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Chapter 9

DISEASE AND TRANSPORT: A COSTLY TICKET AROUND THE WORLD

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ABSTRACT

Over 60 billion animals are reared for food each year worldwide and most are transported for slaughter, often over long distances, both within and between countries. Transportation is one of the most stressful events in a farm animal's life and this massive movement of live animals takes place against a background of increasing public concern for animal welfare in many countries, and of growing evidence that long distance transport may be linked with the spread of animal and human diseases. This article examines the animal and human health implications of transporting animals over long distances and explores measures to limit long distance transport of animals for slaughter, with positive effects for animal and public health and additional economic and social benefits. It concludes that introduction of measures to avoid long distance transport of animals for slaughter, and to replace the movement of live animals with a carcass trade, is not only necessary but urgent.

INTRODUCTION

Over 60 billion animals are reared for food each year worldwide and most are transported for slaughter, often over long distances, both within and between countries. Transportation is one of the most stressful events in a farm animal's life and this massive movement of live animals takes place against a background of increasing public concern for animal welfare in many countries, and of growing evidence that long distance transport may be linked with the

spread of animal and human diseases. This article examines the animal and human health implications of transporting animals over long distances and explores measures to limit long-distance transport of animals for slaughter with positive effects for animal and public health and additional economic and social benefits.

PHYSIOLOGY AND DISEASE

According to the Food and Agriculture Organization (FAO) of the United Nations, "[t]ransport of livestock is undoubtedly the most stressful and injurious stage in the chain of operations between farm and slaughterhouse" and can lead to a significant loss of production (FAO, 2001). Stress may have negative effects on the immune system and this can result in increased susceptibility to infection and increased infectiousness (Manteca, 2008).

Long-distance transport may increase the faecal shedding of disease agents. Barham and colleagues (2002) found that the average prevalence of *Salmonella* within faeces and on the hides of cattle was 18% and 6%, respectively, before transport. After the animals were loaded onto a vehicle and trucked for 30 to 40 minutes, the levels of *Salmonella* found in faeces increased from 18% to 46%, and the number of animals with contaminated hides escalated from 6% to 89% upon arrival at the slaughter plant. Faecal pathogens on the hide might then end up in the meat supply (Barham et al, 2002). Similar results were found in pigs (Marg et al, 2001) and chickens raised for meat (Whyte et al, 2001). Thorough cleaning of transport vehicles with disinfectants has been estimated to remove more than 95% of pathogens (Barrington et al, 2002). In practice, however, a 2003 survey of livestock haulers found that only 16% of the 132 respondents indicated that they washed their transport vehicles between loads, and fewer than 5% used disinfectants as a component of the cleaning process (Spire, 2004). This can be attributed to the lack of written protocol provision by trucking companies on vehicle sanitation or, more likely, the lack of proper economic incentive for the truckers (Fike and Spire, 2006).

Furthermore, transport augments the intensity and frequency of contacts between animals and this can result in diseases being spread (Manteca, 2008). Although in many countries systems are in place to avoid the transport of animals that show signs of disease, the problems arising from subclinically infected animals and difficulties of detection remain unresolved. In the UK, for example, a study found that only 23% of UK sheep farmers could correctly identify foot lesions compared to 79% of veterinarians (Kaler and Green, 2008). This is a serious concern as most loading of animals for transport is done without a veterinarian present. And while Western Australia has codes of practice for the transportation of sheep and pigs, it still allows transport of susceptible animals, ruling that "those most susceptible to disease, stress or injury during transport must be loaded last and unloaded first" (DLGRD, 2003a, b).

ANIMAL DISEASES

The FAO describes live animal transport as "ideally suited for spreading disease," given that animals may originate from different herds or flocks and are "confined together for long

periods in a poorly ventilated stressful environment" (FAO, 2002a). Similarly, the European Union Scientific Committee on Animal Health and Animal Welfare recognises that the stressful effects of the transport might put the animals at greater risk of disease and, to limit the welfare problems and the likelihood of spreading disease, recommends that "animals should not be transported if this can be avoided and journeys should be as short as possible" (SCAHAW, 2002).

Given the associated "serious animal and public health problems," the Federation of Veterinarians of Europe has called for the replacement of the long-distance transportation of live animals for slaughter as much as possible by a carcass-only trade (FVE, 2001).

Of the diseases known to be transmitted by transport, the American Veterinary Medical Association (2007) considers foot and mouth disease (FMD) to be the world's most economically devastating. The importance of classical swine fever has also been emphasised (Elbers et al, 2001) and others listed by the Federation of Veterinarians of Europe include exotic Newcastle disease of birds, bovine viral diarrhoea, African swine fever, swine dysentery, swine vesicular disease, porcine reproductive and respiratory syndrome, post-weaning multisystem weaning syndrome, porcine dermatitis and nephropathy syndrome, enzootic pneumonia, bovine rhinotracheitis, glanders, and sheep scabies (FVE, 2001). Horse diseases that have been problematic include African Horse Sickness, Equine Influenza, Equine Infectious Anaemia, Equine Viral Enteritis and Contagious Equine Metritis (World Horse League, personal communication March 2009).

By contrast, while some important diseases such as FMD and classical swine fever can be carried in meat, the number of these is relatively small and the risk of disease transmission in meat is low, especially if meat waste is properly controlled.

Historically, dozens of outbreaks of FMD have been tied to livestock movements (USDA, 1994) and contaminated transport vehicles (OIE/FAO, 2001). In the 1997 outbreak in Taiwan, 4 million pigs were infected, and 37.7% of the nation's pigs died or were killed, resulting in 65,000 jobs lost (Yang et al, 1999) at an estimated cost of $6.6 billion (FAO, 2002b). The Taiwan Council of Agriculture concluded that the outbreak was likely caused by the smuggling of infected animals from mainland China (FAO, 1999). An analysis of spatial and temporal patterns of FMD occurrence in Turkey, historically an important bridge between the endemic regions in Asia and disease-free Europe, showed a shift of predictors over the study period (1990–2002) away from short-distance spread between neighbouring provinces toward large jumps ascribed to live animal transport over long distances (Gilbert et al, 2005).

Although the origin of the 2001 British FMD outbreak was blamed on the illegal importation of contaminated meat (UK House of Commons Library, 2001), the subsequent explosive spread within the country was, according to the World Organization for Animal Health (OIE), "mainly attributed to the movement of subclinically infected animals, principally of sheep, and by contact with contaminated vehicles used for the transportation of these animals" (OIE/FAO, 2001). The extensive spread facilitated by long-range transport not only makes easy eradication impossible but also undermines "regionalization." Regionalization is the OIE policy allowing affected areas of a country to be risk-stratified independently, thereby limiting international trade losses that would otherwise mount should an entire country be given a single disease-affected status (Seitzinger et al, 1999). Including tourism losses, the cost of the 2001 UK outbreak has been estimated at $20 billion (AVMA, 2007). The further expansion of the 2001 British FMD outbreak into France was via the export of infected sheep, and the spread of the disease into the Netherlands was traced to

certified FMD-free calves imported from Ireland; the latter contracted the virus in transit at an overnight resting stop in France (Pluimers et al, 2002). Thus, live animal transport plays a significant role in both the spread and transmission of infectious disease.

Indeed, it can be argued that disease control is more difficult now than it was just 20 years ago because of the increased ease of animal movement both by air and by road. Examples include the outbreak of classical swine fever in the Netherlands in 1997, the spread of FMD in Europe in 2001 and the dispersal of blue tongue disease in Europe in 2008. The latter is spread only by live animals and is very difficult to control even with the use of new vaccines.

HUMAN HEALTH RISKS

As costly and disruptive as livestock disease outbreaks can be, long-distance live animal transport can also facilitate the spread of animal pathogens with the potential to cause human disease. Rift valley fever (RVF) is known to be endemic in most of the sub-Saharan countries but in September 2000 the first outbreak of the disease outside Africa occurred in Saudi Arabia and Yemen due to the transport of animals from the Horn of Africa to the Arabian Peninsula (Shoemaker et al, 2002). From September 2000 to February 2001, a total of 124 deaths and 884 hospitalised patients were reported in Saudi Arabia and a further 121 deaths and 1,087 hospitalisations in Yemen. Because of the magnitude of the outbreak and the large geographical area, however, the total number of infections was unknown, with data from previous outbreaks suggesting that the number of hospitalised patients represents a small percentage (<1%) (Shoemaker et al, 2002). The potential for further spread of the disease in the region is well acknowledged, particularly during the celebration of the Eid festivals, when large movements of animals occur from the Horn of Africa to the Arabian Peninsula (FAO, 2007).

The Nipah virus emerged in 1998 on an industrial pig farm in Malaysia to become one of the deadliest of human pathogens, causing relapsing brain infections and killing 40% of those infected (Uppal, 2000). The disease erupted in the northern part of the Malaysian peninsula but was trucked nationwide (Smith, 2003). “A hundred years ago, the Nipah virus would have simply emerged and died out,” the Thai Minister of Public Health explained. “Instead it was transmitted to pigs and amplified. With modern agriculture, the pigs are transported long distances to slaughter. And the virus goes with them” (Specter, 2005). In the Malaysian outbreak, the Nipah virus took the lives of approximately 100 people.

Avian influenza viruses have the potential to spawn pandemics capable of killing millions (Murray et al, 2006). In early 2004, outbreaks of highly pathogenic avian flu strain H5N1 were reported nearly simultaneously across eight countries in Southeast Asia. Given the pattern and timing of outbreaks, the FAO identified the transport of live birds reared for human consumption as a primary source in the rapid spread (FAO, 2004a). In February 2004, the FAO reported that 5,000 chickens had succumbed to avian influenza in Lhasa, Tibet, and that these infected birds had been transported to Tibet from China’s Lanzhou city — a trip spanning more than 1,000 miles (FAO, 2004b). The further the animals are transported, the further the diseases can be spread (SCAHAW, 2002).

Long-distance live animal transport has also been blamed for the spread of swine flu viruses in the United States. Throughout much of the 20th century, influenza viruses had established a stable H1N1 lineage in U.S. pigs. That seemed to have changed in August 1998 when thousands of breeding sows fell ill on a North Carolina pig farm. An aggressive H3N2 virus was recovered, bearing the H3 and N2 antigens of the human influenza strain circulating since 1968. Not only was this highly unusual, but, upon sequencing of the viral genome, researchers found that it was not just a double re-assortment (a hybrid of human and pig viruses, for example) but a never-before-described triple assortment (Zhou et al, 1999), a hybrid of three viruses—a human virus, a pig virus, and a bird virus. "Within the swine population, we now have a mammalian-adapted virus that is extremely promiscuous," molecular virologist Richard Webby told *Science*. "We could end up with a dangerous virus" (Wuethrich, 2003). Within months, the virus appeared in Texas, Minnesota, and Iowa (Zhou et al, 1999). Within one year, it had spread across the United States (Webby et al, 2000). The rapid dissemination across the nation was blamed on the cross-country transport of live pigs (Wuethrich, 2003). In the United States, pigs travel coast to coast: They are frequently born in North Carolina, fattened in the corn belt of Iowa, and then slaughtered in California. It is often cheaper to ship the animals to the feed rather than ship the feed to the animals (USDA, 2003). While this regional segmentation of production stages may cut down on short-term costs for the pork industry, the highly contagious nature of diseases like influenza – perhaps made even more infectious by the stresses of transport (Wuethrich, 2003) – must be considered when calculating the true cost of long-distance live animal transport.

ECONOMIC LOSSES

Limiting live animal transport will contribute not only to good animal health and welfare but also to good economics (Harris, 2005). Although live animal transport regulations can be costly in the short-term, David Byrne, the former European Commissioner for Health and Consumer Protection, said that he remained "convinced that the longer-term gains, in terms of increased bio-security and healthier animals, will reap greater economic rewards into the future" (Byrne, 2003).

The costs associated with transport extend well beyond direct freight charges (Speer et al, 2001), and include mortality and losses in terms of quality of meat. Data from the National Institute for Animal Agriculture suggest that 80,000 pigs die annually in the U.S. during the transportation process. Assuming a $100 market value per hog, this equates to an $8 million annual loss to the pork industry, not including carcass disposal fees (Grandin, 2003). Beyond death losses, nonambulatory ("downer") pigs at the slaughter plant may be severely discounted and require additional labour handling costs, and carcass trim loss due to transport-related bruising, and other pork quality defects may pose additional cost burdens (Ritter et al, 2006). Increasing transport floor space may significantly reduce both the percentage of nonambulatory pigs and total losses (dead and disabled), and gentler handling techniques during loading and unloading (plastic canes compared to electric prods) may reduce stress-related disability (Benjamin et al, 2001).

Data from the export industry in Australia for 2007 estimates the death rate for sheep at 0.99% during the journey to the Middle East. This equates to 37,409 dead animals out of a total of 3.7 million sheep exported that year (DAFF, 2008). Even at the estimated value of

AUS$50 per head recorded the year before (Agra CEAS, 2008), that equates to a loss of AUS$1.9 million.

Cattle mortality is relatively rare in transit, but due to the high value of each animal the loss can be high, and to the loss of mortality must be added the transportation-associated loss of mobility. In the U.S. in 1999, the losses associated with the additional handing of nonambulatory cattle were valued at $0.56 for every cow and bull marketed (Smith et al, 2001). With most disabled cattle now excluded from the U.S. food supply as a result of the discovery of bovine spongiform encephalopathy in the U.S. in 2003 (Marg et al, 2001), the U.S. Department of Agriculture (USDA) estimates zero salvage value for these "downer" animals, with the possibility of added disposal costs (USDA, 2004).

The average death rate for cattle transported from Australia to South East Asia, Middle East/North Africa and Mexico was 0.10% in 2007. This equates to 747 dead animals out of a total 712,320 cattle (DAFF, 2008). At the estimated value of AUS$650 per head (Agra CEAS, 2008), that equates to a loss of AUS$0.5 million.

In addition to mortality losses, long-distance transport can affect carcass characteristics and cause losses in terms of quality of the meat. Inanition (failure to eat) associated with transport is likely an important cause of carcass and meat quality depreciation. Pre-slaughter stress might result in paler chicken thigh meat (Kannan et al, 1997) and tougher rabbit leg meat (Lambertini et al, 2006) and can contribute to the formation of dark, firm, and dry (DFD) meat in beef and pale, soft, and exudative (PSE) meat in pork (Lawrie, 1966). In a comprehensive review of 22 different scientific studies on the effect of transport on pigs, it was concluded that all the studies found an effect on the welfare variables studied and 87% found an effect on meat quality (Maria, 2008).

The main meat quality problem associated with cattle is bruising. When bruising is severe, it decreases the quantity of marketable meat. For example, in the Pantanal region in Brasil, a study on the influence of transport on carcass bruising in cattle concluded that, of 121 carcasses assessed, 102 (84.3%) had one or more bruises, totalling 270 bruises, which resulted in the removal of 56.1kg meat (Andrade et al, 2008). Maria (2008) reviewed 37 different scientific studies on the effect of transport in cattle and concluded that 95% found a significant effect on carcass or meat quality.

Table 1. Trade barriers between countries for some major animal diseases (OIE, 2008).

Disease	Time to gain country disease free status	Time to regain status	
		Stamping out	No stamping out
Foot and Mouth Disease	Without vaccine – 1 year	3 months	6 months
	With vaccine – 2 years	6 months	18 months
Rift Valley Fever	Without vaccine – 6 months		
	With vaccine – 21 days		
Blue-tongue	Without vaccine – 2 years	n/a	n/a
	With vaccine – 60 days	n/a	n/a
African Swine Fever	3 years	12 months	n/a
Classical Swine Fever	1 year	1 month	n/a
Avian Influenza	1 year	3 months	n/a

Newcastle Disease	3 years	6 months	n/a
BSE	7 years free to be considered a 'negligible risk'	n/a	n/a

Table 2. Suspension of trade between countries following rejected shipments on the basis of disease and animal welfare considerations (Keniry, 2003; MAF, 2004).

Year	Duration	Countries involved	Reasons
1991	10 years	Australia - Saudi Arabia (sheep)	11 Australian shipments rejected between 1989 and 1991 on the basis of alleged disease grounds.
1990	1 year	New Zealand - Saudi Arabia (sheep)	Cormo Express shipment suffered a 12% mortality followed by rejected shipment on the basis of alleged disease grounds.
2001	1.5 years	Australia – Korea (cattle)	Two consignments of cattle rejected after allegedly testing positive with blue-tongue.
2003	2 years	Australia - Saudi Arabia (sheep)	Cormo Express shipment refused due to 6% animals allegedly infected with scabby mouth.
2006	2 years	Australia – Egypt (cattle)	Non compliance with minimum OIE animal welfare guidelines in Bassatin slaughterhouse.
2006	Ongoing	Australia - Egypt (sheep)	Non compliance with minimum OIE animal welfare guidelines.

Long-distance transport can also lead to a reduction of slaughter yield, an effect which can only be partially explained by fasting (Knowles et al, 1993). Much of the loss is from carcass components and not simply gastrointestinal fill (Jones et al, 1988). Pigs transported for 11 hours might lose a commercially significant 3% of their body weight (Becker et al, 1989); sheep transported for 18 hours could suffer as much as an 8% mean loss of live weight (Knowles et al, 1993); and the transport and holding of goats could result in a 10% loss of live weight (Kannan et al, 2000). Transportation of broilers also results in carcass shrinkage, thought to be largely attributable to energy expenditure related to convective heat loss during transport (Moran and Bilgili, 1995).

Another indirect economic impact of long-distance transport of animals for slaughter arises from the introduction of trade barriers following disease outbreaks (Table 1).

The 2000 outbreak of Rift Valley Fever (RVF) in East Africa that spread to Saudi Arabia and Yemen prompted Saudi Arabia and several Gulf States to ban livestock imports from eight East African countries. This ban reduced East African exports by 75% (USAID, 2008). An earlier outbreak of the disease in East Africa in 1998 resulted in a trade ban estimated to cost $100 million of lost exports from Somalia and Ethiopia alone and disruption in families and communities that depend heavily on livestock for their subsistence (FEWS NET, 2000). Countries are slowly starting to respond to this market uncertainty. The focus of the livestock export trade in land-locked Ethiopia has begun to shift from a traditional reliance on livestock export trade to exporting frozen goat meat to Gulf states and frozen beef to some countries, including by airfreight to Egypt (New Agriculturalist, 2006). The recurring disruption in the livestock trade from East Africa to the Middle East caused by disease outbreaks has helped trade competitors such as Australia, which has a low disease status, to maintain their products in the Middle East markets (Drum and Gunning-Trant, 2008).

Long-distance transport of animals is never devoid of risks. Shipments may be rejected if the threshold for certain diseases is exceeded, leading to a suspension of trade between countries (Table 2). An example that received global media coverage was the Cormo Express shipment of Australian sheep that was rejected by Saudi Arabian authorities in 2003 due to an incidence of scabby mouth. This dispute resulted in a suspension of trade between the two countries, a third review of the live export trade in Australia (Keniry, 2003) and renewed calls for the New Zealand Minister of Agriculture to ban the trade from New Zealand which incurred similar risks (subsequently, the New Zealand authorities did not approve any further animal shipments to the Middle East from 2003). The consignment of 57,937 sheep destined for Saudi Arabia left Freemantle, Australia on 5 August. When it arrived at Jeddah on 21 August, the Saudi authorities rejected the shipment on the grounds (albeit questionable) that 6% of the animals suffered from scabby mouth when the threshold was 5%. Subsequent negotiations by industry representatives and Australian Government representatives with a large number of countries failed to gain acceptance of the consignment. By the time the sheep were accepted and unloaded in Eritrea on 24 October, the sheep had been on the vessel for 80 days and there had been a total of 5,691 (9.8%) deaths (Keniry, 2003). Throughout the disaster there was a lot of public and international pressure on the Australian Government to resolve the problem and prevent it from reoccurring.

A suspension of trade can also be put into place if certain minimal animal welfare criteria are not met on arrival. This is the case of the temporary suspension of livestock trade between Australia and Egypt after Animals Australia footage showing the cruel treatment of animals upon arrival and slaughter in Egypt was aired in Australia. Following this suspension, the countries signed a Memorandum of Understanding requiring Egypt to implement measures consistent with the international animal welfare standards of the World Animal Health Organisation (OIE). Despite the bilateral agreement in place, footage aired later in the year showed animals slaughtered in breach of the agreement (Garcés et al, 2008).

GROWING SOCIAL CONCERN

There also seems to be an emerging social ethic regarding farm animal welfare (Rollin, 2004). As Duncan and Fraser (1997) wrote, “animal welfare is not a term that arose in science to express a scientific concept. Rather, it arose in society to express ethical concerns regarding the treatment of animals.”

The most recent Eurobarometer survey in the 27 member countries of the European Union and Accession countries Croatia and Turkey shows that animal welfare is ranked highly by European citizens (EC, 2007b). The high concern repeatedly expressed by European citizens resulted in the strategic choices made by the European Commission regarding animal welfare policies, including transport (Gavinelli et al, 2008).

Due to the perceived growing social concern but absence of opinion polls such as the Eurobarometer for other countries, the World Society for the Protection of Animals (2007) commissioned a series of opinion polls around the world to explore the degree to which the public is concerned with farm animal welfare and long-distance transport in particular.

In the U.S., 93% of those polled considered it important that farm animals raised for human consumption are treated humanely. Seventy four percent considered that the current

28 hours that U.S. law allows animals to be transported without food, water or rest is too long. And 68% considered it extremely important to reduce the time farm animals could be transported in order to reduce the spread of disease. Sixty three percent agreed that it is extremely or very important to limit the journey times in order to reduce the risk of food contamination.

In Canada, even a higher percentage feel it is important to treat farm animals humanely (96%) and two-thirds (68%) feel that it is extremely or very important for farm animals to be treated humanely. After hearing about the journey times allowed in Canada (the highest among developed nations), almost all Canadians (96%) indicated it is at least somewhat important to limit the maximum amount of time farm animals can be transported before they are provided with food, water, or rest, so animal suffering will be reduced. Seventy five percent think it is extremely or very important to reduce transportation times and thus disease transmission. Seventy four percent think it is extremely or very important for transportation times to be limited, so the risk of food contamination is reduced.

In Australia, the opinion poll on the public perception of the Australian live export trade showed that 57% agree that the country should end the trade and 74% agree that the best way to transport meat overseas is chilled or frozen meat from animals slaughtered in Australia. Similarly, in New Zealand, only 26% of respondents to a recent opinion poll thought the government should allow the export of live sheep to resume. Of those who disagreed with resumption, 88% cited as an extremely important reason the fact that sheep suffer during the export process. And 72% listed the damage to New Zealand's reputation as a responsible exporter as an extremely important reason.

The social concern for the welfare of animals and the negative welfare implication of animal transportation is not limited to Europe, North America and Australasia. Polls in China and Brazil had similar results. Although fewer than one in ten Chinese (7%) feel that they have some knowledge about the conditions under which animals are farmed in China, the majority of people (73%) interviewed feel that the treatment of farm animals is important to some extent and 34% think it is very important. An overwhelming majority of Chinese (82%) agree to some extent that, in order for society to be truly civilised, animal welfare must be a key priority and 39% strongly agree. In Brazil, although only one in six Brazilians (17%) feel they have some knowledge about the treatment of animals in their country, 79% said that the treatment of farm animals in their country is important to some extent and 25% say that it is very important.

Over the last 30 years, campaigns against the long-distance transport of animals mainly in Australia, Europe and North America have received a fair amount of political, public and media attention (Garcés et al, 2008). Motivated by concern for the welfare of farm animals, animal welfare organisations advocate replacing long-distance transport with a carcass trade. In recent years, animal welfare organisations have not only grown in size but they also play an increasingly important role in global issues, often with consultative status with intergovernmental organisations. Long-distance transport campaigns follow this trend and, where traditionally they tended to focus on the longest national or regional routes, they are now becoming increasingly global. Handle with Care is a recent example of this global focus. In 2008, this coalition of organisations from Australia, Europe and North America prepared a scientific review on long-distance transport of animals for slaughter (Appleby et al, 2008) and investigated some of the longest routes of animals transported for slaughter around the world (Handle with Care, 2008).

SHIFTING TOWARDS A CARCASS TRADE

A phase out of long-distance transport of animals for slaughter to prevent outbreaks of animal diseases and potentially serious public health problems may be tenable if there is careful investment, planning and a working partnership between governments and the livestock sector. In addition, the shift to a carcass trade can have positive social and economic benefits. There are several types of approaches to achieve this transition.

Prohibition of Long-Distance Transport of Animals for Slaughter

New Zealand recently prohibited the export of livestock for slaughter unless the risks to New Zealand's reputation as a responsible exporter can be adequately managed. This prohibition further recognised that live animal exportation could result in severe economic consequences to New Zealand (MAF, 2007). New Zealand has had a long association with the live sheep trade. In 1985, after several years of a total trade ban, it recommenced live animal exportation and the trade peaked in the mid-1990s, with over one million sheep being exported annually, mainly to Saudi Arabia (MAF, 2004). In the late 1990s shipments dwindled and the last shipment was made in 2003. Following the Cormo Express incident in 2003, where a shipment of Australian sheep was rejected by Saudi Arabia on the grounds of disease, New Zealand decided to put any further exports of livestock on hold until animal welfare requirements could be guaranteed. In the period 1986 to 2006, the value of New Zealand's beef, sheep, lamb and deer meat exports increased 75%, while quantity has remained relatively constant (New Zealand Trade and Enterprise, 2007). New Zealand exports frozen meat to the Middle East (about 15% of the total sheep meat exports) but the trend has been towards shipment of products where more value is added locally in New Zealand (New Zealand Trade and Enterprise, 2007).

As the Keniry report also notes for Australia, the value of the red meat (carcass) export industry is significantly larger than live exports and adverse incidents in the live export trade (such as the Cormo Express) could have serious consequences for both industries (Keniry, 2003). The lack of control over the treatment and care of animals once they leave Australia, and especially at the export destination, makes the live export trade high risk in terms of negative economic and social impacts.

Introduction of Legislation and Maximum Journey Times

This has been the traditional approach of the European Union, where livestock transport has long been regulated. The rationale for this approach is expressed in the recent Animal Health Strategy for the European Union (2007-2013) entitled "Where prevention is better than cure: The movement of animals has to reach a balance where the free movement of animals is proportionate to the risk of introducing and spreading of diseases and to the welfare of the animals during transport" (EC, 2007a).

A 2005 European Directive (95/29/EC amending 91/628/EEC) concerning the protection of animals during transport made exports of sheep from the UK less viable and so these have declined. From a peak of around 2 million sheep exported in 1993, sheep exports declined to around 100,000 sheep in 2006, mainly to France and other EU countries. It should be added that although live sheep as well as lamb meat exports declined following the FMD outbreak in 2001, lamb meat exports have since then steadily risen, while live sheep exports remained at much lower levels than those predating the FMD outbreak (Red Meat Industry Forum, 2007a).

A Council Regulation (EC No 1/2005) that came into effect in 2007 introduced further restrictions to the transport of livestock in the European Union by setting lower livestock densities as well as a limit of 24 hours for the transport of pigs and horses and 28 hours for cattle, sheep and goats. After this time limit, animals have to be unloaded at resting points for 24 hours before continuing the journey. In addition, horses have to be transported in single partitions. The effects of proper and full implementation of this Regulation mean that the carcass trade has the potential to become more profitable than the live animal trade. Such is the case for horses transported from Spain to be slaughtered in Italy. A detailed economic analysis of this trade completed by the International League for the Protection of Horses (now World Horse Welfare) concluded that, from an economic point of view, the trade becomes uneconomical if the new Regulation is adhered to on journeys from Southern Spain (i.e. journeys that take over 24 hours). Journeys that take less than 24 hours (i.e. from Northern Spain) also become less profitable as fewer horses can be transported per journey and more vehicles or trips would be needed (Leckie, 2007).

Partnerships between Governments, Livestock Sector and Animal Welfare Organisations

Although the exports of cattle and beef have been heavily influenced by the outbreak of BSE in 1996 and FMD in 2001 (Red Meat Industry Forum, 2007b), the UK has a long involvement in calf exports to veal farms in other European countries. This trade has caused protests as the calves were sent to farms using rearing systems that did not meet UK standards. But after the interruption of the trade following the outbreak of BSE, the country had the problem of surplus male Holstein/Friesian dairy calves. The Beyond Calf Exports Stakeholders Forum was convened in 2006 and comprises farmers, industry bodies, milk and beef processors, retailers, welfare assurance bodies, animal welfare organisations and consumers. The Forum came together to address the surplus of male dairy calves born in the UK and increase the uptake of these calves into the UK beef chain, to avoid them being euthanised or exported to veal farms (Beyond Calf Exports Stakeholders Forum, 2008). Since then, key retailers in the UK such as Tesco and Marks & Spencer started phasing out the sale of imported veal in favour of domestically reared veal (Food Productivity Daily, 2008).

Another example of the partnership approach comes from Namibia. The opening of the EU beef market to Namibia had a positive impact in the Namibian meat industry and resulted in a shift from exporting live cattle to South Africa to meat exports instead. The stringent requirements from the EU required a concerted response from the Namibian industry, which came in the form of the Farm Assured Namibian Meat Scheme (FAN Meat), managed by the Meat Board of Namibia and monitored by the Directorate of Veterinary Services. In 1989,

only 46% of all Namibian cattle marketed were slaughtered in Namibia and the remaining 54% were exported live to South Africa. By 2001, the position reversed and 58% of all cattle were being slaughtered in Namibia, and 42% exported live to South Africa (Paskin, 2004).

CONCLUSION

The FAO projects worldwide annual meat production doubling from 2000 to 2050 (Steinfield et al, 2006) and the movement of animals is expected to increase as a consequence. If no measures are taken to avoid long-distance transportation of live animals, the animal and human health risks are expected to increase, along with associated economic and social costs. In the framework of the growing social concern surrounding animal welfare and the risks for animal and human health arising from the long-distance transportation of animals, inaction is not an option. As justly pointed out by the President of the OIE International Committee, current controls (including legislation) of long-distance transportation may limit the problems but do not prevent them, and "the question I suggest we need to be challenging ourselves with is whether this approach is really sustainable over the longer term?" (O'Neil, 2008). A complete ban on long-distance live animal transport may not be tenable (Byrne, 2003), as there may always be a need for long-distance transport of specialized livestock such as breeding stock and racehorses. Depending on the circumstances of each country, however, introduction of one or a combination of measures to avoid long-distance transport of animals for slaughter – and to replace the movement of live animals with a carcass trade – is not only necessary but urgent.

REFERENCES

Agra CEAS Consulting Ltd. (2008). Economic Aspects. pp 18-68 in: M. C. Appleby, V. Cussen, L. Garcés, L. A. Lambert, & J. Turner (Eds.), *Long Distance Transport and Welfare of Farm Animals*. CAB International, Wallingford, UK.

American Veterinary Medical Association (2007). Foot and mouth disease. http://www.avma.org/reference/backgrounders/fmd_bgnd.pdf. Accessed July 2007.

Andrade, E. N. de, et al. (2008). Ocorrência de lesões em carcaças de bovinos de corte no Pantanal em função do transporte. *Ciência Rural* 38 (7):1991-1996, Santa Maria. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-84782008000700030. Accessed December 2008.

Appleby, M. C., Cussen, V., Garcés, L., Lambert, L. A. & Turner, J. (Eds.) (2008). Long Distance Transport and Welfare of Farm Animals. CAB International, Wallingford, UK.

Barham, A. R., Barham, B. L., Johnson, A. K., Allen, D. M., Blanton, J. R. Jr. & Miller, M. F. (2002). Effects of the transportation of beef cattle from the feedyard to the packing plant on prevalence levels of Escherichia coli 0157 and Salmonella spp. *J Food Prot*, *65*, 280-283.

Barrington, G. M., Gay, J. M. & Evermann, J. F. (2002). Biosecurity for neonatal gastrointestinal diseases, *Vet Clin North Am Food Anim Pract*, *18*, 7-34.

Becker, B. A., Mayes, H. F., Hahn, G. L., et al. (1989). Effect of fasting and transportation on various physiological parameters and meat quality of slaughter hogs. *J Anim Sci*, *67*, 334-341.

Benjamin, M. E., Gonyou, H. W., Ivers, D. J., et al. (2001). Effect of animal handling method on the incidence of stress response in market swine in a model system. *J Anim Sci*, *79*, 279.

Beyond Calf Exports Stakeholders Forum (2008). Report on Conclusions & Recommendations. Published January 2008. Report: http://www.calfforum.org.uk/ForumReport.pdf. Forum: http://www.calfforum.org.uk/index.html. Accessed March 2009

Byrne, D. (2003). Animal transport: improvement on the way. Annual General Meeting of the Veterinary Officers Association of Ireland. Tullamore. http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/03/182&format=HTML&aged=0&language=EN&guiLanguage=en. Accessed July 2007.

DAFF - Department of Agriculture, Forestry and Fisheries (2008). Livestock Mortalities for Exports by Sea. http://www.daff.gov.au/animal-plant-health/welfare/export-trade/mortalities. Accessed December 2008.

DLGRD - Department of Local Government and Regional Development Western Australia (2003a). Code of Practice for the Transportation of Sheep in Western Australia – Sheep Transportation. http://www.dlgrd.wa.gov.au/Publications/Docs/CodeOfPractice_SheepTrans.pdf. Accessed December 2008.

DLGRD - Department of Local Government and Regional Development Western Australia (2003b). Code of Practice for the Transportation of Pigs in Western Australia – Pig Transportation. http://www.dlgrd.wa.gov.au/Publications/Docs/CodeOfPractice_PigsTrans.pdf. Accessed December 2008.

Drum, F. & Gunning-Trant, C. (2008). Live Animal Exports: A Profile of the Australian Industry, ABARE research project 08.1 for the Australian Government Department of Agriculture, Fisheries and Forestry. Canberra. February.

Duncan, I. J. H. & Fraser, D. (1997). Understanding Animal Welfare. pp 19-37 in: M. C Appleby, & B. Hughes (Eds.), Animal Welfare. CAB International, Wallingford, UK.

Elbers, A. R., Moser, H., Ekker, H. M., et al. (2001). Tracing systems used during the epidemic of classical swine fever in the Netherlands 1997–1998. *Rev Sci Tech*, *20(2)*, 614-29. http://www.oie.int/eng/publicat/rt/2002/elbers.pdf. Accessed May 2007.

European Commission (2007a). A new Animal Health Strategy for the European Union (2007-2013): Where Prevention is Better than Cure. Luxembourg: Office for Official Publications of the European Communities.

European Commission (2007b). Special Eurobarometer 270/Wave 66.1. Attitudes of EU citizens towards animal welfare. Fieldwork February-March 2005. http://ec.europa.eu/food/animal/welfare/survey/sp_barometer_aw_en.pdf. Accessed December 2008.

FAO - Food and Agriculture Organization of the United Nations (1999). FMD Situation in Europe and other regions in 1999.

http://www.fao.org/ag/againfo/commissions/en/eufmd/app/33/app01.html Accessed July 2007.

FAO - Food and Agriculture Organization of the United Nations (2001). Guidelines for Humane Handling, Transport and Slaughter of Livestock. Bangkok. http://www.fao.org/docrep/003/X6909E/x6909e00.HTM. Accessed May 2007.

FAO - Food and Agriculture Organization of the United Nations (2002a). FAO Animal Production and Health Paper 153: I*mproved Animal Health for Poverty Reduction and Sustainable Livelihoods*. Rome. http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/005/y3542e/y3542e00.htm. Accessed May 2007.

FAO - Food and Agriculture Organization of the United Nations (2002b). Animal diseases: implications for international meat trade. Nineteenth session of the intergovernmental group of meat and dairy products. Rome. 27–29 August.

FAO - Food and Agriculture Organization of the United Nations (2004a). Animal health special report: avian influenza questions and answers. FAO, Rome.

FAO - Food and Agriculture Organization of the United Nations (2004b). Update on the avian influenza situation. FAO, Rome.

FAO - Food and Agriculture Organization of the United Nations (2007). Empres Watch. Emergency Prevention Systems. Rome. http://www.fao.org/docs/eims/upload/236966/EW_africa_dec07_rvf.pdf. Accessed December 2008.

FEWS NET Horn of Africa. (2000). Food Security Update: October 20, 2000. Rift Valley Fever Threatens Livelihoods in the Horn. http://www.fews.net/docs/Publications/east_200009en.pdf. Accessed December 2008

Fike, K. & Spire, M. F. (2006). Transportation of cattle. *Vet Clin North Am Food Anim Pract*, *22*, 305-320.

Food Productivity Daily (2008). Tesco backs campaign to stop buying foreign veal. Food Productivity Daily.com. http://www.foodproductiondaily.com/Supply-Chain/Tesco-backs-campaign-to-stop-buying-foreign-veal. 21 January. Accessed December 2008.

FVE - Federation of Veterinarians of Europe (2001). Transport of Live Animals. FVE Position Paper. FVE/01/043. Brussels: FVE. http://fve.org/papers/pdf/aw/position_papers/01_043.pdf. Accessed May 2007.

Garcés, L., Cussen, V. & Wirth, H. (2008). Viewpoint of animal welfare organisations on the long distance transportation of farm animals. *Veterinaria Italiana*, *44*, 59-69.

Gavinelli, A., Ferrara, M. & Simonin, D. (2008). Formulating Policies for the Welfare of Animals During Long Distance Transportation. 2008. *Veterinaria Italiana*, *44*, 71-86.

Gilbert, M., Aktas, S., Mohammed, H., et al. (2005). Patterns of spread and persistence of foot-and-mouth disease types A, O and Asia-1 in Turkey: a meta-population approach. *Epidemiol Infect*, *133*, 537-545.

Grandin, T. (2003). Livestock Trucking Guide: Livestock Management Practices that Reduce Injuries to Livestock during Transport. Bowling Green, KY

Handle with Care (2008). Beyond Cruelty Beyond Reason - Long Distance Transport of Animals for Slaughter. Handle with Care Coalition http://www.handlewithcare.tv. Accessed December 2008.

Harris, T. (2005). Animal transport and welfare: a global challenge. *Rev Sci Tech* 24: 647–653.

Jones, S. D. M., Schaefer, A. L., Tong, A. K. W. & Vincent, B. C. (1988). The effects of fasting and transportation on beef cattle. 2. Body component changes, carcass composition and meat quality. *Livest Prod Sci*, *20*, 25-35.

Kaler, J. & Green, L. E. (2008). Naming and recognition of six foot lesions of sheep using written and pictorial information: A study of 809 English sheep farmers. *Preventive Veterinary Medicine*, January 83, 52-64.

Kannan, G., Heath, J. L., Wabeck, C. J., Souza, M. C., Howe, J. C. & Mench, J. A. (1997). Effects of crating and transport on stress and meat quality characteristics in broilers. *Poult Sci*, *76*, 523-529.

Kannan, G., Terrill, T. H., Kouakou, B., Gazal, O. S., Gelaye, E. A. & Samaké, S. (2000). Transportation of goats: effects on physiological stress responses and live weight loss. *J Anim Sci*, *78*, 1450-1457.

Keniry (2003). Livestock Export Review: A Report to the Minister for Agriculture, Fisheries and Forestry. http://www.daff.gov.au/__data/assets/pdf_file/0008/146708/keniry_review_jan_04.pdf. Accessed December 2008.

Knowles, T. G., Brown, S. N., Warriss, P. D., et al. (1995). Effects on sheep of transport by road for up to 24 hours. *Vet Rec*, *136*, 431-438.

Knowles, T. G., Warriss, P. D., Brown, S. N., et al. (1993). Long distance transport of lambs and the time needed for subsequent recovery. *Vet Rec*, *133*, 286-293.

Lambertini, L., Vignola, G., Badiani, A., Zaghini, G. & Formigoni, A. (2006). The effect of journey time and stocking density during transport on carcass and meat quality in rabbits. *Meat Sci*, *72*, 641-646.

Lawrie, R. A. (1966). Metabolic stresses which affect muscle. 137–164 In: E. J. Briskey, R. G. Cassens, & J. C. Trautman (Eds.), The Physiology and Biochemistry of Muscle as Food. University of Wisconsin Press, Madison, WI.

Leckie, E. (2007). The economics of the trade in horses for slaughter from Spain to Italy and the cost implications of the proper implementation of Regulation (EC) No1/2005. International League for the Protection of Horses.

MAF - Ministry of Agriculture and Forestry (2004). Live Sheep Exports – What's happening? http://www.maf.govt.nz/mafnet/publications/primarysource/february-2004/primary-source-0204-8.htm. Accessed December 2008.

MAF - Ministry of Agriculture and Forestry (2007). Analysis of Submissions: New Zealand's requirements for export of livestock for slaughter. December 2007. http://www.biosecurity.govt.nz/files/regs/exports/animals/nz-req-export-livestock-slaughter-subs.pdf. Accessed December 2008.

Manteca, X. (2008). *Physiology and Disease*. pp 69-76 In: M. C. Appleby, V. Cussen, L. Garcés, L. A. Lambert, & J. Turner (Eds.), Long Distance Transport and Welfare of Farm Animals. CAB International, Wallingford, UK.

Marg, H., Scholz, H. C., Arnold, T., Rosler, U. & Hensel, A. (2001). Influence of long-time transportation stress on reactivation of Salmonella Typhimurium DT 104 in experimentally infected pigs. *Berliner und Munchener tierarztliche Wochenschrift*, *114*, 385-388.

Maria, G. A. (2008). Meat Quality. pp 77-112 in: M. C. Appleby, V. Cussen, L. Garcés, L. A. Lambert, & J. Turner (Eds.), Long Distance Transport and Welfare of Farm Animals. CAB International, Wallingford, UK.

Moran, E. T. & Bilgili, S. F. (1995). Influence of broiler livehaul on carcass quality and further-processing yields. *J Appl Poult Res*, *4*, 13-22.

Murray, C. J., Lopez, A. D., Chin, B., Feehan, D. & Hill, K. H. (2006). Estimation of potential global pandemic influenza mortality on the basis of vital registry data from the 1918–20 pandemic: A quantitative analysis. *Lancet*, *368(9554)*, 2211-2218.

New Zealand Trade and Enterprise (2007). New Zealand meat industry profile. http://www.marketnewzealand.com/common/files/NZ%20Meat%20Industry%20Profile%2007-08.pdf. Accessed December 2008.

O'Neil, B. (2008). Opening Address to the 2nd OIE Global Conference on Animal Welfare, Cairo, Egypt, 20-22 October 2008.

OIE - World Organization for Animal Health (2008). Terrestrial Animal Health Code 2008. http://www.oie.int/eng/normes/Mcode/en_sommaire.htm. Accessed December 2008.

OIE/FAO - World Organization for Animal Health/Food and Agriculture Organization of the United Nations (2001). International Scientific Conference on Foot and Mouth Disease; Paris; 17–18 April. ftp://ftp.oie.int/FMD20010417-18/OIEFAO_conf.pdf. Accessed May 2007.

Paskin, R. D. (2004). The Farm Assured Namibian Meat Scheme and Namibian Meat Exports. Meat Board of Namibia. Power Point Presentation.

Pluimers, F. H., Akkerman, A. M., van der Wal, P., Dekker, A. & Bianchi, A. (2002). Lessons from the foot and mouth disease outbreak in The Netherlands in 2001. *Rev Sci Tech*, *21*, 711-721.

Red Meat Industry Forum (2007a). Sheep meat and live sheep exports 2007. http://www.redmeatindustryforum.org.uk/supplychain/SheepMeatExports.htm. Accessed December 2008.

Red Meat Industry Forum (2007b). Beef and veal exports 2007. http://www.redmeatindustryforum.org.uk/supplychain/BeefAndVealExports.htm. Accessed December 2008.

Ritter, M. J., Ellis, M., Brinkmann, J., et al. (2006). Effect of floor space during transport of market-weight pigs on the incidence of transport losses at the packing plant and the relationships between transport conditions and losses. *J Anim Sci*, *84*, 2856-2864.

Rollin, B. E. (2004). Annual meeting keynote address: Animal agriculture and emerging social ethics for animals. *J Anim Sci*, *82*, 955-964.

SCAHAW - Scientific Committee on Animal Health and Animal Welfare (2002). The welfare of animals during transport (details of horses, pigs sheep and cattle). *Report of the European Commission's Scientific Committee on Animal Health and Animal Welfare,* March.

Seitzinger, A. H., Forsythe, K. W. Jr. & Madell, M. L. (1999). Regionalization's potential in mitigating trade losses related to livestock disease entry. *Ann N Y Acad Sci*, *894*, 95-99.

Shoemaker, T., Boulianne, C., Vincent, M. J., Pezzanite, L., Al-Qahtani, M. M., Al-Mazrou, Y., et al. (2002). Genetic analysis of viruses associated with emergence of Rift Valley fever in Saudi Arabia and Yemen, 2000-01. *Emerg Infect Dis* December. http://www.cdc.gov/ncidod/EID/vol8no12/02-0195.htm. Accessed December 2008.

Smith, G. C., Belk, K. E., Tatum, J. D., et al. (2001). National market cow and bull beef quality audit-1999: a survey of producer-related defects in market cows and bulls. *J Anim Sci*, *79*, 658-665.

Smith, S. (2003). Crossing the species barrier from AIDS to Ebola, our most deadly diseases have made the leap from animals to humans. *Boston Globe*, April 29. Section C1.

Sones, K. (2006). Making more of the Middle East market. New Agriculturalist on-line 1 May. http://www.new-ag.info/06-3/focuson/focuson5.html. Accessed December 2008.

Specter, M. (2005). Nature's bioterrorist. *New Yorker*, February 28, 52-61.

Speer, N. C., Slack, G. & Troyer, E. (2001). Economic factors associated with livestock transportation. *J Anim Sci*, *79*, E166-E170.

Spire, M. (2004). Kansas trucking survey results. Program of the Kansas Transport Initiative Workshop, College of Veterinary Medicine, Kansas State University, Manhattan, KS. 1-3.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. & de Han, C. (2006). Livestock's Long Shadow: Environmental Issues and Options. *Food and Agriculture Organisation*, Rome.

UK House of Commons Library (2001). Foot and mouth disease. Science and Environment Section. Research Paper 01/35, London.

Uppal, P. K. (2000). Emergence of Nipah virus in Malaysia. *Ann N Y Acad Sci*, *916*, 354-357.

USAID (2008). East Africa Press release. Djibouti Livestock Export Facility Begins Animal Testing. http://eastafrica.usaid.gov/en/Article.1010.aspx. Accessed December 2008.

USDA/APHIS - United States Department of Agriculture/Animal and Plant Health Inspection Service (1994). Foot and mouth disease: sources of outbreaks and hazard categorization of modes of virus transmission. USDA, Washington, DC.

USDA/ERS - United States Department of Agriculture/Economic Research Service (2003). Interstate Livestock Movements. http://www.ers.usda.gov/publications/ldp/jun03/ldpm10801/ldpm10801.pdf. Accessed July 2007.

USDA/FSIS - United States Department of Agriculture/Food Safety and Inspection Service (2004). Preliminary Analysis of Interim Final Rules and an Interpretive Rule to Prevent the BSE Agent from Entering the U.S. Food Supply. USDA, Washington, DC.

Webby, R. J., Swenson, S. L., Krauss, S. L., Gerrish, P. J., Goyal, S. M. & Webster, R. G. (2000). Evolution of swine H3N2 influenza viruses in the United States. *J Virol*, *74*, 8243-8251.

Whyte, P., Collins, J. D., McGill, K., Monahan, C. & O'Mahony, H. (2001). The effect of transportation stress on excretion rates of *Campylobacter* in market-age broilers. *Poult Sci*, *80*, 817-820.

World Society for the Protection of Animals (2007). Opinion polls on farm animal welfare and long distance transport. Unpublished data. London.

Wuethrich, B. (2003). Infectious disease: Chasing the fickle swine flu. *Science*, *299*, 1502-1505.

Yang, P. C., Chu, R. M., Chung, W. B. & Sung, H. T. (1999). Epidemiological characteristics and financial costs of the 1997 foot-and mouth disease epidemic in Taiwan. *Vet Rec*, *145*, 731–734.

Zhou, N. N., Senne, D. A., Landgraf, J. S., et al. (1999). Genetic reassortment of avian, swine, and human influenza a viruses in American pigs. *J Virol*, *73*, 8851-8856.