Animal Health Management
Review of issues that influence Animal Health Management

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INTRODUCTION

After completing this module students will be expected to know and understand the main issues that influence animal health management in the livestock sector. They will be expected to understand the influence that the epidemiological features of diseases exert on control strategies and the principles on which disease control measures are based, to enable them to make science-based animal health management decisions that are appropriate to the conditions under which they will be implemented.

There are four major issues that influence animal health management. These are the following:

- The types of animals involved
- The production system
- The diseases that need to be managed
- The options available for managing the diseases (basic principles of disease control measures).
ANIMAL FACTORS AND ANIMAL HEALTH MANAGEMENT

Introduction

Animal factors that influence disease management include the following:

- Species
- Breed
- Age and stage of the production cycle
- Behaviour
Livestock Health, Management and Production › Animal Health Management › Review of issues that influence animal health management

Goats being driven along the road

Local breed sheep, Ivory Coast

Nguni cattle, South Africa

Village chickens, Boane, Mozambique
Influence of species characteristics on disease management

The diseases to which an animal is susceptible depend first and foremost on its species. Foot and mouth disease (FMD) targets all cloven-hoofed species, i.e. important domestic livestock species as well as numerous wild species. Not all the cloven-hoofed species are equally susceptible. Cattle and pigs develop the most prominent clinical signs; sheep develop subtle lesions that may easily be overlooked and they can therefore spread the disease undetected. African buffalo (*Syncerus caffer*) are a maintenance host of the virus and are resistant to its pathogenic effects, but under certain conditions can infect other species. FMD is therefore impossible to eradicate in the areas where they maintain the virus.

On the other hand, contagious bovine pleuropneumonia (CBPP) is restricted to cattle; lumpy skin disease (LSD) causes clinical signs in cattle but it is uncertain whether there is any wildlife involvement. African and classical swine fever (ASF, CSF) only affect members of the pig family, but African wild pigs are refractory to the effects of ASF virus and a cycle of maintenance occurs in warthogs (*Phacochoerus africanus*) and argasid ticks in southern and eastern Africa that makes ASF impossible to eradicate in these regions.

The species of animal determines the purpose for which it is kept as well as the husbandry system options and to some extent the areas in which it will be kept. Although humans are adept at creating an artificial environment in which to raise animals, there are limitations and, for example, pigs are not commonly kept in arid and semi-arid environments on account of their water and shade requirements. However, many species that evolved in these environments, like sheep and ostriches, are raised under very different environmental conditions, for example on planted pastures, and this can result in an imbalance between the host and its adapted pathogens.

Size can play a role in how likely a species is to spread diseases that depend on movement of live animals. Large animals like cattle are more likely to be noticed moving illegally than small ruminants, pigs or poultry, which are also easier to move.

Finally, the physiological characteristics of species may influence their susceptibility to disease and also how diseases can be managed. There are marked physiological differences between mammals, birds and reptiles. Mammals and birds are homeothermic and thus able to maintain their body temperature within narrow limits regardless of the ambient temperature. Reptiles are poikilothermic and their body temperature is largely dependent on ambient temperature. Birds have a high metabolic rate and higher
average body temperatures than mammals, so that they may be unaffected by pathogens that are harmful to mammals because their body temperature is too high for the pathogen, e.g. *Bacillus anthracis*.

Nutrition has a strong influence on health and on immunity to diseases, and the nutritional requirements of ruminants and monogastric animals are different, as are the requirements of different species within those groups. In particular, failure to adapt to a completely different habitat in terms of edible vegetation has resulted in losses in the wildlife ranching industry. Animals suffering from malnutrition may be unable to mount a strong immune response to infections and infestation with ticks and other external and internal parasites. Differences in ability to absorb and eliminate drugs between species means that dosages have to be determined according to species, which is why extra-label administration of drugs is only permitted for veterinarians at their own responsibility.

**Influence of breed on disease management**

Among domestic animals, breed has a strong influence on disease susceptibility and therefore on disease management. Most breeds of domestic livestock kept in Africa originated either in Europe or Asia, although many have been in Africa for a very long time. The history of cattle on the continent is lost in time, but may be elucidated by a combination of archaeological and genetic research. It is generally agreed that *Bos taurus* cattle were either introduced very early or were domesticated in Africa from wild cattle (African aurochs) and are represented today by, for example, the N’Dama breed in West Africa. Zebu cattle (*Bos indicus*) were introduced from Asia and these had a strong influence on the local cattle because they were sought after for their larger size. Most of the ‘indigenous’ cattle breeds are adapted to a tropical climate and are characterised by an elevated resistance to ticks and tick-borne diseases. The N’Dama cattle have an elevated resistance to trypanosomes, and recent research has identified two candidate genes that appear to confer resistance. The colonisation of Africa by Europeans in the last few centuries saw the introduction of new, mainly European cattle breeds, mostly *Bos taurus* but also new zebu breeds like Brahman, developed in the USA from Asian stock. Some of the newly introduced breeds proved highly susceptible to diseases like East Coast fever and other tick-borne diseases. Similarly, breeds of small ruminants, which originated in Asia but have a long history in Africa are generally hardy, while relatively recently introduced breeds like merino and Île de France sheep and Angora goats are more susceptible to local diseases.
Unlike ruminants, pigs do not have a long history in Africa, and were probably introduced about 500 years ago, probably mainly from Portugal. Many of the traditionally farmed breeds, and certainly those in the former Portuguese colonies, were derived from the Iberian pig, which showed better resistance to ASF when it was introduced into Portugal and Spain than more modern breeds. This may be why populations of this type of pig in an area that includes adjacent regions in Mozambique, Malawi and Zambia have a much better survival rate when infected with ASF virus than most pigs, with up to 50% of healthy pigs having antibodies to ASF. The breeds of chickens that are found in rural areas also tend to be more resistant to diseases like Newcastle disease than modern breeds. However, recruitment of modern genetics into populations of rural livestock has frequently occurred and in this way a degree of resistance has been lost.

For more information on livestock breeds refer to modules on livestock production.
Influence of stage of production cycle/age on disease management

Age, sex and stage in production cycle influence susceptibility to many diseases and how they can be managed. In general, young animals are more susceptible to infectious diseases because immunity usually becomes stronger over time. On the other hand, young animals are less susceptible to certain tick-borne diseases like bovine anaplasmosis, which causes more severe disease in mature cattle. Young animals that do not get colostrum soon after birth are particularly prone to infections. Another dangerous period is at the time when passive immunity wanes and active immunity has not yet resulted from exposure or vaccination. Immunity may also decline in old animals but most production animals in modern husbandry systems do not become very old as they are culled as soon as they pass their peak of production.

Young animals are usually more susceptible to diseases

Age can also influence the way in which a disease manifests. Porcine reproductive and respiratory syndrome (PRRS), for example, causes high mortality in suckling piglets, respiratory disease in older piglets and abortions in pregnant females. Lamb dysentery, caused by Clostridium perfringens Type B
affects animals under the age of 14 days. The majority of cases of infectious diarrhoea in all species occur in the pre-weaning and early post-weaning stages. Some diseases like ASF will affect animals of all ages and high mortality in animals of all ages alerts animal health practitioners to the fact that they are dealing with a particular type of disease.

Diseases that affect reproduction are naturally influenced by sex, with some affecting the female reproductive tract only, for example trichomosis and genital campylobacteriosis, and others only the male, e.g. *Brucella ovis*. Sexually transmitted diseases are restricted to sexually active animals and the incidence of venereal diseases can be reduced by using artificial insemination.

The stage of production is linked to age but there are additional issues, for example peri-parturient diseases in females that may be linked to a decline in natural immunity around the time of giving birth. Some infectious agents are capable of crossing the placenta and infecting the embryo or foetus *in utero* and causing abortions, stillbirths, and/or abnormal neonates. These include various viruses such as bovine viral diarrhoea virus, bovine herpesvirus, the recently emerged Schmallenberg virus in Europe, CSF virus, porcine parvovirus, PRRS virus and several other pig viruses, and bacteria such as *Brucella*, *Lepstospira*, *Salmonella*, *Coxiella* and *Chlamydia*. Diseases that cause high fever in the pregnant female can result in abortion at any stage of pregnancy without crossing the placenta, e.g. bovine ephemeral fever and African swine fever (ASF).

**Influence of behaviour on disease management**

The way in which animals behave is determined by species, breed and individual temperament. The latter is not easily predictable but may be of relevance in animals that are used for individual work, for breeding, or as companion animals. Epidemics are more likely to affect herd animals that associate closely as part of their natural behaviour than solitary animals or those that congregate in small groups and are territorial and keep a distance from other individuals or groups of the same species. Animals that groom and nuzzle one another (e.g. horses, ruminants, canines and felines, primates) are likely to transmit diseases in the process. Fighting is another way in which some blood-borne diseases are transmitted, for example in pigs, cats and dogs.

Curiosity, as displayed by animals like cattle, horses and pigs, can result in exposure to pathogens. Rabies in cattle and horses probably most often results from a bite on the nose from a rabid animal that they were investigating. Rabies can affect all warm-blooded species and is invariably fatal, but certain species are regarded as vectors that are likely to infect other animals. These species include members of the dog family, raccoons, various species of mongoose, and vampire and other bats, which have been incriminated in transmission of classical rabies as well as related (rabies-like) viruses. Apart from vampire bats, which infect animals and humans when feeding on their blood, the others are species that readily bite when provoked and the reaction is heightened in the aggressive form of rabies. Hunting dogs are prone to infection by infected prey and may themselves spread infection before succumbing to the disease.
Predators and scavengers are exposed to infection when feeding on animals that are sick or have died of disease. Most of them (carnivores, pigs, humans) are comparatively resistant to diseases like anthrax, presenting milder forms of the disease than ruminants or horses. However, exposure to a pathogen to which they have evolved no resistance, as happened to predators such as lions and cheetahs feeding on buffalo infected with bovine tuberculosis in the Kruger National Park can result in serious to fatal illness.

The way in which animals feed can also determine how susceptible they are to becoming infected. Cattle usually become infected with anthrax by ingesting spores that contaminate vegetation or soil in areas where other animals have died of anthrax. Cattle are more likely to take in contaminated vegetation and even soil when grazing than sheep, which are fastidious feeders, or goats, which are predominantly browsers. An outbreak of rabies in Namibia that affected large numbers of kudu was ascribed to high population density with heavy browsing pressure on shrubs and trees, which are mainly thorny xerophytes that cause some trauma to the mucous membranes of the mouth. The heavy browsing pressure resulted in kudu feeding on plants that were contaminated with fresh saliva from animals that were infected with the rabies virus. This explained the large number of animals that became infected without any evidence of bite wounds or high incidence of rabies in other species.

**Principal livestock species**

The numbers and percentages of cattle, goats, sheep and pigs in African countries are given in Table 1 and Table 2. The figures are based on the most recent figures obtainable from FAOSTAT (2011) (www.fao.org). Many of the statistics are extrapolations but it is likely that the percentages do reflect the relative importance of the different species in African countries. The notes below provide some salient facts about species that are farmed or bred for human purposes. More comprehensive information is available in the modules on animal production, in particular about ruminants, pigs, poultry and wildlife.

<table>
<thead>
<tr>
<th>Numbers</th>
<th>Cattle</th>
<th>Goats</th>
<th>Sheep</th>
<th>Pigs</th>
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<tbody>
<tr>
<td>&gt; 20 000 000</td>
<td>Ethiopia (38m), Sudan (38m)</td>
<td>Nigeria (28m), Sudan (42m)</td>
<td>Nigeria (23m), South Africa (25m), Sudan (48m)</td>
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<td>Burkina Faso, Cameroon, Chad, Mali, Somalia, Uganda</td>
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<td>Burkina Faso, Mali, Mauritania</td>
<td>Nigeria</td>
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### Numbers

<table>
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<th>Numbers</th>
<th>Cattle</th>
<th>Goats</th>
<th>Sheep</th>
<th>Pigs</th>
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<td>2 500 000 – 4</td>
<td>Zimbabwe</td>
<td>Uganda</td>
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<td>Cameroon, Ghana, Namibia, Niger, Senegal, Tanzania</td>
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<td>Angola, Benin, Botswana, Côte d’Ivoire, Eritrea, Guinea, Madagascar, Malawi, Namibia, Rwanda, Togo, Zambia</td>
<td>Côte d’Ivoire, Eritrea, Guinea, Togo, Uganda</td>
<td>Burkina Faso, Cameroon, Madagascar, Mozambique, South Africa, Uganda</td>
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<td>500 000 – 999</td>
<td>Congo DRC, Guinea Bissau, Lesotho, Malawi, Swaziland</td>
<td>Burundi, Djibouti, Lesotho</td>
<td>Benin, Congo DRC, Lesotho, Madagascar, Zimbabwe</td>
<td>Angola, Central African Republic, Congo DRC, Zimbabwe</td>
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<td>999 999</td>
<td>Congo Republic, Gambia, Guinea Bissau, Mozambique, Swaziland</td>
<td>Burundi, Djibouti, Gambia, Togo</td>
<td>Congo Republic, Gambia, Guinea Bissau, Mozambique, Swaziland</td>
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<td>Benin, Côte d’Ivoire, Ghana, Guinea Bissau, Kenya, Malawi, Rwanda, Senegal, Tanzania, Togo, Zambia</td>
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<td>999 999</td>
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<td>Cabo Verde, Comoros, Liberia</td>
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<td>Sheep</td>
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<tr>
<td>25 000 – 49 999</td>
<td>Comoros, Gabon, Liberia, Mauritius</td>
<td>Equatorial Guinea, Swaziland</td>
<td>Chad, Congo Republic Ethiopia, Namibia, Niger, Swaziland</td>
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<td>10 000 – 24 999</td>
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<td>Cabo Verde, Comoros, Mauritius</td>
<td>Gambia, Mauritius, Seychelles</td>
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<td>5 000 – 9 999</td>
<td>Equatorial Guinea</td>
<td>Equatorial Guinea, São Tomé e Principe, Seychelles</td>
<td>Botswana, Equatorial Guinea</td>
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<td>1 000 – 4 999</td>
<td>São Tomé e Principe, Seychelles</td>
<td>São Tomé e Principe</td>
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<td>&lt; 1 000</td>
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<td>Seychelles</td>
<td>Comoros, Djibouti, Eritrea, Mauritania, Sudan</td>
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Table 2  Percentages of bovine, caprine, ovine, porcine of total

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Cattle</th>
<th>Goats</th>
<th>Sheep</th>
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<tr>
<td>&gt;70%</td>
<td>Madagascar</td>
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<td>Algeria, Libya, Tunisia</td>
<td>Seychelles</td>
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<td>60 – 69%</td>
<td>Swaziland</td>
<td>Comoros, DRC, Mauritius</td>
<td>Equatorial Guinea</td>
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<tr>
<td>50 – 59%</td>
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<td>Burundi, Congo, Malawi, Niger</td>
<td>Mauritania, South Africa</td>
<td>Cape Verde</td>
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<tr>
<td>40 – 49%</td>
<td>Benin, CAR, Chad, Eritrea, Gambia, Mozambique</td>
<td>CAR, Djibouti, Ghana, Mali, Rwanda, Somalia, Uganda</td>
<td>Lesotho, Morocco, Somalia, Togo</td>
<td>Mozambique</td>
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<tr>
<td>20 – 29 %</td>
<td>Burkina Faso, Burundi, Comoros, Congo, Djibouti, Lesotho, Malawi, Mali, Nigeria, Senegal, S Africa, Sudan</td>
<td>Angola, Cameroon, CIV, Egypt, Guinea, Guinea Bissau, Libya, Namibia, Seychelles, Zambia</td>
<td>Burkina Faso, Cameroon, Eritrea, Ethiopia, Kenya, Mali</td>
<td>Guinea Bissau, Madagascar</td>
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<td>10 – 19%</td>
<td>DRC, Ghana, Mauritania,</td>
<td>Algeria, Equatorial Guinea, Ethiopia,</td>
<td>Benin, Burundi, Chad, Comoros,</td>
<td>Angola, CAR, DRC, Equatorial</td>
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### Percentage

<table>
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<th>Sheep</th>
<th>Pigs</th>
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<td>5 – 9%</td>
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<td>Congo, DRC, Gambia, Guinea, Guinea Bissau, Rwanda, Sao Tome, Tanzania</td>
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<td>Benin, Burkina Faso, Burundi, Cameroon, Congo, CIV, Mauritius, Nigeria, Togo, Uganda, Zambia, Zimbabwe</td>
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<tr>
<td>&lt;5%</td>
<td>Libya</td>
<td>Angola, Cape Verde, CAR, Madagascar, Malawi, Mozambique, Seychelles, Swaziland</td>
<td>5 N Africa, Botswana, Chad, Comoros, Djibouti, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Kenya, Lesotho, Mali, Mauritania, Namibia, Niger, Senegal, Somalia, S Africa, Sudan, Swaziland, Tanzania</td>
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### Bovine

Cattle are usually regarded as the most important livestock species worldwide, although in many countries they are outnumbered by other species, particularly sheep or goats. They provide humans with meat, milk, hides, traction, manure, status and security.
Cattle are used to plough the fields

Cattle transporting goods on a mokoro (canoe) used as a sled

Cattle are often driven long distances to markets or to find grazing

Caprine and ovine

Goats are kept mainly for meat and milk. In poorer countries and countries with insufficient pasture suitable for cattle they are often the most numerous livestock species. Sheep tend to predominate in countries with drier, cooler climates, being found in the largest numbers in North Africa, and in Lesotho and South Africa in southern Africa. Sheep are produced for meat, wool and hides.
Porcine

The statistics for pigs, like those for small ruminants and poultry, are not reliable, since they reflect the small commercial production, while the greatest numbers of pigs in many countries in Africa, as well as in some countries in Asia and South America, occur in the informal sector and these pigs seldom reach the mainstream market.
Although pigs in Africa account for less than 5% of the world’s pigs, and there is a widely held perception that pigs are generally unpopular in Africa for religious and cultural reasons, this is not strictly true. Firstly, the numbers of pigs most likely are under-estimated; an example is the fact that while FAOSTAT indicated in 2005 that Mozambique had about 350,000 pigs, a census in 2006 indicated that 1.6 million would be more accurate, and also that the greatest concentration of pigs is found in the northern provinces; the FAOSTAT figures have since been updated. Ninety per cent of the pigs in Mozambique are found in the so-called family sector and they are of great importance as a source of household income and a mobile bank. Families with pigs are seen to be better off than families without pigs in many parts of rural Africa. In many of the coastal countries in West Africa where conditions are not suitable for cattle production pigs are kept in large numbers and replace cattle as a ceremonial animal in some societies. In these areas they are important from the point of view of biodiversity conservation, as they relieve the pressure on ‘bush meat’ by providing a more reliable and accessible source of food.

Most domestic pigs are derived from the Eurasian wild boar, *Sus scrofa*, which has a wide distribution in the northern hemisphere (Europe and Asia). Some pigs farmed in Asia are derived from local breeds of wild pig (Warty pigs). African wild pigs have not been domesticated to any extent and domestic pigs in Africa are derived largely from Europe. The pigs that are kept in traditional systems in particular are fairly hardy but are nevertheless periodically decimated in many countries by ASF. Relatively few African countries have highly developed commercial pig industries, although this is changing. South Africa probably has the most developed pig industry in sub-Saharan Africa, with high health status and SPF herds, followed by Kenya and Zimbabwe. Nigeria has by far the greatest number of pigs of any African country (7 million).

**Equine**

Horses and donkeys are used widely in Africa for traction and transport. In the SADC region Lesotho is known for the widespread use of horses, in particular the indigenous Basuto pony which, apart from its many other uses, is widely used in the tourist industry. Horses are also used extensively in the Eastern Cape Province of South Africa and in North Africa. In South Africa there is a high value racehorse industry. Donkeys are commonly used for transport including in the drier parts of western southern Africa. They are known for their resistance to disease and ability to survive in minimal conditions.
Canine

Dogs are used for a variety of purposes, mainly as companion animals but also for hunting, guarding, and herding. In some areas they are used as food animals. The main importance of dogs from a veterinary point of view in developing countries is their potential to share parasites including worms like *Ancylostoma*, *Echinococcus*, *Toxoplasma* and *Trichinella*, and contagious diseases like rabies and ringworm with humans owing to the close contact between them. There are also concerns about dogs at the interface with wildlife, as outbreaks of rabies and distemper have caused serious mortality in charismatic wild species like African wild dog (*Lycaon pictus*), Ethiopian wolf (*Canis simensis*) and lion (*Panthera leo*).
Wildlife

Wildlife forms the basis of the tourist industry in many African countries, either for game viewing or hunting or both (see modules on wildlife health and production). Wildlife species have been recognized to be important as a source of established and emerging pathogens that can affect domestic livestock and humans (see modules on One Health). In recent years two new paramyxoviruses that affect domestic animals but are also potent zoonoses have emerged in south-eastern Asia and Australia and are associated with fruit bats (*Pteropus* spp.). This may be the result of changes in land use that have brought about closer proximity between domestic animals and fruit bats. More information about the drivers of emerging diseases is available in other modules. Diseases of domestic livestock can also affect wildlife adversely, as for example the spread of bovine tuberculosis among a large number of wild species in the north-eastern part of South Africa. The development of transfrontier conservation areas, particularly in southern Africa, has progressed and is enlarging and intensifying the interface between wildlife and livestock. In addition to conflict relating to land use, animal diseases and animal disease control have become a major issue. The fences that have traditionally been used to separate wildlife and livestock are coming down. Fences are the subject of a dedicated module. New ways to manage interface diseases, in particular FMD, will have to be developed if biodiversity conservation and livestock production are to co-exist for the mutual benefit of people who live in the affected areas.
(see DVD: Beauty and the Beef). Commodity-based trade is discussed more fully in modules on the topic of livestock marketing and trade.

Avian (Domestic poultry)

Chickens, ducks and turkeys are the main poultry species kept, with domesticated guinea fowl and pigeons also being extremely popular in many countries in Africa. Chickens are produced commercially in many countries on a small scale, while some countries, in the SADC region notably South Africa, have large and well developed commercial poultry industries. For more information see module on poultry health and production. Peculiarities of birds are the high mobility of migratory species, the ease with which wild birds adapt to suburban and urban habitats and the fact that a large number of bird pathogens can affect many species of birds, e.g. avian influenza, Newcastle disease, avian pox, *Salmonella*, *Chlamydia* and various other bacteria. They are also highly portable and the H5N1 avian influenza pandemic demonstrated that a vast trade in smuggled poultry is virtually impossible to control.
Figure 1: Phylogenetic tree of the animal kingdom

Click here for a review of principal livestock species.
Short notes on livestock species that are of local importance in sub-Saharan Africa

Camels

Arabian single-humped camel, or dromedary (*Camelus dromedarius*)

Camels are of importance in North Africa because they are well adapted to withstand desert conditions that prevail in the Sahara, the Sahel, and the Horn of Africa. The camels used in Africa are the Arabian single-humped camel, or dromedary (*Camelus dromedarius*). Some of these animals were imported into southern Africa, notably the Northern Cape Province of South Africa and Namibia, in the early part of the last century, and their descendants are still found in the region, where they are sometimes used for tourism.

Water buffalo (*Bubalus bubalis*)

Water buffalo are native to Asia, where they have a long history of domestication. They are used as draught animals as well as for meat and milk production. They have been imported into Europe, Africa and Australia into areas that are suitably wet and marshy. A few herds are present in Mozambique and South Africa. From the point of view of animal health they can to a great extent be treated like cattle, since they are susceptible to most of the diseases that affect cattle.
Cats (Felidae)

Cats have been domesticated for centuries and are kept as companion animals and to control rodents. In some areas cats are used as food. It is believed that cats were first domesticated in Egypt as early as 2500 BC. Their ancestor is thus accepted to be an African wild cat, Felis silvestris lybicus. The natural life span of a cat is about 15 years. Cats are self-sufficient predators, multiply rapidly and this has resulted in the development of feral cat populations; such a population on Marion Island caused severe damage to the bird population and had to be eradicated.
Rabbits (*Lagomorpha*)

Rabbits and hares have been domesticated for use as food animals, especially in southern Europe, and as companion animals (mostly as pets for children). They are also widely used as laboratory animals. Because of their rapid rate of reproduction they have easily become pests in areas into which they have been introduced and feral populations have become established, for example in Australia, New Zealand and on Robben Island in South Africa.

Rodents

In developing countries, rodents like the large South American capybara and coypu and guinea pigs are used as food, particularly in times of drought or scarcity. The cane rat, grass-cutter or “agouti” in francophone countries (*Thrinomys swinderianus*) is not only hunted and sold as food but is also farmed in some parts of Africa. Rodents are widely used as laboratory animals in developed countries. Some, in particular hamsters, white rats, and giant rats (mainly *Cricetomys gambianus*) are kept as pets. Rodents tend to live in close proximity to people and to farm animals, and are generally regarded as pests. They have been incriminated in the spread of diseases, including zoonoses like bubonic and pneumonic plague and leptospirosis.

Ostriches

Ostriches (*Struthio camelus*) are farmed in many parts of the world, notably in several countries in southern and eastern Africa. Historically in southern Africa the main purpose of keeping ostriches was for feather production, but currently the feathers are of lesser importance, the main commodities being meat and skins.
Game birds

Various game birds (e.g. guinea fowl, partridges, pheasants, quails) have been domesticated and are farmed like domestic poultry. The most popular of these in sub-Saharan Africa are guinea fowl.

Domesticated guinea fowl

Ornamental and recreational birds

Parakeet and a pelican in a wildlife sanctuary, Canberra, Australia

Ornamental and song birds are popular worldwide as pets. Many are wild caught and exported to dealers in various parts of the world. Tanzania is noted for exports of ornamental birds. It has
been recognized that wild-caught birds are of uncertain disease status, and the trade in exotic birds is generally subject to rigorous movement control and quarantine measures. However, demand dictates that there will always be an illegal trade, particularly in protected species that are not allowed to be sold.

Recent outbreaks of avian influenza have affected ornamental water birds in Europe and Asia. Swans have proven particularly susceptible to the disease, while migratory water birds are suspected to have played a role in spread of the virulent H5N1 virus.

Pigeon racing is popular in many parts of the world, and in some areas doves and pigeons are also kept and bred for food. The movement of racing pigeons over long distances has been linked to disease outbreaks, for example a Newcastle disease epidemic that occurred in Europe in 1981 that affected both pigeons and domestic poultry.

**Crocodiles**

Various species of crocodilians are farmed in different parts of the world. In Africa the Nile crocodile (*Crocodilus niloticus*) and to a lesser extent the dwarf crocodile (*Osteolaemus tetraspis*) are farmed for skins and food. Like all reptiles, crocodiles are poikilothermic (“cold blooded”) and their biological activities are therefore dependent upon the temperature of their environment. This has implications for their management when they are farmed under unnatural conditions, and also enables a degree of manipulation of production through temperature control. Thus the sex of crocodiles is determined by the temperature at which they develop. Crocodilians are mainly aquatic although they may spend long periods basking on land. Outbreaks of disease in crocodiles can be an indicator of deterioration of the quality of the water in which they live and hunt. High mortality due to pansteatitis in Nile crocodiles in the KNP recently was traced to poor water quality. Interestingly, although crocodiles are used for food and there is a limited export in crocodile meat, crocodile diseases are not covered in either the Terrestrial or the Aquatic Animal Health Codes of the OIE. They are affected by a variety of infectious diseases including chlamydiosis, poxviruses and mycoplasmas.
Bees

Bees are the most important of the terrestrial invertebrates farmed, and are widely kept for production of honey. Their inclusion in the Terrestrial Animal Health Code of the Office International des Épizooties (OIE) emphasises the importance that they have attained in international trade. Bee colonies are susceptible to a number of infectious and parasitic agents that not only may destroy the colonies but also result on bans on export of honey. They are insects and therefore fall into a category of animals of which most veterinarians have little or no knowledge or experience. Outbreaks of disease among bees are often referred to entomologists. Nevertheless standards for the important diseases of bees are included in the Terrestrial Animal Health Code, which implies that certification of bees and their products is a veterinary responsibility.
PRODUCTION SYSTEMS AND ANIMAL HEALTH MANAGEMENT

Introduction

Production systems have a profound effect on animal health management. They are systems in which animals are raised in varying degrees of confinement and are to a greater or lesser extent fed and tended. Broadly divided into extensive and intensive production systems, the aim is generally to reach production goals in the most cost-effective way possible. The least developed type of production systems, in which animals are grazed on communal land and receive a minimum amount of care and feeding, are usually characterized by low productivity, but may nevertheless be the most cost-effective way for poor owners who do not have good market access. However, commercial farmers expect a better return and large investments have been made in developing animals and production systems that will yield a high return on the investments made.

Classification of production systems

The characteristics of production systems are discussed in detail in modules on livestock production. More details are also available in Module 1.2 on the influence of production systems on animal health management. For the purposes of the animal health management modules the classification system is based on the implications of the different systems for animal health management (rather than on socio-economic considerations such as potential to generate income):

- Extensive production systems
  - Sedentary (fixed) systems
    - Ruminant production
      - Commercial
      - Subsistence and communal grazing land
    - Pig production
    - Poultry and ostrich production
      - Nomadic/pastoralist systems: cattle, sheep, goats, camels
  - Landless production systems in the peri-urban setting
  - Intensive production systems
    - Zero-grazing dairy
    - Feedlots (cattle, sheep, goats)
Extensive livestock production systems

Extensive livestock production systems are systems in which animals are kept free-range for part or all of their production cycle.
Commercial ruminant production

The principal infectious disease threats are vector-borne diseases, reproductive diseases and, in most parts of Africa depending on the area, wildlife/livestock interface diseases. The main challenges for animal health management are:

- Sufficient observation to ensure early diagnosis of problems
- Logistics of rounding up for observation, vaccination and treatment
- Applying the necessary level of biosecurity to prevent uncontrolled access to pastures and animals

Production on communal grazing

In addition to the above diseases and challenges, additional challenges to animal health management are:

- Failure of treatment, e.g. prophylactic treatment against parasites, because not all the animals are treated owing to different levels of commitment amongst owners, resulting in high levels of pasture contamination
- Build-up of pathogens that may affect production and reproduction (*Brucella* spp., *Mycobacterium bovis*, *Salmonella*) as a result of limited availability of land
- Complete lack of control over access to the land by people, newly introduced animals and sometimes wildlife, resulting in exposure to a wide range of new pathogens including fatal diseases like MCF
• Uncontrolled movement of animals

**Extensive pig production**

Most extensive pig production in sub-Saharan Africa occurs in traditional systems in which pigs are never confined, confined only at night or seasonally to protect crops, and find most of their own food.

![Scavenging pigs, Ghana](image)

Pigs kept extensively are free from the majority of infectious diseases that commonly occur in confined pigs, such as PRRS, porcine multisystemic wasting syndrome, porcine pleuropneumonia, enzootic pneumonia, swine dysentery, porcine proliferative enteropathy, Glässer's disease to name a few), but are more prone to ASF and CSF because they may be in contact with wild pigs, carcasses of pigs that have died, and pigs from other herds. Large populations of free-ranging pigs can become a reservoir in which the viruses of those diseases can circulate for long periods of time, probably indefinitely. They also often have access to human waste and in that way ingest the eggs of the pig tapeworm, *Taenia solium*, and become infested with the cysts formed by the larvae that migrate mainly to striated muscle. Ingestion of raw or undercooked pork containing cysts by humans, the definitive host, enables the cycle to be completed. There are no known clinical effects on the pig, and the effects of human taeniasis are generally mild, but neurocysticercosis caused by pig tapeworm, resulting from accidental ingestion of the eggs by humans and migration of the larvae to the brain, is a serious zoonosis recently recognised by WHO as a ‘major neglected disease’ and a major cause of epilepsy in sub-Saharan Africa and many of the poorest countries elsewhere where free-ranging pigs are raised and hygiene standards are low. Pork that is infested with cysts is not able to be sold in the formal market.
The main challenges for animal health management in extensively kept pigs are:

- Lack of observation leading to delayed diagnosis of serious diseases
- Lack of investment in pig health by their owners
- Lack of awareness by the owners about diseases like porcine cysticercosis
- Uncontrolled movement of pigs
- Difficulty in applying preventive or control measures

In compliance with consumer demands for pigs to be kept under more natural conditions, pigs in outdoor systems are becoming more frequent in developed countries, for example member states of the European Union, with pressure on other pig-producing countries to follow suit. These systems differ markedly from the traditional extensive systems in that the pigs are fed, the property is fenced and there is likely to be some health management by the owners. Many of the diseases to which confined pigs are prone will be eliminated because pathogens are less concentrated and may be destroyed by exposure to the elements. However, increases in helminths including large roundworm (*Ascaris suum*) have been observed. Although the origin of the outbreak of CSF in UK in 2000 was never confirmed, it was first diagnosed in outdoor sows and it appeared that the disease may have been present for some time before it was noticed. It was also surmised that the first infection could have been due to infected material being fed by a passer-by to outdoor pigs, although this was of course impossible to prove.

**Extensive poultry and ostrich production**

There is inevitably contact between poultry kept out of doors and wild birds, which can enhance the chances of infection with Newcastle disease and avian influenza. As in all extensive systems, it is more likely that disease, unless it causes high mortality, will not be noticed and will be able to spread throughout the flock before it is noticed. This is particularly true in the case of subclinical infection, which apparently occurred in the 2011 outbreak of H5N2 avian influenza in South Africa. Like outdoor pigs, outdoor poultry flocks are spared the diseases of intensification that can occur in housed birds. For more information on extensive poultry production systems see modules on poultry health and production.

**Nomadic/pastoralist systems**

Nomadic systems involve cattle, sheep, goats and camels, as the other commonly kept species of livestock are not susceptible to herding and therefore to moving about with their owners. The movement of herds varies from seasonal movement over relatively short distances to take advantage of grazing that is only seasonally available in another area to long-distance movements that may involve crossing the borders of one or more countries. Nomadism is a major reason why diseases like foot and mouth disease, peste des petits ruminants (PPR) and sheep-
and goatpox and camelpox have proven impossible to eradicate, because flocks regularly come into contact with new flocks and infections can be exchanged. The main challenges for animal health management are:

- Mingling of herds and flocks that originated from different areas at water points, in grazing areas and at markets
- Inconsistent or no access to animal health services

On the other hand, nomadic livestock owners are usually strongly dependent on their animals for their livelihoods and will often take the best care of them that they can based on a fund of traditional knowledge.

Landless livestock production systems

Landless livestock systems refer to those systems where livestock are raised on a minimum amount of land, generally on land that is not dedicated to the purpose of keeping livestock. They are in this module restricted to smallholder production in the urban and peri-urban setting, i.e. backyard farming. Most backyard farming involves small stock and poultry, but sometimes cattle and equids are also kept under those conditions.

In terms of diseases, ‘backyard farms’ can range from models of biosecurity to potential sources of outbreaks. Restricting access to a residential property is relatively easy and making sure that a good level of hygiene is maintained prevents living conditions on the property from becoming unpleasant and generating complaints from neighbours. However, unhygienic conditions may prevail in poorer communities. These will attract flies and rodents. Wet conditions can lead to foot and skin problems. The main challenges for animal health management are:
Review of issues that influence animal health management

- Lack of hygiene that results in a build-up of pathogens including internal and external parasites and consequent disease; consumption of rotting material can result in botulism

- Feeding animals on waste material that in the worst case scenario may emanate from a port and contain infective material that will introduce an epidemic disease like ASF, CSF or FMD

- Lack of information about the animals being kept in backyards, which complicates disease control, particularly in an outbreak

- Lack of awareness and resources on the part of the owners

Intensive livestock production systems

Many of these systems are also essentially "landless", since the animals are housed and fed. They include feedlots for cattle and small ruminants, zero-grazing dairy production, and indoor and semi-indoor systems for pig and poultry production, as well as production of more unusual species like rabbits and crocodiles. A production system may combine extensive and intensive components, depending on the production stage of the animals. Thus, dairy cattle may be kept on pasture but calves are raised in indoor systems; dry sows may be kept in large outdoor camps in pig production systems that are otherwise fully intensive.

Biosecurity measures are easier to apply in intensive systems, particularly if the animals are housed, as it is possible to restrict access and to plan the farm so as to minimise entry of vehicles and people to the facility. However, internal biosecurity can become a problem because large numbers of animals are being kept at close quarters and a build-up of pathogens is likely unless hygienic measures are strict. The main challenges for animal health management in intensive production systems are:
Livestock Health, Management and Production › Animal Health Management › Review of issues that influence animal health management

- Maintaining a management plan and level of biosecurity that will be effective in preventing disease but affordable; this will have a strong emphasis on hygiene and disinfection as well as restricting access to the facility where the animals are kept
- Reducing stress as far as possible
- Ensuring rapid detection and intervention in the event of a disease occurring to minimise its spread and effect on the herd or flock

DISEASES OF IMPORTANCE TO LIVESTOCK PRODUCTION AND TRADE

Infectious animal diseases can affect livestock trade in two important ways. Firstly, there are the so-called transboundary animal diseases (TADs) (see also modules on high impact diseases and on marketing and trade) that have the capacity for rapid spread over long distances and are feared by countries that have never had them or have eradicated them. For this reason they are highly trade-sensitive and countries that are free of them require assurances that they will not import them when they import livestock or livestock commodities. The World Trade Organization has mandated the OIE to develop standards for trade in live animals and livestock commodities that will prevent the spread of TADs. These standards constitute the Terrestrial Animal Health Code which is updated annually and is available on the OIE website (www.oie.int). Secondly, there are diseases, including TADs, which affect animal production and consequently reduce the amount and quality of animals available for trade. At the subsistence level of livestock production, where trade may not be an important issue, these diseases can jeopardise household food security. In poor mixed farming systems livestock are needed for crop production and if they are not there to provide manure and traction families may not have enough to eat.

The important characteristics of the selected diseases are summarised in Table 3. For more details about the diseases please refer to the relevant chapters in Coetzer, J.A.W. & Tustin. R.C. 2004. Infectious Diseases of Livestock (2nd edn), Oxford University Press, Cape Town. References for Newcastle disease and avian influenza are provided at the end of the section and more information is available from the module on poultry health and production.
**Table 3  Characteristics of diseases important for production and trade**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Geographical distribution</th>
<th>Transmission and reservoirs</th>
<th>Survival outside host</th>
<th>Potential for transboundary spread</th>
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<th>Effects on production and trade</th>
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</thead>
<tbody>
<tr>
<td>FMD</td>
<td>Worldwide (Not N America, Australia, New Zealand and most of Europe)</td>
<td>Highly contagious; direct contact with infected animals and material; airborne in special conditions</td>
<td>Sensitive to low pH; cannot survive in matured muscle but survives for long periods in lymphoid tissues, bone marrow, and in some dairy products</td>
<td>High, mainly via live animals and bone-in meat</td>
<td>None</td>
<td>Production: Most severe in high-producing dairy cattle and in pigs</td>
</tr>
<tr>
<td></td>
<td>Viral disease that affects cloven-hoofed animals and camels</td>
<td>African buffalo (<em>Syncerus caffer</em>) are the reservoir host</td>
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<td></td>
<td>Trade: Trade bans during outbreaks and permanent market exclusion for producers in endemic areas</td>
</tr>
<tr>
<td>PPR</td>
<td>North, West and Central Africa as far south as Tanzania; south-western Asia</td>
<td>Direct contact with infected animals and material; airborne over short distances</td>
<td>Ability to survive outside the host is poor</td>
<td>Spread is by live infected animals and the potential for spread is high</td>
<td>None</td>
<td>Production: Can cause high mortality and also production losses</td>
</tr>
<tr>
<td></td>
<td>Viral disease of sheep and goats</td>
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<td></td>
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<td>Trade: Uninfected countries might ban live goats from infected countries</td>
</tr>
<tr>
<td>RVF</td>
<td>Africa (including Madagascar) and the Near East (Saudi Arabia and</td>
<td>Transmission to animals is by a number of species of mosquitoes (<em>Aedes</em>,</td>
<td>Sensitive to temperature and pH; long-term survival is probably</td>
<td>Spread is probably mainly by live infected animals; mosquitoes may</td>
<td>RVF virus causes mild to occasionally serious and even</td>
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<td></td>
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<td>Major losses can occur due to abortions and death of young</td>
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<td></td>
<td>Serious viral disease of domestic</td>
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</table>

*FMD*: Foot and Mouth Disease  
*PPR*: Peste des Petits Ruminants  
*RVF*: Rift Valley Fever
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<tr>
<td>ruminants</td>
<td>Yemen)</td>
<td><em>Culex</em></td>
<td>in mosquitoes</td>
<td>move over distances in vehicles</td>
<td>fatal disease in humans; infection is usually due to contact with blood of infected animals</td>
<td>animals</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Trade in live animals may be banned during outbreaks</td>
</tr>
<tr>
<td>Rabies</td>
<td>Worldwide. Many countries that are free of rabies are islands</td>
<td>Usually by bites of infected animals; other routes described are rare</td>
<td>Survival outside an animal is very brief under natural conditions</td>
<td>Spread would be mainly by infected animals incubating the disease</td>
<td>Rabies is a fatal disease in humans</td>
<td>Usually only individual animals are affected but outbreaks in cattle and wildlife have caused serious losses</td>
</tr>
<tr>
<td>BSE</td>
<td>Most cases occurred in UK followed by other European countries, Canada, Japan and USA ex Canada; no cases have been reported in the southern hemisphere</td>
<td>Infection is by oral ingestion of infected tissues</td>
<td>Prions are highly stable in tissues and very high temperatures are required to destroy them</td>
<td>Owing to the lengthy incubation period (years) before clinical signs appear and long persistence in meat (certain types of tissue) and bone meal the potential for transboundary spread is high</td>
<td>In the 1990s BSE was linked to a variant of Creutzfeld-Jakob disease (vCJD) that appeared in younger people and is invariably fatal</td>
<td>Herds with an infected cow were culled; most were valuable dairy cattle After the link to human disease was discovered there were massive effects on trade due public fear and to surveillance requirements that</td>
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<tr>
<td>BT</td>
<td>Africa, Asia, Australia, USA, Europe (recent introduction to N Europe now apparently extinct)</td>
<td>Transmission by blood-sucking midges (<em>Culicoides</em> spp.)</td>
<td>The virus is labile; it is probably maintained during winter in midges; ruminants can only be infected by midges</td>
<td>Spread is by movement of infected animals and possibly by wind-borne midges; establishment requires suitable midges to host the virus</td>
<td>None</td>
<td>High mortality can occur in sheep Outbreaks, particularly in new areas, can cause restrictions on movement of live animals including game</td>
</tr>
<tr>
<td>AHS</td>
<td>Endemic in sub-Saharan Africa; epidemics occurred after introduction into Spain, Portugal, North Africa and the Near and Middle East</td>
<td>Transmission is by blood-sucking midges (<em>Culicoides</em> spp.) Dogs can be infected by eating infected meat Zebras are considered to be reservoirs of the virus</td>
<td>The virus is labile; equines can only be infected by midges</td>
<td>Spread is by movement of infected animals; the outbreak in Spain was traced to zebras imported from Namibia</td>
<td>None</td>
<td>AHS can cause high mortality and loss of working time in horses Movement restrictions can have negative effects on the high value racing industry</td>
</tr>
<tr>
<td><strong>Disease</strong></td>
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<tr>
<td><strong>ASF</strong></td>
<td>Endemic in sub-Saharan Africa and in Sardinia (Italy); it occurred in Western Europe, Caribbean countries and Brazil (1960 – 1994) and in the Caucasus and non-Caucasian Russia (2007 – present)</td>
<td>Highly contagious and transmission among domestic pigs is by direct contact with infected pigs and contaminated objects and eating infected meat; it can also be via argasid ticks (<em>Ornithodoros</em> spp.) Common warthogs (<em>Phacochoerus africanus</em>) maintain the virus in a sylvatic cycle with <em>Ornithodoros</em></td>
<td>Long survival is possible in a suitable protein environment like chilled or frozen pork and uncooked pork products</td>
<td>Spread over long distances is mainly by infected pork products; cross-border sales of pigs in the incubatory phase of the disease may occur between neighbouring countries</td>
<td>None</td>
<td>High mortality can cause serious losses to pig producers, exacerbated at times by drastic control measures Trade restrictions are applied to pigs and pork originating from infected areas</td>
</tr>
<tr>
<td><strong>CSF</strong></td>
<td>Worldwide with the exception of the African region, where it is only endemic in Madagascar. South Africa and Mauritius have</td>
<td>CSF is transmitted directly by contact with infected pigs and contaminated objects; it can be transmitted in semen, vertically to foetuses, and under</td>
<td>Long survival is possible in a suitable protein environment like chilled or frozen pork and uncooked pork products</td>
<td>Spread over long distances is mainly by infected pork products</td>
<td>None</td>
<td>High mortality can cause serious losses to pig producers, exacerbated at times by drastic control measures Trade restrictions</td>
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<tr>
<td>CBPP</td>
<td>Experienced epidemics. Eradicated in North America and in Western Europe with the exception of wild boars</td>
<td>Particular conditions can be airborne&lt;br&gt;Eurasian wild boar populations can become reservoirs of the virus</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Outbreaks in naïve populations can cause high mortality&lt;br&gt;Restrictions may be placed on buying animals from countries that are infected</td>
</tr>
<tr>
<td></td>
<td>Formerly worldwide, it is now restricted to some countries in Africa and Near and Middle East</td>
<td>Direct contact between infected and susceptible cattle</td>
<td>The organism cannot survive for long outside the host</td>
<td>Spread is by infected animals that may harbour the mycoplasms in their nasal cavities up to 40 days before becoming serologically positive</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Anthrax</td>
<td>Anthrax occurs worldwide</td>
<td>Transmission is usually by ingestion or inhalation of bacilli or spores; mechanical transmission by biting flies has been reported</td>
<td>Spores can survive for very long periods (centuries) in soil. Bacilli do not survive long in carcasses and must be released into the environment for</td>
<td>Spread is by movement of material contaminated by spores, for example the hides of animals; outbreaks have been traced to hide drums</td>
<td>Severity of disease in humans depends on the route of infection. Percutaneous infection results in the skin form (sores), while</td>
<td>If carcasses of animals that die of anthrax are not dealt with promptly large outbreaks with 100% mortality can occur in ruminants,</td>
</tr>
</tbody>
</table>
### Table: Diseases and Their Characteristics

<table>
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<tbody>
<tr>
<td>ECF and CD</td>
<td>Both diseases are endemic in some countries in sub-Saharan Africa</td>
<td>Transmission is via the bites of the ixodid tick vector, mainly <em>Rhipicephalus appendiculatus</em></td>
<td>No survival outside the host or vector</td>
<td>Spread is by movement of infected cattle (ECF) and buffalo (CD) or ticks; it may occur between neighbouring countries</td>
<td>None</td>
<td>Both diseases can cause high mortality and ECF can also reduce performance in endemic areas</td>
</tr>
<tr>
<td></td>
<td>African buffalo are reservoir hosts of CD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>There are restrictions on trade in buffalo from CD-infected areas; some local trade restrictions may result from ECF</td>
</tr>
<tr>
<td>Trypanosomosis</td>
<td>Nagana in cattle is widespread in</td>
<td>Tsetse flies (<em>Glossina</em> spp.)</td>
<td>The parasite cannot survive outside the host</td>
<td>Spread is by movement of infected cattle (ECF)</td>
<td>Human sleeping sickness is</td>
<td>Mortality is usually low except in newly infected areas</td>
</tr>
</tbody>
</table>

- **Anthrax** is considered one of the foremost potential bioterrorism agents.
- Ingestion of infected meat results in the pharyngeal form that is fatal if not treated. Inhalation of spores can result in serious, often fatal systemic disease, including in wildlife.
- Anthrax is a zoonotic disease that can be transmitted to humans and other animals through contact with infected animals or their products.
- The geographical distribution of anthrax is widespread, with outbreaks occurring in both rural and urban areas.
- The disease is transmitted through direct contact with infected animals or their products, such as meat or skin.
- The disease is often seen in livestock, particularly in cattle, but can also affect other animal species.
- Anthrax is preventable through vaccination and early treatment of infected animals.
- The disease is recognized as a priority for animal health management due to its potential for human and animal disease and economic impact.
<table>
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</tr>
</thead>
<tbody>
<tr>
<td>(nagana)</td>
<td>tropical Africa and distribution is determined by the presence of the vector</td>
<td>transmit the trypanosomes that cause nagana</td>
<td>host and vector</td>
<td>infected cattle but the disease can only be established where there are tsetse flies</td>
<td>caused by <em>Trypanosoma brucei gambiense</em> and <em>T. b. rhodesiense</em></td>
<td>introduced cattle, but affected cattle are less productive and often in very poor condition</td>
</tr>
<tr>
<td>Bovine babesiosis</td>
<td>Widespread in tropical, subtropical and warm temperate regions wherever the vectors are present</td>
<td>The ticks <em>Rhipicephalus</em> (<em>Boophilus</em>) <em>decoloratus</em> and <em>R. (B.) microplus</em> transmit babesias</td>
<td>The parasites cannot survive outside the host and vectors</td>
<td>Infected cattle or ticks can introduce babesiosis to new areas as occurred in Australia with the introduction of <em>B. microplus</em></td>
<td>None</td>
<td>European cattle breeds are most severely affected</td>
</tr>
<tr>
<td>Heartwater</td>
<td>Throughout sub-Saharan Africa, mainly in tropical and subtropical areas; was established on two Caribbean islands</td>
<td><em>Ehrlichia ruminantis</em> is transmitted by ticks of the genus <em>Amblyomma</em>; <em>A. variegatum</em> is the most important vector in southern Africa</td>
<td>The parasite cannot survive outside the host and vector</td>
<td>Infected cattle can spread the agent and the vector, which can become established if conditions are suitable</td>
<td>None</td>
<td>Major stock losses occur due to high mortality in ruminants including some wild species when introduced into endemic areas</td>
</tr>
<tr>
<td>Bovine anaplasmosis</td>
<td>Worldwide; endemic in most of southern Africa (cattle farming areas)</td>
<td>Ticks transmit the anaplasmas; the main vector is <em>Rhipicephalus</em> (<em>Boophilus</em>)</td>
<td>The parasite cannot survive outside the host and vector</td>
<td>Spread is by movement of infected cattle and this can result in outbreaks in non-endemic areas</td>
<td>None</td>
<td>The effects range from a drop in milk production, weight loss and poor conditions with slow recovery</td>
</tr>
</tbody>
</table>

Diseases discussed include nagana, Bovine babesiosis, Heartwater, and Bovine anaplasmosis. Each disease is characterized by its geographical distribution, transmission and reservoirs, survival outside the host, potential for transboundary spread, zoonotic potential, and effects on production and trade.
### Disease Geographical distribution Transmission and reservoirs Survival outside host Potential for transboundary spread Zoonotic potential Effects on production and trade

<table>
<thead>
<tr>
<th>Disease</th>
<th>Geographical distribution</th>
<th>Transmission and reservoirs</th>
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<th>Potential for transboundary spread</th>
<th>Zoonotic potential</th>
<th>Effects on production and trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newcastle disease</td>
<td>Worldwide</td>
<td>Direct contact with infected birds or contaminated material resulting in ingestion or inhalation of infected material Ducks are relatively resistant to ND</td>
<td>The virus is easily inactivated by changes in pH and disinfectants but faeces are a potent source of infection for other birds</td>
<td>Spread is mainly by movement of live poultry</td>
<td>Mild conjunctivitis in humans has been described</td>
<td>ND can cause severe losses due to mortality as well as drop in egg production and growth Trade restrictions may occur during outbreaks</td>
</tr>
<tr>
<td>Avian influenza</td>
<td>Worldwide</td>
<td>Direct contact with infected birds or contaminated matter, including water, and aerosols Some water birds appear to be</td>
<td>The virus is easily inactivated but can persist in faeces at low temperatures for up to 44 days as well as in water</td>
<td>Live infected poultry and infected migratory birds have proven highly efficient in moving the virus over long distances</td>
<td>H5N1 HPAI has caused more than 300 human deaths since 2002 although humans are relatively resistant to infection</td>
<td>High mortality occurs and because of the zoonotic potential even birds infected with LPAI are killed so losses can be very heavy</td>
</tr>
</tbody>
</table>

**Newcastle disease**
ND is a viral disease of birds (probably all species) that occurs in mild to virulent forms.
## Disease Geographical distribution Transmission and reservoirs Survival outside host Potential for transboundary spread Zoonotic potential Effects on production and trade

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<tr>
<td>HPAI)</td>
<td></td>
<td>relatively resistant</td>
<td></td>
<td></td>
<td></td>
<td>Trade restrictions are severe if there is an outbreak and trade is also damaged by fear of human disease</td>
</tr>
</tbody>
</table>
Disease control measures, both in routine and emergency situations, are aimed at preventing or reducing to a minimum transmission of the causative agent. The measures adopted will therefore be determined by the way in which the target disease is transmitted. Transmission of contagious diseases can result from direct contact of susceptible with infectious animals, release of the infectious agent into the environment by infected animals, e.g. as aerosols or onto objects that then act as fomites, ingestion of material containing infectious agents, sexual transmission, or bites of infected animals (e.g. rabies). Vertical transmission to foetuses in the uterus results occurs when pathogens present in the dam are able to cross the placenta. Vector-borne diseases depend on invertebrates, usually arthropods, to transmit the agent. Most primarily vector-borne diseases are not contagious, but some diseases, e.g. arboviral diseases like Rift Valley fever (RVF) and ASF, are able to be transmitted by more than one of the above means. The individual diseases are described in detail in the modules on high impact diseases.

Rate of transmission of infectious diseases

The rate at which an infectious disease spreads determines whether an epidemic will occur and has important implications for control. The basic reproduction number, $R_0$, is the rate at which an infectious agent will spread through a susceptible population. It is based on the number of cases that will result from the introduction of an infectious individual into a fully susceptible population. When $R_0$ is $>1$, i.e. one infectious individual will infect more than one other individual, an epidemic will occur. The spread of contagious diseases within a population is represented by a simple model known as the SIR model:

$$\text{Susceptible} \rightarrow \text{Infected} \rightarrow \text{Recovered}$$

$R_0$ depends on the infectiousness of the pathogen, the movement of an infectious individual through the population and the density of the susceptible population. Other factors that influence $R_0$ are the incubation period of the disease $R_{0e}$ and the duration of immunity post-infection. During the course of an epidemic, the susceptible population decreases in size as individuals join the infected population and then the recovered population through immunity or death. When $R_0$ becomes $<1$ the epidemic will fade out. An estimation of can be used to predict whether an epidemic will occur and how large it will be, so that decisions with regard to interventions can be taken.

$R_0$ can also be calculated for vector-borne diseases, for which the density of the vectors as well as the density of the susceptible population must be estimated.
Routes of transmission of infectious diseases

Contagious diseases

*Diseases transmitted by direct contact with infectious material*

Highly contagious diseases such as FMD, ASF, CSF, Newcastle disease and highly pathogenic avian influenza (HPAI) pose a major challenge for control, since they can cause massive outbreaks owing to their high potential for spread. The following measures may be applied to prevent transmission of these and other primarily contagious diseases:

- Prevent contact of domestic livestock with identified potential sources of infection; under various circumstances this can be effected by:
  - the use of fences (e.g. at the wildlife/domestic livestock interface),
  - the creation of zones or compartments of known status with respect to particular diseases (see modules on disease control and trade),
  - animal movement control and quarantine, and, in the case of outbreaks,
    - “stamping out” by compulsory slaughter and destruction of infected and in-contact animals.

- Vaccinate susceptible livestock.

- Implement strict biosecurity measures to ensure that infection is not introduced from unknown/unsuspected sources.

- Chemoprophylaxis (mainly bacterial and parasitic diseases) by treatment of sick animals and/or prophylactic medication of healthy animals.
Diseases transmitted by ingestion of infected material

Diseases that are naturally transmitted only through ingestion of infected material, like bovine spongiform encephalopathy (BSE), can be prevented by ensuring that such material does not enter the food chain of susceptible animals. Many of the contagious diseases can also be transmitted by ingestion of infected material. Ensuring that infected material does not enter the food chain may be effected by:

- Prohibition of feeding certain materials to livestock;
- Processing potentially infected material in such a way that pathogenic agents are destroyed.

Vaccination may protect animals from infection via this route.

Sexually transmitted diseases

Sexually (venereally) transmitted diseases (STDs) are prevented by ensuring that breeding animals are healthy. Imported stud animals are usually tested for a range of sexually transmitted diseases during a quarantine period, as are semen donors. Vaccination is used to prevent some STDs, e.g. brucellosis.

Diseases transmitted by bites

Rabies is the only disease that depends almost exclusively on the bites of rabid animals for transmission. Confining animals may to a large extent protect them against bites, but vaccination is widely used and is the most important control measure for rabies.
Vector-borne diseases

Vector-borne diseases continue to pose a challenge for animal health management. The ease with which vectors can be controlled depends on the life style of the vector (see modules on high impact diseases). Vectors that spend a long time on their domestic livestock hosts and have well defined life cycles, such as most of the ixodid ticks, can be controlled by dipping programmes using an effective acaricide to break the life cycle (see module on tick identification). Effective control is most readily achieved for ticks that are single-host species. Flying vectors such as mosquitoes, midges, and flies are far more difficult to control (see modules on mosquitoes, midges, biting flies and tsetse fly). Generally a combined approach to control diseases borne by flying insects is used, that may include:

- Control of known vector breeding areas where possible, e.g. eliminating places where stagnant water provides mosquito and Culicoides breeding sites around stables and removing dung, which provides a breeding site for flies as well as some species of Culicoides.

- Reduction of the vector population by targets (e.g. tsetse flies) and by the release of sterile flies. This method is still under development but so far has worked best in isolated populations (e.g. tsetse flies on the island of Zanzibar, Tanzania). House flies and stable flies that can act as mechanical vectors can be controlled by trapping devices like fly paper or by treating breeding sites with hormonal products.

- Use of repellent or insecticidal products on livestock e.g. pyrethroids

- Vaccination against diseases for which vaccines are available

- Chemotherapy

- Stabling animals during periods when the vectors are active, e.g. stabling horses between dusk and dawn to protect them from Culicoides midges.
Bathing pigs with an ectoparasiticide, Mozambique

The options for controlling the diseases for which short notes are provided above are summarised in Table 4.
<table>
<thead>
<tr>
<th>Disease</th>
<th>Control options</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMD</td>
<td>Physical barriers (fences); vaccination; quarantine and movement control; stamping out of outbreaks</td>
</tr>
<tr>
<td>PPR</td>
<td>Vaccination; quarantine and movement control; stamping out of outbreaks</td>
</tr>
<tr>
<td>RVF</td>
<td>Vaccination</td>
</tr>
<tr>
<td>Bluetongue</td>
<td>Vaccination</td>
</tr>
<tr>
<td>African horse sickness</td>
<td>Vaccination; movement control; stabling animals at night</td>
</tr>
<tr>
<td>Rabies</td>
<td>Vaccination; preventing contact with rabid animals; control of stray dog populations (vaccination, sterilisation)</td>
</tr>
<tr>
<td>BSE</td>
<td>Ban feeding of ruminant tissue to ruminants; removal of specified risk materials; rendering at recommended temperatures</td>
</tr>
<tr>
<td>ASF</td>
<td>Physical barriers; strict biosecurity on pig farms; ban on feeding uncooked swill/all swill; quarantine and movement control; stamping out of outbreaks</td>
</tr>
<tr>
<td>CSF</td>
<td>Vaccination; strict biosecurity on pig farms; ban on feeding uncooked swill/all swill derived from kitchen waste; quarantine and movement control; stamping out of outbreaks</td>
</tr>
<tr>
<td>CBPP</td>
<td>Vaccination; chemotherapy; quarantine and movement control; stamping out of outbreaks</td>
</tr>
<tr>
<td>Anthrax</td>
<td>Vaccination; complete destruction of carcasses by burning/burial</td>
</tr>
<tr>
<td>Theileriosis</td>
<td>Control of ticks; vaccination; chemotherapy</td>
</tr>
<tr>
<td>Trypanosomosis</td>
<td>Vector control; chemotherapy; chemoprophylaxis</td>
</tr>
<tr>
<td>Heartwater</td>
<td>Control of ticks; vaccination; chemotherapy</td>
</tr>
<tr>
<td>Bovine babesiosis</td>
<td>Control of ticks; vaccination; chemotherapy</td>
</tr>
</tbody>
</table>
FAQS

1. **Why do some diseases affect lots of different kinds of animals and others are much more specific in the species they target?**

   There is no simple answer to that question, but it depends on the disease agent’s ability to survive and replicate in the host. All living organisms have preferences for the habitat that they occupy, and some have very narrow preferences (for example Koalas, which only eat eucalyptus leaves), while others can find ways to adapt to almost any habitat (humans!). Micro-organisms behave in the same way and therefore some can adapt to a wide range of hosts while others are restricted to a single species.

2. **Why is genetic resistance not used more as a disease control strategy?**

   One of the reasons is that the number of known instances of genetic resistance that can be reliably exploited is quite low. The other is that genetic resistance may be combined with other heritable characteristics that are less desirable, for example low productivity.

3. **Are disease outbreaks more likely in farmed animals kept in or out of doors?**

   Outbreaks of disease can occur in animals that are kept in or out of doors, it really depends on how the disease is transmitted and maintained and also on how well the animals are managed. Some diseases can be avoided to some extent by keeping the animals indoors, for example when avian influenza outbreaks occur in wild birds poultry owners in the vicinity are advised to keep their birds indoors to avoid contact with wild birds. However, indoor farming systems imply close contact between animals as well as a possible build-up of pathogens, so good hygiene management is essential for the animals to remain healthy.

4. **Why do reports of diseases occurring at the livestock wildlife interface seem to be becoming more common, and can anything be done to prevent this increase?**

   The reasons may include encroachment of human populations with livestock into wildlife areas and also better diagnostics that allow us to identify diseases more efficiently. Furthermore, strict separation of wildlife populations, which resulted in unfavourable situations for the wildlife, is no longer acceptable. This means that new ways have to be discovered to manage diseases at the interface.
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Avian diseases


Wildlife


Bees and crocodiles

   Section 9 (Chapters 9.1 – 9.6) – Bee diseases.


Genetics and genetic resistance


Zoonoses


Websites

1. World Organisation for Animal Health (Office International des Épizooties) [www.oie.int](http://www.oie.int)
3. International Livestock Research Institute (ILRI) [www.ilri.org](http://www.ilri.org)