. A working lifetime of 20 years is common.

They are of the Mediterranean type, black or slate grey, and many are seen with white points and walleyes. The average liveweight of mature specimens is around 530 kg and the biggest individuals attain 700 kg.

Little attention is given to nutrition. From spring to late autumn the buffaloes graze on rough pasture, with sedges and other water plants. Working and milking animals may get a small ration of concentrates. In winter they are fed straw, beans, hay or chaff and a small allowance of maize meal, bran, cottonseed or poppyseed cake or vetches. They eat more during the night and early hours than in daytime.

Women look after the buffaloes on small farms.

Identification marks are seldom applied. Castration is performed when the subject is 3 years old, usually by the bloodless castrator, in the hands of a veterinarian.

In the better herds the breeding males are selected on the basis of the dam's milk record and on conformation and markings. There is no difficulty in recognizing the onset of heat in most Yugoslav buffalo females. Mating on common pastures is unrecorded. The age at first calving is from 3 to 4 years. The calving interval is said to be as brief as 12 to 14 months.

Calves are generally allowed to suck the two hind teats while the other two are milked by hand. They are usually weaned at 6 to 8 weeks of age.

Both females and castrates are used for work, ploughing and road haulage. Some working females are also milked.

In summer they are allowed to wallow. In winter they may be protected by a blanket while working. Stables are made as draught-free as possible.

For cartage, buffaloes are harnessed in pairs with the double yoke at the withers. Teams may be hired. Most working buffaloes are shod with a plate on each claw, fitted cold with nails. No nose rings are seen, and the only means of control are the halter, reins and goad. Wire muzzles are often worn while working, but they appear to be unnecessary.

Many buffaloes are kept solely for milk production. A daily yield of

about 4 litres in a lactation of 270 to 300 days is normal. With good nutrition and management yields of 8 to 10 litres can be attained. Butterfat content may be as high as 9 percent.

Whole milk, mixed milk, ghee and yoghurt are marketed. A salted cheese is made and stored for the family, little being sold.

Advanced studies, many in collaboration with research staff in Bulgaria, have produced excellent papers on various aspects of buffalo meat production. They confirm the outstanding potential for production of quality meat at low cost, and provide information useful in the development of vast areas of the world for buffalo breeding and meat production. Some of the results are reviewed in the chapter on meat and meat production (see p. 137).

Slaughter is by pithing and bleeding, or by the ritual Muslim practice. As in many other countries, most of the meat is derived from old animals and is tough and coarse-grained. Surplus calves are slaughtered and buffalo veal is very popular. In the cities there is some degree of prejudice against buffalo meat but the manufactured products are in demand. In rural districts, little meat is eaten fresh, most is salted, dried and smoked, or chopped, salted and made into sausage with added onion. Both buffalo and sheep casings are used in sausage manufacture.

Hides are bought by dealers and there is no system of grading. Hides of young buffaloes are in keen demand for making suede garments. Heavy hide leathers are made into shoe soles, cartridge belts and many other articles. Good quality ropes and reins are manufactured. Horns are the raw material of a small-scale cottage industry making useful and decorative articles.

Outbreaks of haemorrhagic septicaemia occur in winter and in some years cause severe losses. Vaccination should be more widely practised. Foot-and-mouth disease, anthrax, blackquarter and tetanus are also reported. The most important parasitic conditions are sarcoptic mange and liver fluke. Warbles are prevalent in cattle but are not seen in buffalo hides. Cases of indigestion, colic and bloat are frequently dealt with.

In country districts there is widespread belief in the power of the evil eye and amulets are worn. In Muslim areas a small pouch containing a verse from the Koran may be suspended round the buffalo's neck or between the horns.

The buffaloes of Hungary

Domestic buffaloes were brought to Hungary by the Turks in the sixteenth century via Bulgaria and Macedonia. A tenacious population

has been maintained but, at the present time, it probably numbers no more than 500. The rapid decline in recent years is attributed to the progress of the mechanization of agriculture. The main breeding stock is located on the state farm at Nagykanizsa, southwest of lake Balaton.

Hungary marks the northern limit of the extension of domestic buffalo breeding. The cattle population in 1974 was reported at 1 930 000.

The buffaloes of Albania

The Turks took buffaloes also to Albania about the beginning of the sixteenth century. The population has declined sharply in recent years and only about 2 000 remain at the present time. The estimated number of cattle in 1974 was 400 000.

The buffaloes are black or slate grey shorthorn animals, similar to those of Yugoslavia. Most of them are bred in the central districts and along the frontier with Yugoslav Macedonia. They are kept for milk and work, with meat as the end product.

The buffaloes of Greece

Buffaloes were not known in ancient Greece. By the thirteenth century, however, large numbers were present in Thrace and Macedonia, and further movements from Turkey continued in later years. Little official encouragement is given to buffalo breeding and the population has declined in recent decades. FAO estimates for 1974 were 8 000 but local figures are much higher. The estimated number of cattle was 1 050 000.

Nearly all the buffaloes are kept in Thrace and Macedonia. They are very well adapted to the environment and highly esteemed by peasant owners as working animals. In their districts they outstrip both cattle and equines in work capacity, and also in milk and meat production. And they thrive on poor pastures with a minimum of concentrate supplements.

In general appearance the buffaloes of Greece are similar to those of Turkey, but the average size is somewhat bigger. The average liveweight is in the region of 500 to 600 kg, and individuals weighing 800 kg have been noted. They are black or slate grey, with white points in many specimens, and hoofs without pigment are often seen.

The tails of calves are very short, seldom reaching the hocks, but in mature buffaloes they are long, and the switch may touch the ground. Traces of chevrons have been reported to occur occasionally. Walleyes are common, and believed in some areas to indicate good milk yields.

Albinoids are extremely rare. Twins are unknown. The beard under the jaws is seen in many specimens, and the hair coat is thickest over the shoulders.

The buffalo is primarily the domestic animal of the small farmer and is usually grazed on communal pasture throughout the long summer. From December to March buffaloes are housed and fed on straw and low-grade fodders rejected by cattle.

No breeding records are kept. The onset of heat is shown by agitation, bellowing and a tendency to wander. The first calf is born at around 4 years of age and the calving rate is said to be two calves in three years. The service interval is 20 to 26 days in females in good condition, otherwise it may be as long as three months.

The long productive life of the female is well known; in many cases it is more than 15 years. Milk yields vary widely and no records are available. The average daily yield is said to be about 2 to 4 litres including the amount taken by the calf. A good milking buffalo, when well fed, will yield 5 to 7 kg daily at the peak of lactation, with a butterfat content of 7 to 8 percent. In Macedonia, the buffaloes give more milk than local cattle kept under the same conditions, and have longer lactation periods.

Yoghurt is the chief dairy product, sometimes made with mixed buffalo and cow milk. Ghee and butter are made but olive oil is gaining in popularity for cooking. Many different kinds of soft and hard cheese are produced.

Both working and milch buffaloes may be hired. Male and female animals are used for work in the fields and on the roads. Few are castrated. Some wear rings. Young buffaloes are trained by being harnessed with an older animal. For work on the roads they are shod with metal plates, one on each claw.

Much of the buffalo meat is derived from old animals and is of poor quality but there is a trend toward production from young, fattened buffaloes. This should be encouraged as animals cease to be used for work.

A few production details of buffaloes kept under existing conditions are shown below:

Age	Liveweight	Dressing-out
Months	*Kilograms*	*Percentage*
11	110-120	44
24	250-300	50
Females over 60	400-600	45

Considerable quantities of meat are condemned on account of sarcosporidiosis. Some degree of infection is estimated to be present in 60 percent of slaughter animals.

Buffalo meat is popular and buffalo veal is in demand at the same price as prime quality calf veal. Several types of sausage are manufactured for the home market and for export.

Hide accounts for up to 12 percent of the liveweight. Heavy leathers are produced. No warble damage is seen in buffalo hides. Horns are used in handicraft production of a wide variety of articles.

Piroplasmosis and mastitis are not seen so frequently in buffaloes as in cattle. Haemorrhagic septicaemia causes severe losses when vaccination is not practised regularly. Liver fluke damage is often seen after slaughter but causes little obvious trouble during the animal's lifetime. Various forms of kidney disease are encountered; they are attributed to drinking infected water together with the effects of chilling. Foot-and-mouth disease is controlled by vaccination and the slaughter of infected herds. There have been frequent invasions of the virus from Asia.

Some superstitious practices still exist but they have little effect on management. Amulets are worn, such as blue beads on a cord wound round the horns, or in the form of an iron shoe plate — iron being disliked by demons. Bells are often seen on buffaloes, perhaps to aid the discovery of a wandering animal or, in part, as an amulet.

The buffaloes of Italy

Opinions differ on the history of the origin of the Italian buffaloes. Neither the Greeks nor the Romans of the classical periods knew the species. One school of thought concludes that they were originally introduced by the barbarians, during invasions from eastern Europe, at the end of the sixth century. But another historian believed that they were sent by a bey of Tunis in the seventh century.

Large dairy herds are now kept in the provinces of Caserta and Salerno and many smaller herds in Frosinone, Latina and Foggia. A few buffaloes are also kept in Sicily and Sardinia, and several consignments have been exported to Brazil, Trinidad, Venezuela and Mozambique, where they have acclimatized without trouble, and where they are flourishing.

The buffalo population in Italy in 1974 was reported to be 80 000 but is believed to be at least 100 000; the number of cattle was 8 408 000.

During the period of fascist dictatorship the number of buffaloes declined. They were regarded as symbolizing a backward agriculture. Since then there has been more official encouragement and the stock has

increased steadily. The rate of increase now appears to be accelerating. Many small farmers are interested in maintaining a few buffaloes and the areas of rearing for meat are extending.

Italy is now one of the leading countries in the development of buffalo production. Comprehensive programmes of research and practical demonstration have been undertaken on the improvement in milk yield, the potential for meat production, and in raising the standard of the breed. An international conference on buffalo production was held in Caserta in 1974.

All Italian buffaloes are of the same breed; local variations may be attributed to different environments and levels of nutrition. They are short-limbed and broad in proportion to their length. Animals from the same foundation stock and bred in different provinces showed consistent differences in body measurements, but they are not significant. It was thought, at the time of the drainage of swamplands in three valleys, that buffaloes would not be suitable for the drier land. However, it was shown that they could survive and be just as productive as cattle when kept under appropriate systems of management. Buffaloes respond to good treatment: milk yields increase, fertility improves, growth rate accelerates, and better meat is produced.

The age at first calving of buffaloes at the zootechnical institute near Rome ranged from 27 to 55 months; that of related animals in the province of Salerno was about nine months later on average. Females in both herds produced tenth calves at the average age of just over 14 years, a remarkable breeding performance.

Buffaloes kept in range conditions show a distinct seasonal breeding pattern, with most calvings in September. Stabled buffaloes, on the other hand, have a fairly even spread of births throughout the year.

The longest calving interval is that between the first and second calves. The average productive lifetime of 159 females at the institute near Rome was 9.42 years, well in excess of the 8 years recorded in the province of Salerno.

Buffaloes are reared primarily for milk production, meat being a secondary but increasingly emphasized consideration. They are not used as draught animals, although in the past work was the major purpose.

Milk recording has led to a noteworthy improvement in milk yields. In Salerno, selective breeding started in 1942 and herdbooks were established in 1947. There are 20 breeding stations. In the province of Caserta, herdbooks were instituted in 1955 and the number of registered buffaloes has grown rapidly.

The range of average lactation yields of buffaloes in Salerno is from 1 661 kg for the first lactations to 1 809 kg for third and later lactations.

Maximum yields were 2 620 and 3 498 kg respectively. The recorded periods were of 270 days. The average fat content was 7.87 percent. Comprehensive research programmes dealt with the composition and physical characteristics of buffalo milk and of dairy products.

A recent study of the records of 1 285 calvings showed that 26 percent occurred in September. The average age at first calving was 36.7 months and the average first lactation yield was 1 695 kg in 305 days.

The well-known Jemma herd at Torre Lupara, Caserta, has 1 600 dairy buffaloes, all pedigree, now machine-milked in a large rotary parlour. There was formerly a herringbone parlour, but the animals adapted readily to the new routines and equipment. The total buffalo population on the estate is over 3 000. The average yield is 1 500 kg in recorded lactations of 270 days. The average productive life is 20 years. The milk is made into mozzarella cheese.

On the majority of farms milking is still done by hand.

Most of the buffalo milk produced in Italy is made into mozzarella cheese which may by law contain a proportion of cow milk. The cheese made from whole buffalo milk is a much better product than that made from mixed milk. True mozzarella cheese is snow white and fragrant and should be eaten fresh. There is a smoked variety, *provola affumicata*, smoked over a fire of maize stalks, which is increasing in popularity. Small quantities of other kinds of cheese are made and also some butter.

TABLE 19. — GROWTH RATES OF BUFFALOES

Age	Average liveweight		Age	Average daily weight gain	
	Male	Female		Male	Female
	Kilograms			*Grams*	
At birth	41.38	37.70		—	—
3 months	97.84	92.48	Birth to 3 months	627	609
6 "	178.47	156.58	3-6 "	896	712
9 "	237.59	199.28	6-9 "	657	475
12 "	297.13	239.15	9-12 "	662	442
18 "		309.99	12-18 "		393
24 "		389.26	18-24 "		440
36 "		520.88	30-36 "		316
48 "		599.30	36-48 "		200

No difference in growth rates of young calves was found in groups fed on buffalo milk for three months and on cow milk with 4 percent fat. It is thought that cow milk is more digestible, even for buffalo calves.

TABLE 20. — CARCASS WEIGHTS OF GRADE 1 ITALIAN BUFFALOES, AND DRESSING-OUT PERCENTAGES

Males	Average carcass weight	Dressing-out
	Kilograms	*Percentage*
Adult male	263.19	48.50
Adult castrate	252.79	48.23
Yearling	127.46	45.60
Calf under one year	74.14	45.29
Sucking calf, grade 2	27.14	55.99
Females		
Adult female	241.18	47.23
Heifer	200.19	49.75
Yearling	122.75	45.26
Calf under one year	83.35	46.68
Sucking calf, grade 2	28.38	54.92

The forequarters, cut at the last false rib, weigh more than the hindquarters. The proportion of meat is surprisingly high.

A notable example of excellent meat yield is recorded in the case of an adult male of the herd of the experimental institute: the liveweight was 742 kg, dressing-out percentage 55.2, loss on cutting 0.5 percent, meat yield 86.81 percent of carcass weight.

In recent trials growth rates of entire and castrated buffalo calves were compared; they were 110 to 115 days old at the start and the average weight was 110 kg. They were stall-fed on hay and cereal concentrates at a high level of nutrition. At the end of 12 months the entire calves averaged 441 kg, the castrates 427.1 kg. The average daily weight gains were 0.883 and 0.851 kg respectively. The feed conversion index was 5.593 for entires and 5.670 for castrates. There were some early cases of digestive disturbance among the castrates, none among the entires.

Trials with early weaned calves showed good growth rates up to 6 months of age. Carcass yields were over 50 percent and meat proportions satisfactory. The death rate of the young calves was 22 percent.

Meat production is hindered by low prices and poor demand. Improvement in quality is being achieved as more buffaloes are reared and fed for early slaughter. Efforts are being made to popularize buffalo meat and there is evidence of growing demand.

Haemorrhagic septicaemia, the throat form of which is called *barbone*, caused widespread losses in the past. It is now controlled by regular vaccination. Vaccination against foot-and-mouth disease is obligatory. Official measures to control brucellosis and tuberculosis are in operation. Positive reactors are slaughtered in some provinces. Parasitic conditions are prevalent and treatment is available in all districts.

21. THE WATER BUFFALO IN AFRICA

Nowhere in the continent of Africa, apart from Egypt, has the water buffalo flourished for long. Many importations into areas south of the Sahara were made during the last four centuries, but the small colonies invariably succumbed to disease, or were eliminated by war, or simply disappeared through mismanagement.

In this chapter the buffaloes of Egypt will be dealt with first, followed by notes on some recent attempts to introduce buffaloes into other countries.

The buffaloes of Egypt

No evidence has been found of the existence of water buffaloes in ancient Egypt. It is generally accepted that they were introduced from India, Iran and Iraq shortly after the Arab invasion in the seventh century. They established themselves quickly in the favourable environment and have become the most important domestic animals in the land.

Buffaloes are popular with peasant farmers who recognize the value of the animal's ability to thrive on coarse roughage in a tropical climate, to produce good milk and to work well in the fields. The need for shade, large, airy sheds and a plentiful supply of water is well understood.

During the past half century the buffalo population more than doubled, and the rate of increase is being maintained. FAO estimates for 1974 were 2 150 000 for buffaloes and 2 160 000 for cattle.

The Egyptian buffaloes are of one breed, with two vaguely differentiated local types, the Beheri of the delta and the Saidi of upper Egypt. The usual colour is black, although a fawn-grey colour is not uncommon. Milking buffaloes kept in the shade are lighter in colour than working animals. White markings on the face, legs and tail are seen in many specimens. Walleyes are not unusual. Albinoids are not known. Egyptian buffaloes are not so docile as other breeds.

The principal feedstuff during the winter — November to May — is the clover berseem *Trifolium alexandrinum*, fed as green forage. In the summer, the dry season, buffaloes get wheat or rice straw, clover hay or maize grown as a fodder crop, and concentrates for the milk producers. The main protein ingredient is undecorticated cottonseed cake; carbohydrates are provided in wheat and rice brans.

Calves in village herds are reared the natural way; those in the experimental farms are reared on the bucket. A total of 316 kg of milk is given in a period of 120 days. Satisfactory results were obtained when skim milk was substituted for whole milk. By giving suitable concentrate and roughage feed at an early age, calves were reared on as little as 100 kg of milk in 45 days. In all systems the calves are allowed to suck the colostrum during the first week of life.

Calf mortality may be as high as 33 percent during the first three months. The causes of death are closely associated with management deficiencies such as overcrowding, poor hygiene, parasites and virus infections. Losses in village herds are much less serious because natural rearing and small numbers favour the calves. Male calves are usually sold to dealers at about one month of age. The Government provides males for both natural service and for artificial insemination.

The age at first calving varies widely, depending largely on the level of nutrition from birth to puberty. The average of many reports for Egyptian buffaloes is 38 months. There is a well-defined breeding season: the percentage coming into heat is highest in September to November and lowest during the months of longest hours of sun. A small variation in the length of gestation was also recorded: the average during winter, December to February, was 319.6 days; and during September to November it was 315.6 days. Conception to first service was highest in summer, 66 percent, and lowest in winter, 59 to 62 percent. The service interval after the first calf was longer in winter, 193 days, than in spring, March to May, 167 days.

The average productive lifetime appears to be shorter than that of other domestic buffaloes. One study found an average of 4.5 years' breeding life; another gave 2.47 lactations in just over three years following the first calving.

Signs of heat in the Egyptian buffalo female are often subdued and, in the absence of a male, pass unrecorded. Oestrus lasted on the average 28 hours and the complete oestrous cycle averaged between 21 and 22 days. The best season for calving is September to November, when the climate is mild and green fodder is abundant.

The Egyptian buffalo is basically a triple-purpose animal. For working in padi fields its performance is much better than that of other animals.

It is used for threshing and water-raising for irrigation. On the road it is slow but powerful and can pull a load of more than a ton. In areas of high demand for milk there are many herds kept exclusively for milk production.

There are no records of milk yields by buffaloes in village herds. The average at the experimental farms is between 1 320 and 1 760 kg, but individual variation is very wide. The average length of lactation was 325 days; that of the dry period 200 days; and of the calving interval 520 days. The long calving interval can be reduced by improved nutrition, appropriate management systems during the hot season, by early detection of the onset of oestrus and by sex hygiene. The short productive lifetime of buffaloes in experimental farm herds is due, in part at least, to the severe culling practised in order to improve the performance of the breed.

The average butterfat content is 7 percent. In a total yield of 1 760 kg of milk the total fat was 123 kg. Most of the milk is separated, and the cream is made into ghee, called *samna* in Egypt. A fermented milk product, known as *zabadi*, is made from whole buffalo milk or toned milk. Skim milk is used in the manufacture of salty cheeses. They have good keeping quality and attract a high demand.

Most of the male calves born in dairy herds are sold for slaughter at about 3 to 4 weeks of age. The veal, known as *bitello*, is tender and is in demand. It is most plentiful in the winter. Most of the buffalo meat is derived from females that have been culled because of poor yields, barrenness, old age or injury. The rearing of calves for slaughter before the age of 18 months is advocated. Beyond that age the quality of the meat deteriorates, and growth rate and feed conversion rate decline. Some results of feeding trials are shown in Table 21.

TABLE 21. — MEAT PRODUCTION FROM YOUNG EGYPTIAN BUFFALOES

Age	Average liveweight	Dressing-out
	Kilograms	*Percentage*
50 days	74	59.9
6 months	157	57.2
12 "	230	57.7
18 "	359	57.6
24 "	449	52.7

The meat of castrates is lighter in colour than that of entire buffalo males. To attain good growth and high dressing-out percentages with quality meat, it is essential to maintain a high level of nutrition throughout the life of the animal.

Buffalo hides are of economic value in the leather industry. The types of leather depend on the age of the buffalo and on methods of flaying and tanning. Calfskins are made into quality leathers for shoes, handbags and suede garments. Horns are carved or moulded into useful and ornamental articles.

Many of the infectious diseases and parasitic conditions that afflict buffaloes and cattle in other countries occur from time to time in Egypt. Buffaloes are believed to be more resistant than cattle to rinderpest. Conditions that may be specific to buffaloes are "oedematous skin disease" and tail necrosis. Luxation of the patella is common. Surgery usually results in restoration to useful working or productive capacity.

Interesting results are reported on studies of causes of wastage in buffalo herds. Out of over 3 000 calves, 41.46 percent attained maturity, and 11.6 percent were culled because of defects of conformation or condition. Of the heifers reared to puberty, 5.7 percent were barren. The annual rate of wastage of adult females was 14.91 percent (6.1 percent for health reasons and 8.8 percent were culled for poor yields and other reasons). Of the males, 46.32 percent were sterile, 16.63 percent had poor semen quality or service performance.

Research teams in Egypt have made outstanding contributions to the knowledge of most aspects of buffalo production. Some of the programmes have involved modern, sophisticated techniques such as the use of isotope-marked elements in metabolism studies.

Introductions of water buffaloes into other African countries

Many attempts were made before there was adequate knowledge of the methods of control of tropical African diseases. The missionary-explorer David Livingstone, on his last journey in east Africa, took along camels, mules, donkeys and four Indian water buffaloes. He suspected the tsetse fly of transmitting disease, and carefully noted the dates on which the animals were bitten and the interval before the onset of illness. Within three months the buffaloes were all dead. Livingstone knew that the neglect of the sepoy attendants had contributed to the fatal termination. He mentioned the adverse effect of keeping the buffaloes in the sun's rays.

The importance of employing attendants who have long experience in buffalo husbandry is of particular urgency when attempting to acclimatize

to new environments. Native African herdsmen, though accustomed to the care of cattle, may not be in a position to give proper attention to buffaloes.

Attempts to domesticate *Syncerus* buffaloes have not been successful but, in view of their resistance to infections transmitted by tsetse flies and their adaptation to the environment, the possibility of harvesting the species for meat is worthy of study. The possibility of producing hybrid African × Asian buffaloes has been investigated, without success. They will mate but no conception follows.

Madagascar

Domestic buffaloes were introduced from India in 1957, with strict precautions of quarantine and vaccination. Losses from tickborne anaplasmosis occurred. Weekly dipping failed to keep the animals completely free from ticks. After two years the herd was split up, and this process was repeated in 1964 and 1965. With all precautions adopted, buffaloes can be kept in the east coast districts of Madagascar. Unfortunately, interest in the project was not sustained, largely because the local people are not inclined toward cattle-raising and still less to the care of buffaloes.

Milk yields ranged from 600 to 1 800 kg. Castrated males slaughtered at 2 years of age had dressing-out percentages of 42.45. The meat was of good quality.

The former Portuguese east African territories

A few domestic buffaloes were taken to Mozambique after the first world war, but all trace is now lost. In 1969 the veterinary service imported a herd of 100 of the Mediterranean type from Italy. They were kept in the Beira area for five months, during which period they were regularly dipped and well fed. Tests indicated that they had become infected with *Trypanosoma brucei* and *T. vivax*, and there were some indications of piroplasmosis and rickettsioses. It was shown that domestic buffaloes can be kept in the coastal area provided all the necessary health safeguards are maintained.

The herd was transferred to the Quelimane area, where they settled without trouble. The number transferred was 94; at the end of three years there were 216 at the new farm. The success of the project has aroused great interest among cattlemen.

There are many records of importations of Indian buffaloes from Goa and Sri Lanka by the early Portuguese into east African military stations, but none of them became permanently established. They were killed, in several instances, during conflicts with Arabs.

South Africa

Water buffaloes are kept in several zoological gardens. Crossbreeding trials with the African buffalo have not been successful.

In the National Zoological Gardens in Pretoria, where water buffaloes were first introduced in 1904, calves have been born regularly. At the Johannesburg zoo a small stock of buffaloes, imported many years ago, have bred exceptionally well.

There are also small herds on a few farms, maintained mainly as curiosities. The original foundation stock came from zoos or circuses.

These small collections might constitute a source of stock for trials in suitable water buffalo breeding areas.

Tanzania

Three water buffalo females were presented to the Tanganyika administration by the Government of Zanzibar in 1923, and an Indian male was imported. They thrived at first but died from trypanosomiasis or plant poisoning. Further consignments were imported from India and the services of an Indian attendant were retained. All required regular treatment but, by 1929, there were 22 in the herd. It was decided to attempt to breed hybrids with African buffaloes at the Mpwapwa institute of the Department of Veterinary Science and Animal Husbandry. Unfortunately, this coincided with the extension of the tsetse fly belt, involving the farms of the institute and, in spite of treatment with the drugs then available, the Asian buffaloes died or were destroyed. No hybrid was produced.

Water buffaloes seem to be particularly vulnerable to the tsetse fly.

The Government of Egypt presented two lots of Egyptian buffaloes to Tanzania in 1968. They have acclimatized well and are reported to be in good condition. They are kept at the Mpwapwa institute and at the Makubi government livestock station.

Tunisia

A few buffaloes were sent from Italy about a century ago; they subsequently became wild. More recently there have been importations of domestic buffaloes intended for work in agriculture. All have been eliminated.

Uganda

Ten Murrah buffaloes were presented by the Government of India in 1971; they were from a state farm. After some initial losses, they were

moved to the livestock station at Entebbe. Since then they have been dipped every week in an arsenical dip and at the end of 1972 there were 18 in the herd, all in excellent condition. They are allowed to wallow freely in the lake. They graze on napier grass and Rhodes grass and have up to 1.36 kg of concentrates per day. Some data are shown below:

	Kilograms
Average weight of adult females	538
" " " " males	781
" " at birth, males	37
" " " " females	31
" " at 4 months, males	104
" " " " " females	74
" " at 5 months, females	138
Milk production in 223 days: 1 167 kg	
Range: 337-1 478 kg	

The Indian buffalo has been shown to adapt well to conditions in central Africa when given proper care and health protection.

Zaire and Congo

Before 1914 12 domestic buffaloes were imported from Italy and kept at the Zambi station in the lower Congo. It is thought that they died from trypanosomiasis. In the 1930s further consignments were acquired from Sri Lanka and east Java and located at the National Institute for Agricultural Studies, where they flourished in spite of initial losses from parasitic worms. Early in 1953 the institute imported 12 Kundis from Pakistan, 5 of which were sent to the research station at Nioka at an altitude of 1 800 m and the rest kept at Yangambi on the Congo river. Initial results were satisfactory. High growth rates of calves were reported: 460 kg at 420 days in one case, and 417 kg at 395 days in another. Milk yields were higher than those of cattle. One herd was almost wiped out by rinderpest in 1961.

The domestic buffaloes were highly susceptible to *Theileria parva* and *Trypanosoma vivax*, less severely affected by *T. congolense*, and resistant to *Babesia bigeninum* and *Anaplasma marginale*.

Interesting observations were made on the existence of parasites of

Pakistani origin in calves born in Congo and infected from their dams.

A commercial herd established with stock from the institute farms was maintained for cheese production. The calving rate was low and there was difficulty in obtaining unrelated males but, apart from some parasitic disturbances, the health status was satisfactory. Milk yields were very variable, the best up to 1 403 kg in a ten-month lactation, with 11.20 percent butterfat. The enterprise was not economically rewarding and was being wound up by slaughter for meat.

Nigeria

In recent times several consignments of water buffaloes have been transported by air from the Northern Territory of Australia. Initial reports were that the animals had travelled well, with no loss in transit or on landing, and that they seemed to be acclimatizing well in quarantine.

The environment is suitable for buffalo rearing and, provided that management skills are available and disease control measures are applied, the experiment should succeed. The water buffalo could make a notable contribution to large-animal agriculture in Nigeria.

22. WATER BUFFALOES IN THE AMERICAS

The water buffalo is not an indigenous species in the new world. The American buffalo is the bison of North America. Water buffaloes have been introduced with success into several countries of South America and into Trinidad in the Caribbean zone.

There are still vast areas of land awaiting development. In the Amazon basin and in the Orinoco valley extensive lowlands subject to periodic flooding are ideal for buffalo breeding. The same observation may be made on areas in many other countries in South and Central America. The higher and drier lands are attracting the attention of cattlemen, but the possibilities for buffalo development are boundless.

The new world has, so far, managed to keep free from the most devastating diseases of livestock of other continents, but there are health problems that are particular to the Americas, and some diseases present different aspects, for example rabies transmitted by vampire bats.

The buffaloes of Brazil

Although the first introduction was made less than a century ago, there is little historical record of the earliest consignments. They were probably moved without any official control. The numerous importations in recent decades have been subject to health control for long periods in island quarantine stations.

It is thought that the first water buffaloes were moved into the Amazon delta from French Guiana and Surinam. They were Swamp buffaloes descended from stock from then French Indochina or the Dutch East Indies. They have prospered in the ideal buffalo environment of the island of Marajó.

River breeds were imported from Italy, Egypt and India in the early years of the present century and further groups have been brought in at intervals since. River breeds have been distributed widely in Brazil and there are now established herds in many states. The main populations are in Pará, São Paulo, and Minas Gerais, and there are some herds in Mato Grosso, Maranhão, Paraná, Santa Catarina and Rio de Janeiro.

FAO estimates for the buffalo population in 1974 were 150 000, but it seems highly probable that this figure is far too low. The Associação de Criadores de Búfalos (Buffalo Breeders' Association) gives a recent estimate of 300 000.

The rate of natural increase is believed to be higher than in other continents and reaches 10 percent annually in some districts. Three quarters of the total buffalo population are in the Amazon basin, many of them on the island of Marajó.

The livestock census does not differentiate between cattle and buffaloes. This grouping of bovines for census returns is also used in some other countries and it is one of the causes of the underestimated buffalo numbers. Many are counted as cattle or left out altogether. In some countries the number owned by a farmer cannot be cited exactly when the buffaloes live in a feral state. Low numbers may also be indicated in order to avoid taxation.

The Buffalo Breeders' Association has given impetus to the establishment of herds of purebred buffaloes. Herdbooks have been instituted for the Murrah, Jafarabadi, Mediterranean and Rosilho (Swamp) breeds.

The River breeds are typically black and are generally referred to as Preto (black) breeds. Fawn or light brown calves are sometimes produced by black parents; they are called baio (bay) buffaloes. Piebald specimens and walleyes are occasionally seen. The Mediterranean breed is similar to the type kept in Europe and is now the most numerous in Brazil.

Swamp buffaloes are losing ground to the Preto breeds except in the floodland areas. They are sometimes referred to as carabaos.

The herdbooks are recognized by the Ministry of Agriculture and standards for registration in each breed have been formulated. It is unfortunate that in the past attempts at breed selection for fancy characteristics have been common. One herd of Jafarabadi buffaloes is selected for white faces and points; another herd is composed of baio buffaloes. The breeders' association is making every effort to secure selection for performance as well as for breed characteristics.

Purchasing missions have visited Egypt, India, Italy and other countries to acquire further consignments of suitable stock for breed improvement.

It is convenient to consider the buffaloes of Brazil in two sections: those in Amazonia and those in the central and southern states.

THE BUFFALOES OF AMAZONIA

The first water buffaloes to be introduced into Brazil were taken to the low-lying island of Marajó in the delta of the Amazon, where conditions

are ideal. They multiplied rapidly and further importations of improved breeds have been equally successful. Marajó is the largest river island in the world. Apart from a few Indian burial mounds, no part of the surface is higher than 8 m and much of it is flooded for half the year. There are about 50 000 buffaloes on the island and about 600 000 cattle.

The buffaloes and cattle of different owners range freely together. They are rounded up as required for branding, castration and selection for sale. The animals generally keep to the low-lying land while the cattle seek the drier areas. As yet only a small fraction of the land has been developed. Very little fencing is erected and uncontrolled burning is commonly practised. The livestock of the island provide most of the meat, butter and cheese supplies for Belém, a rapidly expanding city of more than 400 000 inhabitants.

Most of the buffaloes are of the Mediterranean type. There are two commercial dairy farms. During the dry seasons platforms are built of hardwood, the surface being above the highest floodwater level. These platforms are called *marombas*. The animals go through a deep pond to remove mud before ascending a ramp on to the platform. During flood seasons they continue to range freely by day, spending much time swimming and eating large quantities of aquatic plants, rushes and canarana grass. Even in the dry season there is always ample vegetation in the water courses and buffaloes keep in good condition all the year round.

Much of the pasturage on the drier land is poor. During floods the cattle overgraze the higher land and have to be fed with cut forage. Considerable damage may be caused by buffaloes in their efforts to make mudholes, but the extent of such damage has been exaggerated by some cattlemen. Dehorning, and the erection of rubbing posts in the pens, reduce the tendency to damage pastures and installations.

The director of the Agricultural Institute of the North, at Belém, established herds during the 1930s and gave a lead in the extension of buffalo breeding in the Amazon region. Herds of Murrah, Jafarabadi and Mediterranean buffaloes are kept at the farm of the institute. Milk yields average 1 100 to 1 200 kg with 8.5 percent butterfat. There are records of two buffaloes calving at the age of 37. At the livestock experimental station of the institute upriver at Maicurú, there are about 1 400 buffaloes but no cattle. The estate could support 10 000 buffaloes. During times of flood the animals are turned loose, the calves taking all the milk. Swamp buffaloes might do well in these conditions for meat production.

Experiments carried out on the estates of the institute showed that smooth canarana grass, *Echinochloa pyramidalis*, is the most successful plant for land subject to flooding. Buffaloes gave yields of up to 2 032 kg of milk on canarana pasture without concentrates.

One buffalo yielded 4 645 kg in 365 days, with 7.3 percent butterfat, in its second lactation.

Electric fences are more satisfactory than barbed wire. Cryobranding is effective for Preto calves at 4 months of age; it is less satisfactory when applied to older buffaloes. A copper marker, with dry ice and absolute ethyl alcohol, is applied to the skin for 60 seconds. Calves are dehorned at 3 to 8 days. Vasectomized males are kept to indicate onset of heat.

The average age at first calving is 39 months. The calving rate is 89 percent, and the calving interval 15 months.

Machine milking has been introduced. The animals are trained during the week after calving; 80 percent can be milked without the presence of the calf.

Buffalo steers attain 200 to 250 kg liveweight in the first year and 400 kg in the second, without the feeding of supplements. At 5 years of age they weigh 600 to 800 kg. Dressing-out percentages average 48.7. Hides weigh up to 56 kg, giving an impression of the size of some of the animals coming forward for slaughter.

Breeding and growth of buffaloes and of cattle may be compared in the data shown in Table 22.

TABLE 22. — COMPARISON OF PERFORMANCE OF BUFFALOES AND CATTLE ON THE ISLAND OF MARAJÓ, BRAZIL

Average	Buffaloes		Cattle
	Male	Female	Both sexes
Weight at birth (kg)	33.6	31.4	27-28
Weight at one year (kg)	164	181	110-130
Weight at marketing (kg) . .	330	330	330
Age at marketing (months) .	24	24	42-48
Age at first calving		24+	36+
Calving interval (months) . .		14-15	18-19
Number of calves		12+	5-6
Dressing-out percentage . . .		48-49	52-53
Calf mortality (%)		4	12

A herd of the Mediterranean breed in Belém recorded an average yield in the sixth lactation of 1 545 kg at once-daily milking and of 1 918 kg at twice-daily milking, an increase of 24.1 percent.

A herd of baio buffaloes has been established upriver. They are said to have originated in two light-coloured Murrahs from south Brazil. There is also a herd of the Swamp breed, but they seem to be yielding place to Preto breeds. A vast estate about 500 km upriver is being developed for livestock. Buffaloes will be bred on islands and low-lying land and cattle on the higher tracts of country.

In one of the dairy herds on the island, five males run with 115 females. Their lifetime is at least 15 years, during which time the females will produce eight to ten calves. The average milk yield is about 3.5 kg in addition to rearing a calf.

Calves are weaned naturally at 8 to 10 months, but if suckling persists, blab plates may be fitted. Many calves of feral buffaloes are captured and domesticated. Males are castrated by rubber ligature or by the bloodless castrator.

Buffaloes are used for haulage on the island and for towing flat-bottomed boats. The cowhands — *caboclos* on Marajó — ride buffaloes, with or without saddle, and generally barefoot with stirrups that accommodate only two toes. They carry long, wooden goads when herding. The cowherds of Brazil — *vaqueiros* — are capable and versatile in managing livestock and are resilient to the demanding environment. When they are called on to herd buffaloes for the first time they tend to drive them too vigorously, being more accustomed to the lively Zebu cattle. They need to be taught the limitations of buffaloes.

Dishorning and dehorning are becoming more widespread. Shooting feral buffaloes has been offered as a tourist sport but has not been well patronized.

In fattening trials of Mediterranean buffaloes at Belém, on elephant grass, wheat bran and minerals, there was an average growth from 213.5 to 333.5 kg in 140 days, an average daily gain of 0.857 kg; 2-year-old buffaloes on improved pastures with mineral supplements attained an average liveweight of 484 kg and dressed out at 55 percent. Canarana grass proved to be the most profitable pasture plant. Individual liveweights of mature buffaloes of up to 1 200 kg for males and 1 000 kg for females have been reported.

Buffaloes of the central and southern states of Brazil

The state of São Paulo is the centre of buffalo development. Most of the herds are kept for milk production. There are several herds of purebred Murrah, Jafarabadi and Mediterranean breeds, and many crossbreds.

Milking is done by hand. The buffaloes stand quietly to be milked. Restraint is rarely required and it is not necessary to tie the tails.

Some performance details for a dairy herd are as follows:

1. The average milk yield was 1 453 kg in 300 days.
2. Most matings took place March to June.
3. Age at first calving was 2 to 4 years.
4. Most calves were born January to May.
5. The average calving interval was 387 days.

Data recorded by the Instituto de Zootécnia de São Paulo include the following:

Liveweight of buffaloes at				1 year:	250-280	kg
"	"	"	"	2 years:	400	"
"	"	"	"	5 years:	800	"

In feeding trials young female Indian buffaloes showed higher weight gains than males. Young Italian buffaloes made greater weight gains than Indian buffaloes.

In a herd in the northwest of the state of São Paulo buffaloes attained top-grade finish at 30 months of age; Zebu cattle not until 42 months.

Dressing-out percentages of up to 55 have been recorded. Buffalo meat is steadily gaining popularity.

A herd of Murrah × Mediterranean buffaloes produces animals of 450 to 500 kg at 2 to 2½ years of age on marshland grazing with colonial grass but no concentrates.

Murrah and Jafarabadi breeds appear to be gaining ground more rapidly than others. Preto breeds are thought to be more docile than Rosilhos. Any variance that there may be is probably due to different systems of management.

The calving rate is around 85 percent annually. The age at first calving is about 3 years, the calving interval 387 days. The average milk yield, with once-daily milking, is about 4 litres, and the best daily yields at the height of lactation are around 10 litres. In purebred herds yields of 16 litres are common.

Most of the calves are reared and many are fattened. They are generally dishorned at about one year of age.

Buffaloes are not used for work in São Paulo; cattle are preferred.

There are about 6 000 buffaloes kept for milk production in the state

of São Paulo and numbers are growing rapidly. Fresh importations are planned and there is a lively market for supplying good quality breeding stock to other states. Some buffaloes have been exported to Venezuela and to other South American countries, but the Government of Brazil now limits and controls the trade.

Interest in breeding buffaloes is widespread, particularly in the regions served by meat-packing plants.

Losses

Outbreaks of foot-and-mouth disease occur periodically; cases are generally mild, and recovery rapid. Many owners believe that the cost of vaccination would exceed the losses from the disease. Brucellosis is a problem on Marajó island and there are local difficulties in the planning of control. In the state of São Paulo, buffaloes are vaccinated against anthrax and brucellosis. Leptospirosis is suspected.

A few cases of tail necrosis and of photosensitization have been recorded.

Most of the common parasitic conditions occur, but it is said that there are no liver flukes; it may be that the specific snail intermediate hosts are not present. Calves must be treated against roundworms.

Mineral deficiencies are common in many areas. The general provision of salt and mineral supplements is advocated.

Predatory animals, particularly jaguars, kill some young animals, but the buffalo will defend itself and its calf with great vigour and courage. Poisonous snakes cause some losses. The stories of damage caused by piranha fishes have been grossly exaggerated, but teats are occasionally injured. Weak animals may get bogged down in deep mud and may then be attacked by caymans and vultures.

French Guiana

Swamp buffaloes were imported from former French Indochina for working in the penal settlements. River breeds were subsequently introduced for milk production. Eventually local interest waned and the buffaloes were allowed to become feral in the marshlands of the coastal belt. In spite of hunting, they persisted for more than 30 years. About 15 are still kept as municipal working animals in Mana.

Female buffaloes calve within the herd and are thus protected from attack by predators at that critical time. Cows, on the other hand, isolate themselves and their calves and are more exposed to attack. The wallowing habit and plastering with mud are said to provide protection against the bites of vampire bats.

Surinam

Swamp buffaloes were introduced from French Guiana in 1895 for working in the sugarcane plantations. Further importations, probably from the then Dutch East Indies, were made to provide working animals for agriculture and haulage. There are now around 280 buffaloes in Surinam, used for logging and as a source of meat.

Guyana

Swamp buffaloes were introduced in the early years of the present century for working in sugarcane plantations. Murrahs were imported later for milk supplies. A peak population of more than 400 buffaloes was reached by 1926. Then a decline followed as a result of the mechanization of sugarcane production, and the population at present is only about 40.

Some feral buffaloes may still breed in the swamps of the coast but, owing to the damage they do to crops, they are harassed by marksmen in low-flying aircraft.

Water buffaloes could, undoubtedly, be raised for meat production in these otherwise unutilized lands.

Venezuela

There are vast areas of marginal land with abundant vegetation suitable for buffaloes and which are too wet for development as cattle ranges. In the Orinoco delta there are many areas subject to annual flooding which are ideal for water buffaloes.

A consignment of buffaloes was imported from Trinidad for milk and meat production but they became feral and were hunted for sport; by 1948 they were thought to be exterminated. There is, however, a report that a few have been sighted in the marshes around lake Valencia.

A small herd was introduced into a dry district of the state of Guárico and has settled well.

An experimental farm was established on Guara island in the delta of the Orinoco in 1968 and a herd of buffaloes from Trinidad was set up. A further herd is to be collected on another official farm, in the state of Apure. It has been shown that the buffaloes in the region of the Orinoco delta produce meat that is equal to beef. A few animals have been selected for milk production trials and have performed satisfactorily. A popular cheese, *cincho*, is made. Many cattlemen are now interested in buffalo development.

is a recurring problem. Reproduction was satisfactory and the herd increased considerably. Unfortunately there were management and handling problems and the herd was slaughtered out. By local standards the carcasses were of outstanding quality.

The moral of this brief sad history is that it is not sufficient to introduce water buffaloes into a suitable environment and to hope for success from management practices that have been applied to cattle-raising. Management skills must be provided.

At the present time official consideration is being given to the establishment of buffalo enterprises in the Cochabamba and Santa Cruz areas where the environment is eminently suitable. Some small experimental introductions of buffaloes have been successfully carried out. Several veterinarians and animal production specialists are gaining buffalo management experience in Italy.

Argentina

There are two herds of water buffaloes in Argentina, one of 300, the other quite small. They are not kept for commercial purposes and their origin is unknown.

A small consignment was imported from Romania in 1910 for milk production, but all trace of the animals has been lost.

Trinidad and Tobago

River buffaloes were introduced from India into Trinidad in the early years of the present century. They were acquired to work on a sugarcane plantation. Several further consignments followed at intervals between 1924 and 1949. The breeds imported were Jafarabadi, Murrah, Nagpuri, Surti, Bhadawari, Nili and Ravi.

As a result of mixing of breeds, there are many nondescript types, but efforts are now concentrated on selection of beef types and the evolution of a breed called the "buffalypso."

The climate is favourable, warm, with little daily or seasonal variation, high rainfall, two short dry seasons, January to April and September/October, never severe. Rough vegetation abounds and, although wallows are not available, the buffaloes thrive.

FAO estimates for the number of buffaloes in 1974 were 7 000; those for cattle 71 000.

Buffaloes are still used for working on sugarcane and coconut plantations

and for haulage; one type can pull a cart on pneumatic tires with a load of 1 270 kg with ease. Milk production has been neglected and there are no commercial dairy herds of buffaloes. Several herds are now primarily concerned with raising young animals for meat.

Trinidad imports relatively large quantities of meat and dairy products. Much could be produced locally.

If buffaloes are to make any real impact on the economy there must be a rapid increase in the total number. Buffaloes have been exported in recent years to Venezuela, Colombia and Costa Rica. The question of limiting exports or, alternatively, importing breeding stock, should be examined.

Water buffaloes are commonly referred to as "bison" or "hog cattle." Red or fawn-coloured specimens are preferred; pink muzzles and albinoids are not prized. The buffalypso has a low, compact body on short legs. It is a quick-growing animal with efficient feed conversion and thrives without wallows.

A group of calves, selected at random, showed the average liveweights as follows:

Age	Liveweight
Months	*Kilograms*
6	195
12	299
18	376
24	476

In another series of trials, 40 buffalo calves, under one year of age, were kept on pasture for nine months. The average daily weight gain was 0.49 kg. During the dry season molasses and sugarcane bagasse were fed with grass. Weight gains were 0.922 kg per day.

Males kept on higher levels of nutrition attained 367 kg at 12 months of age, and 442 kg at 16 months. Very high dressing percentages were recorded, up to 60 percent.

Interesting trials of palatability of buffalo meat were undertaken in Trinidad at "palatability dinners." They confirmed the opinion formed in other places that the meat of well-fed young buffaloes is attractive in appearance, tender and tasty and difficult to distinguish from prime beef. Further details are given in the chapter on meat and meat production (see p. 146).

Breeding is seasonal and the age at first calving is rather late. These factors may be a disadvantage in milk and meat production planning. The long productive life counterbalances the disadvantages to some extent.

Experiments with higher levels of nutrition during the off-season for breeding did not affect the seasonality.

Pastures of savanna grass showed poor growth during dry seasons and suffered some damage by buffaloes and other large domestic animals.

Animal health

Trinidad is free from foot-and-mouth disease but there is a constant danger of its introduction from South America. The production of adequate home supplies of meat would reduce the risk involved in the importation of meat and meat products.

Rabies, transmitted by vampire bats, has caused the death of many cattle and human beings in the past. No cases have been recorded in buffaloes or dogs. Cattle are vaccinated annually with a satisfactory level of protection.

The earliest introductions of buffaloes were decided upon because it was thought at that time that they were resistant to bovine tuberculosis which was causing serious losses in the Zebu cattle in the plantations. It is now recognized that the infection was spread by the insanitary conditions in which the animals were kept when not working. They were maintained in barns which were cleaned out once a year. Feed was spread on the surface of deep, wet dung. Tuberculin tests showed up to 30 percent positive reactors. The resistance of buffaloes is only relative but losses are not now serious.

Trinidad is free from all the major contagious diseases of livestock of Africa and Asia. It is fortunate that early buffalo importations did not carry exotic viruses and bacteria with them.

Most of the common parasites of bovines have been identified in Trinidad. Calves are particularly vulnerable to roundworms but losses do not seem to be severe.

23. THE BUFFALOES OF AUSTRALIA

Swamp buffaloes were brought from Timor in 1826 to military settlements in the Northern Territory. The settlements were abandoned a few years later. In 1828 a station was established at Port Essington and 18 buffaloes were obtained from Kissa island, then part of the Dutch East Indies. A further shipment of 40 buffaloes was added later. This settlement was abandoned in 1849 and the breeding animals were left to become feral. They multiplied and spread and reached an estimated peak population of 150 000 around 1964.

A few were moved to Port Darwin in 1886 in an unsuccessful attempt to establish a butter industry.

Most of the buffaloes live in the coastal floodplains and river courses.

The climate is tropical, with high and intense rainfall during the wet season, October to March, and very little, if any, during the rest of the year. Most of the rivers are deep floodwater channels in their upper reaches; in the plains the courses are often ill-defined. High tides impede drainage from the land. In the dry season there are permanent water holes, known as billabongs, in the riverbeds. Some streams fed by springs run all through the dry season.

Vegetation is typical swampland growth or, on the ridges, abundant spear grasses and native sorghums. There are a few fresh-water mangroves in the plains and numerous eucalyptus trees on the ridges.

Buffalo behaviour

The females and calves have strong attachment to their territories. They have regular routines of visits to drinking point, wallow, grazing area, rubbing tree, dunging spot and resting site. They follow well-defined tracks which vary with the seasons. Reluctance to leave their home territory may have disastrous consequences when water holes dry up and feed is scarce.

Buffaloes wallow during the hottest hours. On entering the wallow they

generally unload dung and urine, then rolling in the mud alternates with periods of chewing the cud and sleeping. Single wallows are common and there are larger ones used by family groups.

During the wet season and for a month or two after, there is abundant feed and the buffaloes graze early in the morning before wallowing, and again in the evening. In dry seasons they gather wherever feed and water are available and may move around at night. During times of flood they submerge completely in search of vegetation.

Most of the calves of feral buffaloes are born during the wet season or shortly after. The calving rate is probably quite high. Out of more than 1 000 slaughtered in 1968 at one abattoir, 82.3 percent were pregnant. Domesticated buffaloes come into heat regularly but around 70 percent of the calves are born during the season January to March.

Calves attempt to stand shortly after birth and to suck soon after. The dam stays with the calf for several hours and, when it moves away to graze, it calls to the calf, which answers the call. Buffaloes have a well-established nursery system for calf care. Females will adopt any calf in need. Even young bulls have been observed to take care of calves.

Losses

Tuberculosis is probably the most important disease. Australia is free from the major contagious diseases of livestock. Leptospirosis has been confirmed.

Most losses occur as a result of weakness toward the end of the dry season. Lack of food due to overgrazing or to indiscriminate burning may lead directly to death, or weakness prevents some animals from getting out of bogs up steep slopes. They may then be attacked by predators — wild dogs, feral pigs or crocodiles. Death from thirst has been noted, although water may have been available not far beyond the buffalo's home territory.

Ticks are the major problem in many parts of Australia, but they appear to be more attracted to cattle than to buffaloes which have a high degree of resistance to infestation. There is no liver fluke problem; the snail intermediate hosts are not present.

Domestication

Feral buffaloes were first captured for domestication in 1958. Many calves are caught, reared, dishorned or dehorned and quickly take their place in the herd. Older animals are tethered to trees for up to six days. In most cases it is possible to handle and lead with a halter within two

weeks. Even old males and females with calves at foot respond to patient and careful attention. They are kept in paddocks with controlled grazing and it is usually possible to walk freely among them at a very early stage in domestication.

Little difficulty is experienced in rounding up feral buffaloes and herding them into pens. Some are taken direct to the abattoir in Darwin.

Many are rounded up for slaughter during a short season each year, others are selected for domestication, and a progressive export trade is developing. In spite of all the harvesting of buffaloes, it is thought that there are at present more than 200 000 (feral and domesticated) in the Northern Territory.

Two large properties started to catch and domesticate feral buffaloes in 1969 and the system has grown steadily. One method is to erect portable steel catching pens; the other has permanent pens at strategic points. It has been found that a helicopter can be used to gather small groups together into mobs of around 150 at a time. One enterprise plans to establish a herd of 15 000 domesticated buffaloes; another already has between 6 000 and 7 000. Many of the smaller properties now have limited stocks of buffaloes.

Dishorning and dehorning are becoming routine operations found to be effective and advantageous in the handling of the animals.

Young buffaloes fed on poor forages without concentrates put on nearly 0.5 kg liveweight daily. Cattle and bantengs scarcely maintained condition. Hay without concentrates was as effective for weight gains as hay with concentrates for buffaloes.

The meat industry

Between 1886 and 1940 nearly 280 000 buffaloes were shot for their hides, and between 1946 and 1965 the trade was renewed and a further 100 000 were shot. The value of hides, however, declined and attempts were made to convert carcases into fertilizer, but there was little demand.

Then meat was harvested for pet food until, in 1959, a small meat industry was established. The first abattoir for buffaloes was opened that year at Marrakai in the Northern Territory. During the first season 2 500 buffaloes were slaughtered and produced 400 tons of boned-out meat. The industry developed rapidly until, in 1965, eight small abattoirs were operational. The total number slaughtered that season was 17 000. In addition, more were shot for animal food and some buffaloes were exported live to Hong Kong.

In most areas only males 3 years of age or over are taken. Numbers are regulated officially each season for each property. Overstocking has

caused severe erosion in some areas and programmes for the reduction of stock were instituted in 1974.

In selecting females, efforts are made to take only barreners, but around 2 percent are found to be pregnant.

Operations are seasonal. Transport is not possible during the wet season. Buffaloes slaughtered at the end of the wet season are in good condition and yield from 230 to 250 kg of meat. At the end of the slaughter season they are generally in poor condition and yield from 160 to 180 kg of meat. Individual yields of 280 to 290 kg have been recorded.

One method of taking buffaloes for meat is to trail the groups and shoot selected animals. They are immediately bled, loaded on to trucks and taken to the abattoir for dressing and inspection. Time is of vital importance.

Movable pens, made of steel tubes that can be taken apart and re-erected in convenient sites, are used by some firms. An entry funnel is made, with a collecting pen and loading crush.

One establishment has erected permanent pens and yards for rounding up and loading. The capital cost of the system is high but operational costs are reduced, the flow of animals for slaughter is improved, and the dressing of the meat is facilitated. Two abattoirs have export licences for meat; the others send boned-out meat in refrigeration trucks to Darwin.

Spray races have a calming effect on buffaloes prior to slaughter and improve the appearance of the carcass.

It is confidently expected that buffalo meat will be widely available in Australian and overseas markets in the near future. Trial shipments have been sent to the United States. Hotels in several Australian cities serve buffalo steaks. Samples are being studied at the meat research laboratory in Brisbane. The boned-out meat is excellent for manufactured products.

Export of live buffaloes

A remarkable development in recent years has been the export of buffaloes by air in consignments of up to 200. It is a profitable business. Groups of various sizes have been sent to Brunei, Papua New Guinea, Guyana, Nigeria and Venezuela. Interest has been shown by the authorities of many countries in the Americas. Small herds have been set up in South Australia and are thriving.

Australia is free from all the major contagious diseases of livestock and is in a very favourable position for the export trade. Health examination and tests are provided by the government services. It is thought that up to 5 000 buffaloes could be exported annually without seriously depleting stocks.

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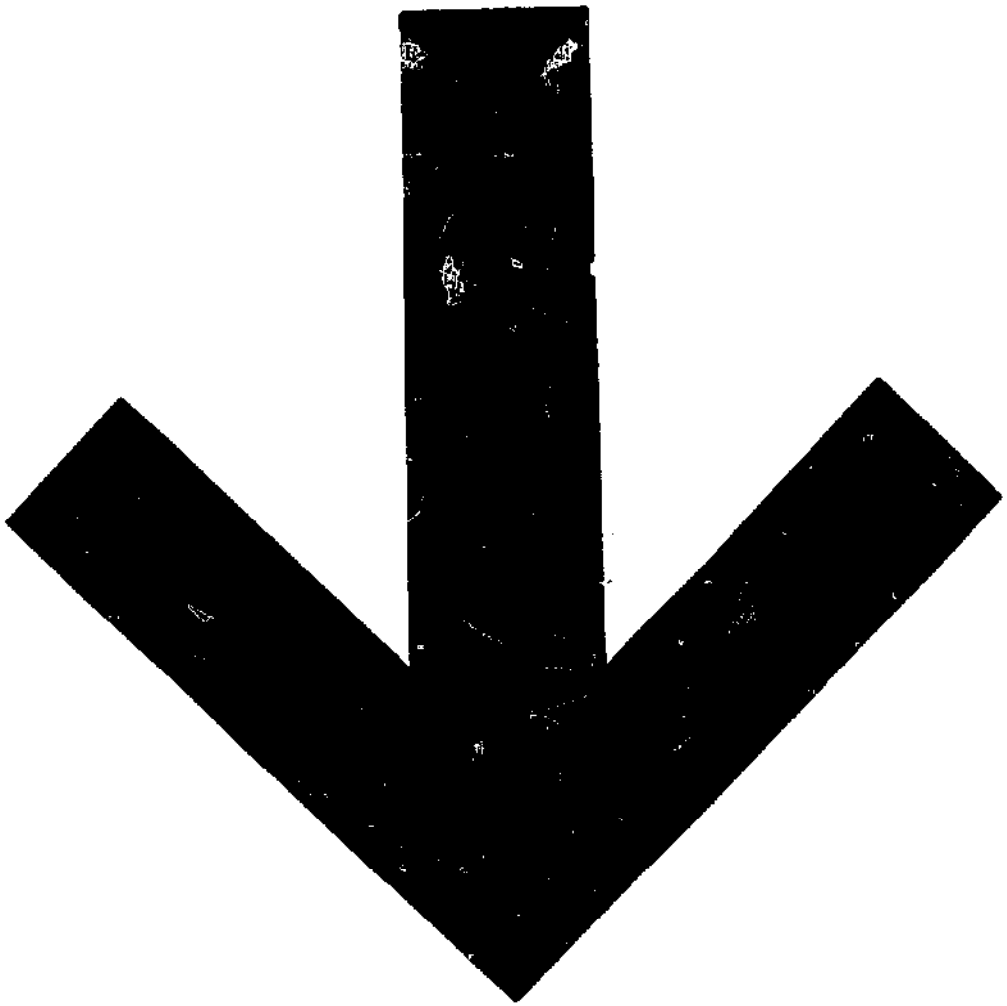

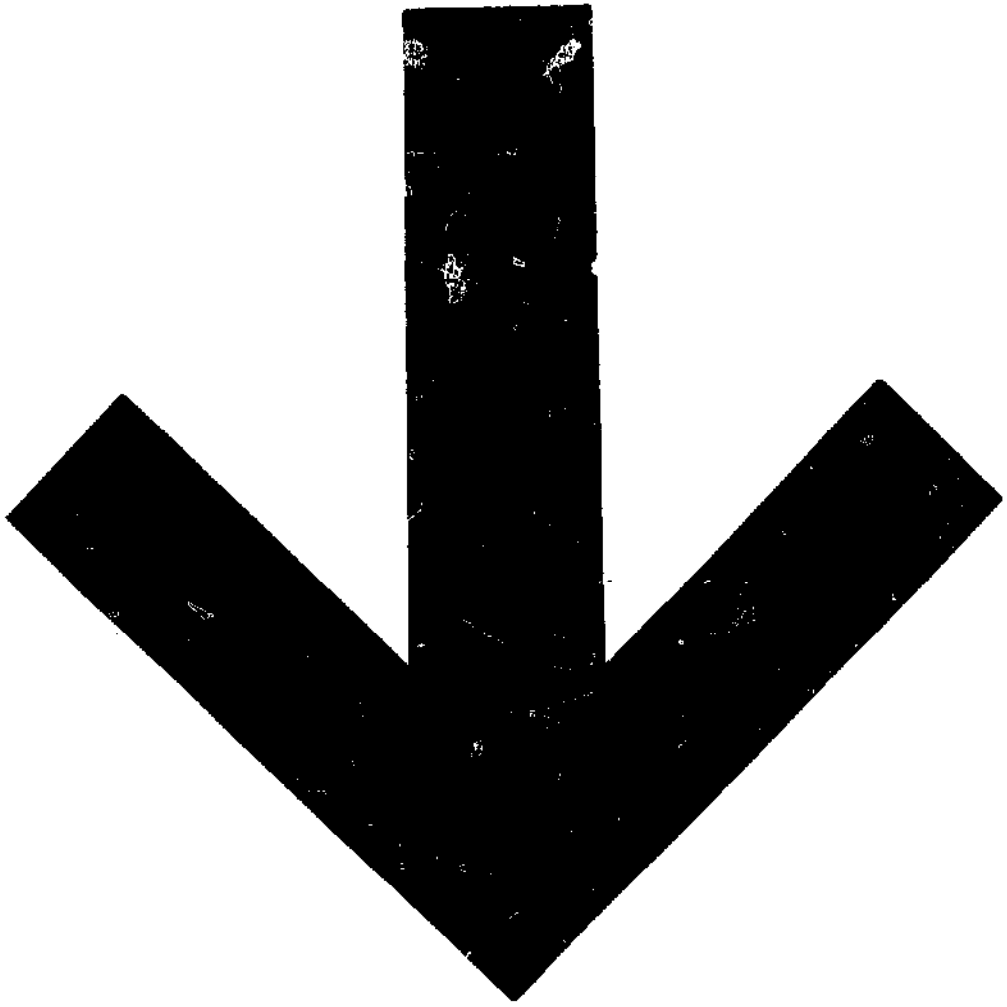

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