Ecosystem Health and Sustainable Agriculture

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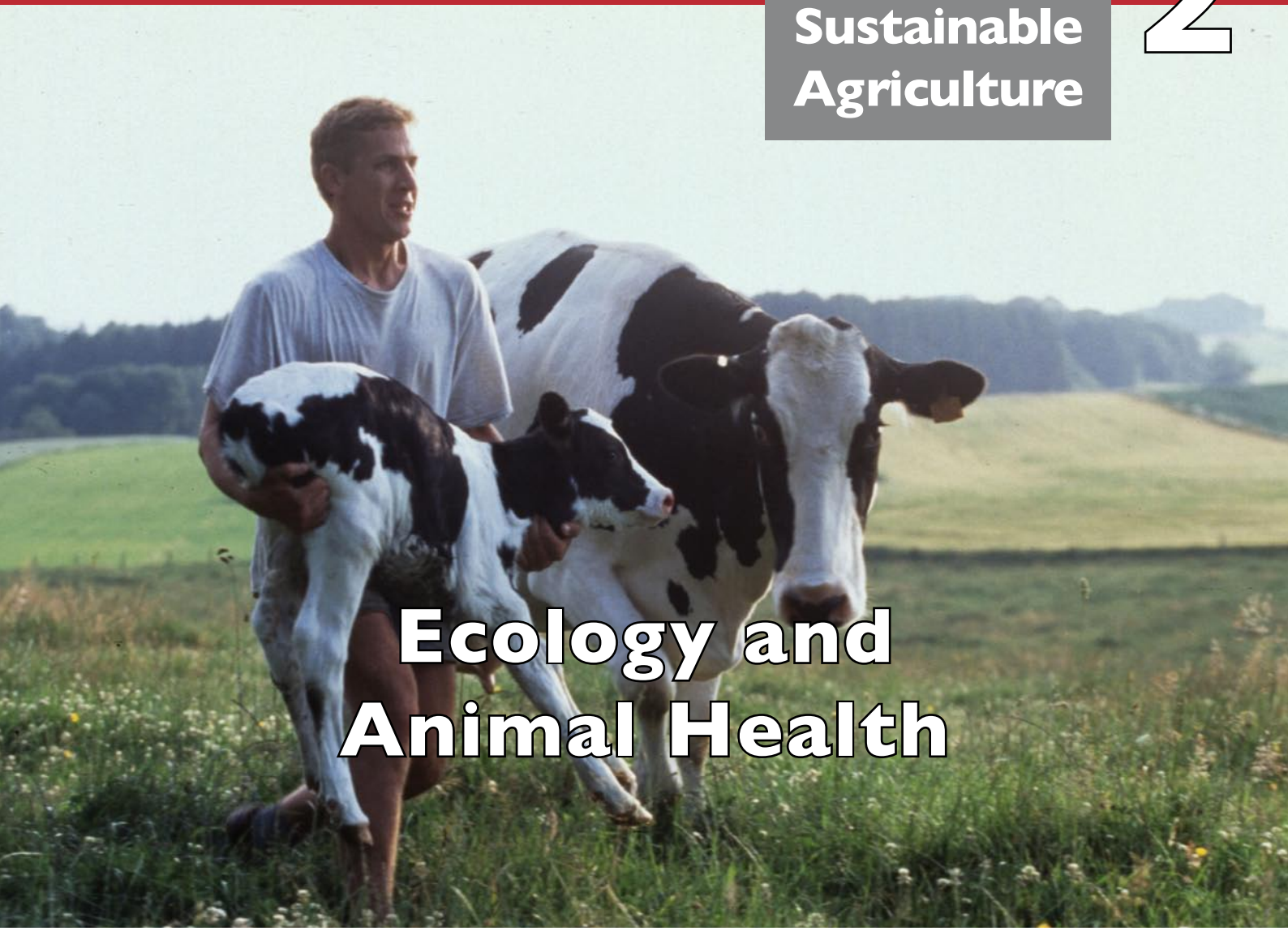

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Overview of Infectious Diseases and the Wildlife-Livestock Interface

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A Global Issue

The current global spread of the highly pathogenic avian H5N1-influenza (HPAI) has brought the insight that diseases can be transmitted between wild and domestic animals and to humans and a broader public. Scientifically, this insight has boosted the interest in the 'one medicine' concept, where human and veterinary medicine meet. About 58% of the infectious diseases of humans are estimated to be zoonoses (diseases that can be transmitted from vertebrates to humans) and they comprise almost three-quarters of emerging infectious diseases (Woolhouse, 2006; Jones et al., 2008).

A group of international organisations such as the WHO, FAO and OIE has proposed the framework 'One world, One health' in this context to emphasise the global dimension of some zoonoses (FAO et al., 2008a). These organisations stress the importance of a holistic view, taking into account human, livestock and ecosystem health. Ecosystem and livestock health generally have the weakest knowledge base in this zoonotic triangle, despite their utmost importance. Livestock, besides being affected *per se*, can serve as reservoirs or vectors and ecosystem and environmental variables tend to govern the intensity and spatial and temporal patterns of outbreaks. Some examples of pathogens that can affect humans, livestock and wildlife in temperate climates are shown in Table 21.1.

Epidemiology

The epidemiology of infections and diseases is highly dependant on several factors within, or in the interfaces between, human, livestock or wildlife populations. For

Table 21.1. Examples of recent reports on zoonotic pathogens in temperate climates that affect livestock and wildlife.

Pathogen	Wildlife	Livestock	Zoonosis	Reference
Rabies virus	Foxes, racoons, dogs	Cattle	Yes	Johnsson et al., 2008
Avian influenza, , H5N1	Waterfowl	Chicken, ducks	Yes	Ward et al., 2009
Leptospira sp.	Wild boar, rodents,	Pigs	Yes	Ebani et al., 2003
Brucella sp.	Wildboar, elk, hares, bison,	Pigs, cattle, sheep, goats	Yes	Godfroid et al., 2005
Mycobacterium bovis	Badgers, deer	Cattle	Yes	Boehm et al., 2009
Trichinellosis	Wild boar, bear	Pigs	Yes	Blaga et al., 2009

instance, the transmission of infections between humans is more likely to happen in areas with high population density, while transmission from livestock to humans is more likely in areas with high human and herd/farm density, especially where humans and livestock live in close proximity, as is often the case in developing countries. Furthermore, the spread of infections in livestock populations is facilitated by high herd/farm density with poor biosecurity, e.g. frequent movement of animals between herds and communal pastures. Finally, transmission between livestock and wildlife is more likely to occur if the animal population density is high and if livestock and wildlife are allowed to come into contact, as in free-range systems. Besides these and other population-related factors in the interfaces between humans, livestock and the ecosystem, there are several factors in habitat structure, farming traditions and practices, ecosystem changes etc. that influence the epidemiology of zoonoses.

The Role of Farming Practices and Habitat Destruction

Well-known examples of how farming practices, some with a strong basis in tradition or other human behaviour, can influence the spread or emergence of diseases are the Nipah virus outbreak in Malaysia 1998-1998 and the recent HPAI in Vietnam.

The novel paramyxovirus Nipah virus emerged in northern parts of Peninsular Malaysia in 1998 and caused severe febrile encephalitis in humans, with a high mortality rate (Chua, 2003). It was found that fruitbats were the natural reservoir hosts, infecting pigs which in turn infected humans coming into contact with the pigs. Notably, in pigs the virus caused encephalitis and respiratory diseases, but with a relatively low mortality rate. Therefore, infected pigs could be asymptomatic and were moved throughout the peninsula, thereby contributing to the spread of the disease. It is believed that the close association of piggeries with orchards and the design of pigsties, combined with destruction of natural habitats for the bats, increased the interface between bats and pigs and thereby contributed to the interspecies transmission of the virus.

In southern Vietnam there is a farming tradition that duck keepers move their flocks between rice paddies for feeding after the harvest. These movements of ducks can sometimes be quite far reaching, even between provinces. Ducks often do not show as clear symptoms of HPAI as chickens, but are very potent carriers of the virus, thus this farming tradition is regarded as contributing to a silent and efficient spread of the H5N1 virus in the country. When it comes to the role of wild birds in the global spread of H5N1, this seems to be limited to just a few cases, especially to, or in, Europe. Legal or illegal trade in poultry seems instead to be the major route for the virus moving between countries or continents (FAO et al., 2008b).

The Role of Wildlife

In wildlife, the occurrence and localisation of disease are determined by a variety of factors including some that relate to the host, some that relate to the causative agent and some that are considered environmental factors (Wobeser, 1994). Common environmental factors are climate, topography, soil, water and biotic features including other fauna and flora. Characterisation of the environmental conditions associated with disease and disease outbreaks is an important part to the understanding for the epidemiology of disease in wildlife. It is impossible to prepare a comprehensive list of all factors that should be taken into consideration during a disease investigation, but it is important to develop standard protocols that incorporate the complex biological, chemical and abiotic interactions of pathogens within the ecosystem (Wobeser, 1994). Cooperrider et al. (1986) and Wobeser (1994) provide excellent information about various environmental factors in relation to wild animals.

The Role of Arthropod Vectors

Pathogens in tropical areas of the Eastern Hemisphere appear more likely to have arisen from wildlife sources and to involve invertebrate vectors than those of the temperate

zone, which tend to be more closely associated with diseases of domesticated animals (Wolfe et al., 2007). Crowd diseases emerged in conjunction with the development of agriculture and the concurrent increase in density of human and domestic animal populations (Diamond, 1999). The geographical dispersal of zoonoses across Europe and North America accompanied the major cultural and technological transitions from small local agrarian groups to large Eurasian nation states and from European intercontinental exploration and conquest to our present status of almost global interconnection (Weiss and McMichael, 2004). Similar to what has been found for free-living organisms, there is a negative latitudinal gradient in the species richness of human pathogens (Guernier et al., 2004). Thus, the greatest burden of vector-borne diseases is in the tropics, but the majority of hotspots for outbreaks tend to be in western Europe, northeastern United States, Japan and southeastern Australia (Jones et al., 2008).

Conclusions

There are a number of bacterial, viral and parasitic diseases present at the livestock-wildlife interface. Quite a few of these are zoonotic and are also emerging globally. To handle these diseases – for the sake of public, livestock and wildlife health – a holistic approach beyond conventional human and veterinary medicine must be taken. This approach must include ecosystem health as well as social/cultural aspects. Overall, there are considerable knowledge gaps among professional health workers about those additional aspects.

In the following sections we therefore discuss the above mentioned crucial elements in the understanding of the interface between livestock and wildlife: disease monitoring in wildlife (chapter 22); the role of arthropod vectors in disease transmission (chapter 23); and infections in relation to habitat fragmentation and species barriers (chapter 24). The control and management of these diseases is discussed in Part F (Prevention of infectious diseases in livestock and wildlife)

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