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Transbounday Animal Diseases:
Assessment of socio-economic impacts and institutional responses

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Preface

This is the ninth of a series of 'Livestock Policy Discussion Papers'. The purpose of the series is to provide up-to-date reviews of topics relating to the livestock sector and its development in various regions of the world. A strong emphasis is placed on the compilation of quantitative information, methodological aspects and on the development of policy recommendations for the topic at hand.

The livestock sector plays a vital role in the economies of many developing countries. It provides food, or more specifically animal protein in human diets, income, employment and possibly foreign exchange. For low income producers, livestock also serve as a store of wealth, provide draught power and organic fertilizer for crop production and a means of transport. Consumption of livestock and livestock products in the developing countries, though starting from a low base, is growing rapidly.

Transboundary diseases are a permanent threat for livestock keepers. They have major economic implications – both through the private and public costs of the outbreak, and through the costs of the measures taken at individual, collective and international levels in order to prevent or control infection and disease outbreaks. This paper is an excerpt of the special chapter on transboundary animal diseases and plant pest presented in the 2001 SOFA. It argues the economic rationale for public intervention, based on the public good nature of many control efforts but also highlights the paucity of information on which to base rational decisions on public investment into disease control.

It is hoped that the paper stimulates discussion and any feedback would gratefully be received by the author and the Livestock Information and Policy Branch of the Animal Production and Health Division of FAO.

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Executive Summary

Transboundary diseases are a permanent threat for livestock keepers. They have major economic implications – both through the private and public costs of the outbreak, and through the costs of the measures taken at individual, collective and international levels in order to prevent or control infection and disease outbreaks.

The paper argues the economic rationale for public intervention, based on the public good nature of many control efforts. The need for public intervention frequently extends to the international level and calls for international and regional co-operation, without which in many cases control efforts can not be expected to be effective. However, in practice it can be more difficult to determine which is the appropriate level and type of control, or what is the proper mix between private and public and national and international action.

One problem is that the paucity of accurate data and information on the costs of both transboundary animal diseases and of control efforts make decisions difficult on the most cost-effective interventions. It can also be difficult to ensure the necessary collective action, particularly at the international level, as involved parties and countries may have quite different incentives to participate in control efforts. Closely related to this is the question of the proper sharing of costs of controlling transboundary animal diseases.

The recent years have seen both progress and retreat. The technical ability to control old problems has greatly advanced and improved information exchange has facilitated reaction to the emergence of transboundary animal diseases. At the same time, however, increased movements of people and goods have facilitated the spreading of many transboundary animal diseases, while a number of new forms of diseases have appeared – the emergence and spreading of BSE in Europe and SARS in East Asia being notable examples.

These developments strengthen the case for collective action at the regional and international level. Some of the challenges are the following.

- Improve the economic evaluation of the costs of transboundary animal diseases and of various control efforts. This will help in choosing technically effective and cost-effective solutions and in devising appropriate mechanisms for cost-sharing and funding of preventive and remedial action. In many instances, new ways of managing the economic impacts (e.g. through insurance schemes) may be more cost effective than controlling the transboundary animal disease directly.
- Strengthen international and regional co-operation; the public good nature of prevention and control of transboundary animal diseases calls for collectively agreed, funded and managed responses.
- Enhance the capacity of developing countries both for national action and for participation in collective efforts; not all countries can by themselves face the cost of prevention and reaction to transboundary animal diseases. In particular, a clear need exists to help developing countries meet the requirements of the SPS Agreement of WTO in order to fully participate in the international trading system. Particular attention to their needs in terms of assistance is required.

I. Overview

Harm from animal diseases has threatened farmers since farming began. The damage can be economic (loss of output, income and investment) and psychological (shock and panic). Combating livestock diseases is a necessity for farmers. As a rule, a farmer's decision to control diseases is a private one. However, the presence of disease on one farm poses a threat to adjacent farms, and sometimes even distant locales. As such, diseases imply negative impacts on third-parties and call for an additional response, either from affected parties or a public agency.

The provision of infrastructure and services to prevent and combat livestock diseases is a public good, which is more efficiently offered by governments rather than by the farming community of even individual farmers. However, the most effective way of government intervention will depend on the disease in question. Experience has often shown that government provision of disease control services can create a dependency among farmers and discourage their adoption of disease management approaches through which they address the problems themselves. In such circumstances, government provision of knowledge, science and information may in the long run be the best and most sustainable way of serving the farming community.

In any case, for transboundary diseases the justification of some government control intervention is stronger than for diseases that only occur locally. Further, the loss of food due to diseases in some countries may appear to pose a threat to food security or rural livelihoods such that government intervention is politically unavoidable.

Animal diseases may pose the greatest immediate threat when they result in epidemics, or are newly introduced in ecologically favourable conditions, with few natural factors to limit their spread and no experience in managing them. In such circumstances diseases often have the most evident economic impact and in many cases also affect marginalized people most severely. The spread of emergent diseases and invasive species has increased dramatically in recent years. At the same time numerous developments, such as the rapidly increasing transboundary movements of goods and people, trade liberalisation, increasing concerns over food safety and the environment, have enhanced the need for international co-operation in controlling and managing transboundary diseases.

Transboundary animal diseases are defined as:

"Those that are of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation between several countries

Within this definition there are many diseases that cause damage or destruction to farmers' property, may threaten food security, injure rural economies, and potentially disrupt trade relations. Box 1 lists some of the most important transboundary diseases.

Box 1: Significant Transboundary Animal Diseases

Foot-and-Mouth Disease (FMD)
Foot-and-mouth disease is highly contagious and can spread extremely rapidly in cloven-hoofed livestock populations through movement of infected animals and animal products, contaminated objects (e.g. livestock trucks), and even by wind currents. Vaccination is complicated by a multiplicity of antigenic types and subtypes. Substantial progress has been made towards control and eradication of FMD in several regions of the world, notably Europe, and parts of South America and Asia. However, outbreaks have occurred in Japan, Korea, Greece, Argentina, and Brazil in 2000. A serious outbreak in Taiwan in 1997 forced the slaughter of 3.8 million pigs. In large parts of the world, particularly in sub-Saharan Africa, eradication can only be viewed as a long term objective.

Rinderpest (RP)
Rinderpest is the most serious cattle plague known. The Americas, Europe and Oceania are free from RP. Rinderpest was eradicated from southern Africa during the first half of this century by strict enforcement of cattle movement controls, quarantining of infected areas and selective 'stamping out' of infected herds and vaccination in risk areas. However, by 1962, rinderpest remained endemic over a large swathe of the pastoral regions of East, Central, and West Africa. Great progress has been made towards RP eradication through the Global Rinderpest Eradication Programme (GREP) coordinated by FAO.

Contagious bovine pleuropneumonia (CBPP)
CBPP is often regarded as an insidious, low mortality disease of cattle, but this is based on experiences in endemic areas. In susceptible cattle populations the disease can spread surprisingly rapidly and cause high mortality. The movement of infected animals (either acute cases or chronic carriers) spreads the disease. Major CBPP epidemics have been experienced in Eastern, Southern and West Africa over the last few years. It currently affects 27 countries in Africa at an estimated annual cost of US$2 billion.

Bovine Spongiform Encephalopathy (BSE)
BSE, caused by a novel infectious agent (prions) was first recognized in the UK in 1986. It has since been detected in native cattle in number of other European as well as non-European (Israel, Japan, and Canada) countries, although the vast majority of cases have been recorded in the UK. The disease is thought to be transmitted among cattle through feed supplements with meat and bone meal containing infected particles from affected animals. BSE can most probably affect humans consuming infected tissues causing a fatal neurological disease called variant Creutzfeldt-Jakob Disease.

Rift Valley Fever (RVF)
Rift Valley fever is a mosquito-borne viral zoonotic disease. The first recorded outbreak of RVF in Egypt in 1977 caused an estimated 200,000 human cases of the disease with some 600 deaths as well as large numbers of deaths and abortions in sheep and cattle and other livestock species. Outbreaks of the disease in East Africa in 1997-8 and 2000 not only caused livestock losses and human deaths but also seriously disrupted the valuable livestock export trade to the Middle East.

Peste des petits ruminants (PPR)
Peste des petits ruminants is a disease affecting sheep and goats. Its spread has been partly due to inadequate international availability of an effective PPR vaccine until recently, and

also the fact that small ruminants have perhaps not received adequate attention in disease surveillance and quarantine programmes in some regions. The Americas, Europe and Oceania are free from PPR.

Classical swine fever (CSF)
Classical Swine Fever or hog cholera is a generalized viral disease affecting only pigs. The disease is endemic in much of South and South-East Asia, where it is a constraint to the development of the pig industry. CSF caused major outbreaks in the European Community in 1997 and 1999. Recent outbreaks have also occurred in Latin America and the Caribbean.

African swine fever (ASF)
African swine fever is the most lethal transboundary disease for pigs. It is also a viral disease which has shown a great propensity for sudden, unexpected international spread over great distances. This is often associated with transportation of contaminated pig meat products, including garbage from ships and aircraft containing food scraps. Presently, there are no vaccines against ASF. ASF is endemic over much of Eastern and Southern Africa. Eradication is currently not feasible there because of wildlife cycles of infection between warthogs, other wild pigs and ticks, and also because of endemicity in uncontrolled village pigs. The only practical disease control measures for commercial piggeries is denial of access to wild and village pigs through fencing and other sanitary precautions. There is a long term prospect of ASF control in endemic areas through the development and breeding of genetically resistant pigs.

Newcastle disease (ND)
Newcastle diseases is caused by a virus spread primarily through bird to bird contact among chickens, but it can also spread through contaminated feed, water, or clothing. Outbreaks of ND occur in most parts of the world, including two major pandemics during this century. It is a major constraint to the development of village chicken industries, particularly in Asia and Africa. A large number of wild bird species can harbour ND-virus and occasionally ND affects large-scale commercial poultry units in developed countries despite tight biosecurity measures. Mexico experienced a major outbreak in 2000, in which 13.6 million birds were destroyed.

Avian Influenza (AI)
Avian influenza has been recognised as a highly lethal generalised viral disease of poultry since 1901. In 1955, a specific type of influenza virus was identified as the causal agent of what was then called fowl plague. It has since been found that AI viruses cause a wide range of disease syndromes, ranging from severe to mild, in domestic poultry. AI viruses are probably ubiquitous in wild waterbirds. Pathogenic strains could emerge and cause disease in domestic poultry in any country at any time without warning. In fact, outbreaks have occurred at irregular intervals on all continents. The most serious epidemic in recent times was in Hong Kong 1997-1998 and 2003, The Netherlands 2003, South-Korea 2003 and East Asia in 2004

Introduction of animal diseases occurs in many ways. The most common include live diseased animals and contaminated animal products either as imports or as food waste from international aircraft or ships. Other introductions are from importation of contaminated biological products (e.g. vaccines) or germplasm (semen or ova); entry of infected people (in the case of diseases transmittable from humans to animals); migrating animals and birds; or even by natural spread of insect vectors or by wind currents.

This paper describes the economic impacts of transboundary animal diseases and the costs of control. It explains why regulatory measures are justified to restrict transboundary animal diseases, why the issue is of growing concern, and the primary measures used to combat the establishment of unwanted and economically-significant diseases.

The paper starts with a brief history of international disease control efforts, and regional incidence of selected. Section II outlines the factors behind a country's need to combat, and how effective they can be. It also describes the economic rationale for controlling transboundary animal diseases. Guiding concepts in determining the efficient level of control are the theories of public goods and externalities. They indicate when there should be government involvement in transboundary animal disease control and the equity issues involved in financing it.

Section III reviews the empirical evidence on the economic impacts of transboundary animal diseases, which include impacts on production, food security, trade, and environment. Section IV summarizes the primary tools used for disease eradication and control and describes the range of possible responses from exclusion to tolerance of the organism. It also discusses options for managing and addressing the economic impacts of pests and diseases. Section V presents emerging and evolving issues affecting countries in their efforts to combat transboundary animal diseases. Finally, Section VI reviews the institutions and policies governing international response to transboundary animal diseases and discusses how to finance transboundary disease control.

History of control of transboundary animal diseases

Many important infectious diseases of animals, such as rabies and anthrax, have been known from antiquity. One of the plagues of Egypt described in Genesis could have been an epidemic of Rift Valley fever. Cultural and religious taboos against eating some livestock species may have originated as hygiene protection against zoonotic diseases (i.e. diseases transmitted from animals to humans).

Little is known about the economic and social consequences of epidemic livestock diseases in early times. One exception is rinderpest. From a probable source in Central Asia, the disease swept into and through Europe, often during periods of war and social upheaval, causing countless cattle deaths and much human misery. The rinderpest crisis in 18th century Europe and later Africa was probably the main stimulus for the development of public veterinary services. The first modern veterinary schools in Europe were established, starting with Lyon in 1762, and some time later the first State Veterinary Services. Although rinderpest was eradicated from Europe by the end of the 19th century, it was re-introduced to Belgium in 1922 with imported Zebu cattle. This incident was directly responsible for the establishment of the Office International des Epizooties.

There was an explosion in the incidence and economic cost of epidemic livestock diseases in the mid 19th century that persisted well into the 20th century. Diseases that advanced included foot-and-mouth disease, contagious bovine pleuropneumonia and classical swine fever. There were three main causes. First was rapid intensification of livestock production to feed the population expansion of the industrial age. Second, improved transportation, ushered in by the steam age, enhanced international spread of both human and animal diseases. Third, European colonisation of other regions brought livestock into contact with new disease agents which had only previously circulated in wildlife. Human encroachment into wild areas continues to be a source of disease spread.

Recent initiatives in control of transboundary diseases can be seen to take three forms: regional initiatives to control and eventually eradicate disease (e.g. the South East Asia FMD control programme); national and regional initiatives to prevent disease incursion into free areas (e.g. concerted attempts over the past two decades to prevent entry of FMD into Western Europe, which are co-ordinated by the European Commission for FMD hosted by FAO); and stamping out of outbreaks occurring in previously free countries (e.g. the 2001 FMD outbreak in the UK).

Regions affected by selected transboundary animal diseases

Some basic conditions affect the likelihood of transboundary animal diseases to establish and spread in regions, countries or zones within countries. These include:

- climate
- geographical isolation
- livestock kept and associated production systems
- prevalent hosts and vectors
- control methods used as part of routine agricultural management

Figures 1 to 3 show the distribution of selected transboundary animal diseases.

Figure 1 Total number of cases of classical swine fever officially reported to OIE (1997-2001)

Figure 2 Total number of cases of contagious bovine pneumonia reported to OIE (1997-2001)

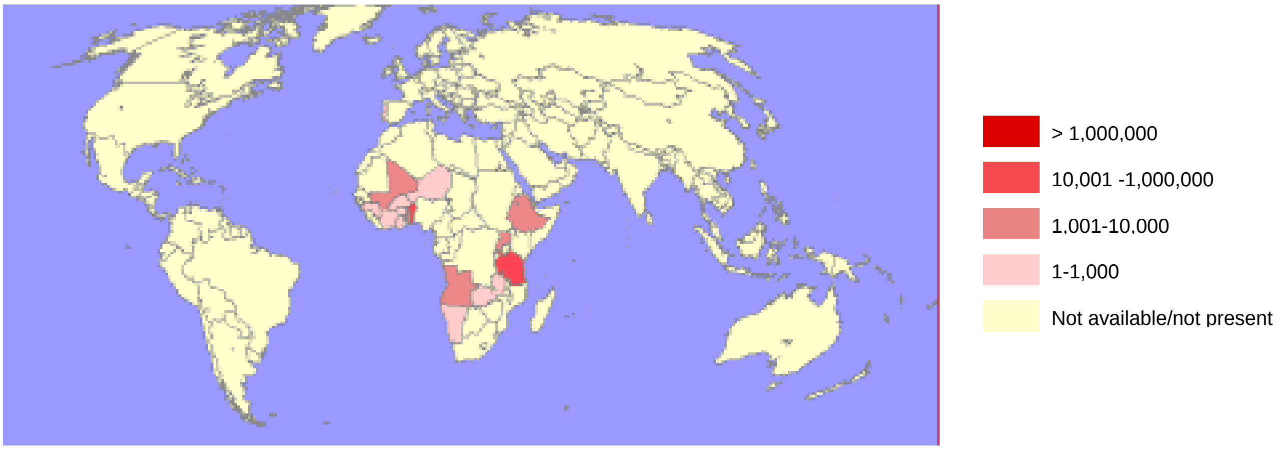
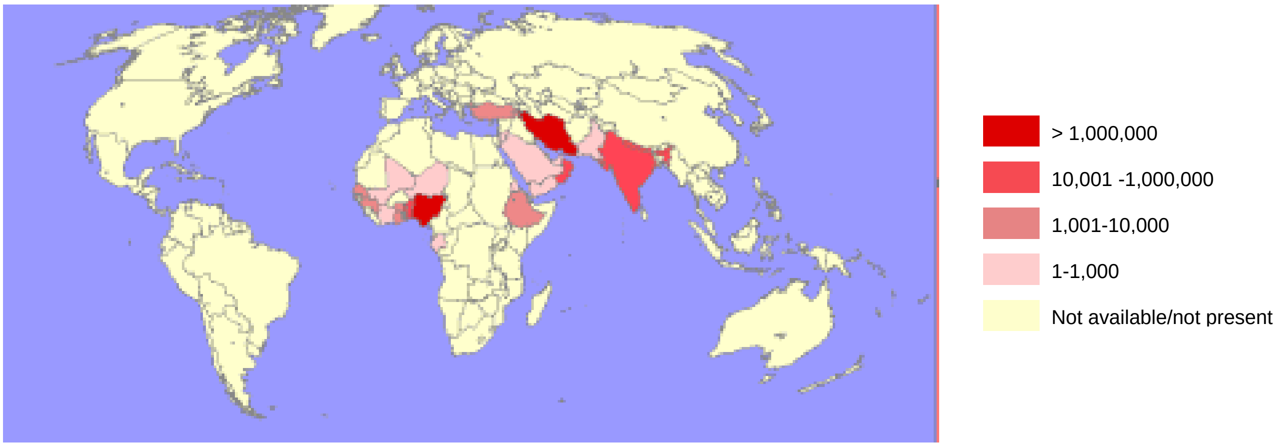


Figure 3 Total number of cases of Peste des petits ruminants reported to OIE (1997-2001)



II. Factors Determining Level of Control for Transboundary Animal Diseases

In recent years, the challenge of transboundary disease movement has increased and the ability to regulate and control disease spread has diminished. This occurs in part because international considerations and private sector capacity must increasingly be considered in the design and establishment of effective protection services. While sometimes leading to more effective and efficient decisions, involvement of more stakeholders complicates and slows implementation. In spite of these trends, national considerations still drive decisions regarding protection against diseases and responsibility rests primarily with national agencies.

A combination of the following national and international factors affects countries in their efforts to combat transboundary animal diseases:

1. Globalization, which has led to
   - More and faster trade (more host material/more packaging/more opportunity for long-distance "hitchhiking")
   - Trade in fresh horticulture, floriculture, live animals and fresh animal products
   - New travel/trade routes (e.g. South Africa to South-east Asia; South-east Asia to South and Central America)
2. Conflict and civil unrest, which has led to
   - Difficulty in enforcement of quarantine in many areas; military and refugee movement
   - Breakdown of institutional support for quarantine and loss of supply lines for materials
   - Increased smuggling
   - Inflows of food aid, which may be contaminated
   - Difficulty in getting access to border areas because of landmines and other dangers, making it difficult to survey
3. Concern about environmental and human health effects from pesticides and barriers to animal treatments
4. Privatization, deregulation and decentralization of animal health services in a large number of countries

Some countries and geographic areas are more vulnerable than others to invasions of transboundary animal diseases. International cooperation is one way to reduce the disparity of control or resources between neighbouring regions or countries. It is important to recognize the vulnerable regions, probable pathways, and existing limitations when establishing international approaches to transboundary animal disease control.

Country and regional differences derive from: perceived economic impact, political conditions and civil unrest; regulatory regime, including resources for prevention and enforcement and attitudes and views on risk; as well as from biological and physical conditions.

<u>Economic Factors</u>

Because of the importance of domestic factors and financial resources in limiting the spread of transboundary animal diseases, the poorer regions of the world are greatly affected. However, there is not a direct correlation between country income levels and the ability of animal and plant protection to keep out threats to agriculture. In addition to factors listed above, the following economic considerations affect efforts to prevent transboundary animal diseases:

1. The importance of agriculture in the national economy increases the resources devoted to quarantine. For example, China's food supply would be devastated by the introduction of a major exotic pig disease such as African swine fever. It therefore has very strict import and border quarantine controls. Argentina and Brazil expend considerable resources on control of foot-and-mouth disease in order to export meat to lucrative Asian and North American markets.

2. Border controls that create significant price differentials for agricultural products (e.g. meat) between countries create a strong stimulus for clandestine movements across borders, as livestock prices are normally higher where the major epidemic diseases are controlled. Thus, there is a price-driven trend of animal movements from areas of lower health status to those of higher health status potentially spreading disease.

<u>Political Conflict</u>

The dissolution of the former Soviet Union and the formation of new trading blocs have increased the risk of disease entry from neighbouring countries. The new governments formed have had to create new institutions and regulations for sanitary and phytosanitary control. New trading relationships have been formed from these political realignments, and they sometimes serve as pathways for the spread of transboundary animal diseases. Improving sanitary and phytosanitary (SPS) capabilities in these neighbouring countries may become an important way for countries with good quarantine systems to protect their agriculture.

Civil unrest leads to the complete breakdown of phytosanitary and zoosanitary controls and the displacement of substantial numbers of people. They often attempt to take their belongings, including livestock and their diseases, with them. Thus, rinderpest was introduced to Turkey in the late 1980s during the Iran – Iraq conflict by people seeking refuge in Eastern Turkey.

Areas with civil unrest or war are vulnerable to entry of animal diseases because of the lack of inspections and border control and increased unregulated movement by military and refugees.

<u>Regulatory Regime</u>

Regulatory systems to manage transboundary animal diseases depend heavily on both government and private sector actions to be effective. They are only as good as the level of resources that governments can provide, as well as the technical capacity that exists in the country. The private sector has a considerable responsibility in monitoring, inspecting, and reporting. Variations exist across countries in the degree to which they tolerate the risk of transboundary animal disease entry.

Regulatory systems can also break down or be inadequate to respond effectively to the new challenges faced in transboundary animal disease control, either because of systemic deficiencies or because the safeguards are evaded. For example, 7 out of 11 primary outbreaks of FMD which occurred in Europe between 1991 and 1996 are likely to have been caused by illegal importation of livestock or livestock products.

Biological and Ecological Factors
Plant, insect and pathogen movements within Europe or the Americas, have had considerable effects, both beneficial and destructive. But overall these have been of less significance than trans-Atlantic and trans-Pacific introductions. The major threat for transboundary animal disease movement comes from intercontinental movement between the four large land masses (the Americas, Europe/Africa, Asia, and Australasia) because of the ecological separation of these distinct regions. Trade in domestic animals (livestock and non livestock species) and livestock products has increased across all these regions.

Economic rationale for control of transboundary animal diseases

The majority of control measures are aimed at preventing the entry and/or spread of a disease agent when a human action -- such as trade or travel -- or natural contagion can carry an organism into a previously unaffected location. The problem of how to respond to the potential introduction is both a public and private decision and is dictated by the severity of the risk and extent of impact of the transboundary animal disease. Two economic concepts guide an understanding of when control should be left to individual farmers, and when it becomes a matter for public agencies to become involved in: *public good* and *externality*.

A *public good* is one which offers benefits to a large group (potentially everyone) without reducing the amount available to each person. The distinctive characteristics of a pure public good are non-excludability and non-rivalry in consumption. In contrast to a purely private good, such as treatment of an individual cow performed by a farmer, the provision of vaccine research is a public good often provided by government. A problem that arises with public goods is the “free rider” problem, in which people believe the good will be provided whether or not they pay a share of the cost. Further, individuals (or countries) have incentives to disguise their actual demand for such a good – sometimes understating it and sometimes overstating it, depending on the expected gain and potential cost burden to them.

An *externality* exists when the actions (or inactions) of one individual (or enterprise) impose costs on or create benefits on another, and which are not taken into consideration by the person (or enterprise) who imposes it. An example of a negative externality is when a communicable disease affects livestock herds in a community, and one farmer chooses not to participate in a disease eradication programme. Though non-participation might be the best strategy for that farmer, it may create a reservoir of the disease in the area which could contaminate animals that are in the programme.

When a disease affects only a small area and number of individuals (farms and others at risk), or if the consequences of an introduction are not severe, then private responses from affected individuals can reach an economically efficient solution. The responses could be legal action, or private negotiations, and will depend upon the socio-economic conditions and risk tolerance of affected parties.

Similarly, when only one country or part of a country is affected by a disease, the externality effects are relatively contained. The response is more likely to involve government action, but can be based on solely domestic conditions and preferences. However, in the case of transboundary animal diseases, large regions and many people are potentially affected by these threats and proper management usually requires a regional or international effort guided by public authorities. This requires a system to decide which control decisions are supranational, and which are national, and to efficiently implement international decisions on transboundary animal diseases.

The control of transboundary animal diseases calls for provision of the public goods at the global, or regional, level. Movement of animal diseases across boundaries generally impose a negative externality upon a recipient country which the country of origin has some obligation to prevent or minimize. A country's actions to protect other countries from invasion of animal diseases through control measures and timely information provision can be considered an international public good. As with protection of human health, a global system of plant and animal health protection is a global public good, available to all countries and populations on an equal basis.

The specific aspects of disease control that fall clearly in the realm of public goods are surveillance, information provision, and research on improved methods of prevention or diagnostics. Development of agreed rules and protocols is also efficiently supported by public institutions, although success depends on participation of the widest number of countries possible.

The framework offered by Jamison *et al* (1988) in discussing human health applies also to international public goods provision of plant and animal health. They suggest that core functions should be provided internationally to all countries because they meet the definition of global public goods. These include: information, standards and regulations, policy development, and research and development. Additional functions should be provided to developing countries in light of their scarce resources to provide for them, and in light of the externalities that are imposed on other countries if they are absent. These are: enhancing capacity and performance of the [animal] health sector. The framework recognizes the interdependence of countries in the battle to control transboundary animal diseases, as well as disparities in the ability of countries to participate in the battle.

How much protection should be provided and by whom?

The challenges facing national and international authorities responsible for plant and animal protection are:

1. How much protection is appropriate?
2. Who should provide the protection?

Both questions can be answered more readily in theory than in practice. Actions to prevent the movement of diseases across borders can be taken by individuals, by one or several country governments, by international organisations, or by any combination of the above. *Efficiency* requires that the effort put into plant and animal protection by an individual, government, or organisation is proportional to the damage that would be caused in the absence of protection. *Equity* demands that the burden of providing protection be borne by those who impose the risk or allow it to spread (in the case of preventable hazard) or those who benefit from protection from risk, or most likely, a combination.

In practice, it is difficult to assess the damage that may occur with introduction of a transboundary animal disease. Countries use past experience (as a guide), along with a scientific assessment of the disease agent to try and judge the extent of the damage. They should weigh the possible losses from an outbreak or introduction against the costs of taking action to prevent it. Yet, difficulties measuring both the likelihood, and the economic extent of damage impede authorities from choosing the efficient level of protection. Further, the actual loss of livestock that arise from a disease can be far outweighed by the loss of trade opportunities for a country that becomes infested. Therefore, it is especially difficult to determine the proper amount of protection a country should provide in cases where significant volumes of trade are at risk.

Up until recently, the criterion for combating transboundary animal diseases was to choose the more cost-effective of several control options, or to decide on an objective and carry it out without regard to cost. However, the past 10 years have yielded a greater number of studies examining both the costs and the benefits of disease control – though largely in developed countries still – with the idea of deciding how much control is worthwhile under given situations. This greater scrutiny of control options has also occurred at the international level with the requirements of the WTO to carry out scientific studies to justify barriers to trade, including sanitary and phytosanitary requirements.

Local, national, and international control efforts against transboundary animal diseases should be aimed at achieving the "optimal" level of protection (if it were known), where marginal cost of control is equivalent to marginal benefit.[1] An international response is warranted if the damage – and hence the control effort – affects multiple countries. Thus, this approach would recommend additional control efforts against FMD only if the benefits of an additional 'unit of FMD control' would exceed its cost, including environmental or other hidden costs.

Finding and meeting such a clear-cut standard is far more difficult at the transboundary level than at the national level. Transboundary disease scenarios do not have the same uniformity or history of research to support decision-making as national control experience. Scientific uncertainty makes economic analysis difficult. Further, control programmes involve multiple governments and organisations whose risk acceptance and willingness or ability to reduce it vary.

The issue of who provides the protection is also more complicated in practice than in theory. Largely as a result of globalisation of trade in agriculture, control of pests and diseases is increasingly driven by countries' international interests, although domestic agricultural sectors remain a major influence. Countries' international obligations are guided by the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) of the World Trade Organisation. National policy is determined by economic and political factors, both domestic and international.

A country is expected to take reasonable action to prevent spreading transboundary animal diseases through its quarantine system. Importing countries are also expected to have safeguards in place to prevent spreading if an introduction occurs. However, it is not always clear what a country's obligations are in preventing spread of transboundary animal diseases. Not all transboundary animal diseases are likely to affect all countries; hence, they will not be equally willing to participate in a control effort. Further, even if a country might be vulnerable to a transboundary animal disease, it may feel its own control mechanisms are adequate to prevent damage domestically, and be unwilling to participate in an international control campaign.

[1] Marginal cost is the cost imposed by one additional increment of the control effort, while marginal benefit is the benefit obtained from an additional increment of control.

Countries may not meet their obligations to prevent spread of transboundary animal diseases for several reasons. For instance, technical and scientific knowledge about the spread of pests and diseases is often incomplete and inexact. It is expensive to conduct the kind of economic and environmental impact studies required by the donor community or trading partners. Second, countries do not all have access to the same technology or institutional response capacity.

A third complication arises from the "free-rider" problem of public goods. It arises because countries can all benefit when the good is provided, and therefore countries become reluctant to unilaterally carry out control efforts. Moreover, for political or humanitarian reasons, donor countries often foot the bill for protection services that help other countries combat pests and disease. Because of differing incentives, donor countries may under-provide the protection relative to the 'optimal' amount, while countries needing protection from transboundary animal diseases may over-state the need. Also, affected countries may feel disincentives to adopt practices to improve or maintain their systems of transboundary animal disease control. Overall, globalisation or regionalisation of regulatory and control systems have many benefits, however, in reducing negative externalities and expanding the beneficiaries of public goods.

After it has been determined that an international response is warranted, the different control strategies needed for animal diseases must be considered. The choice of approach depends on how the risk is spread (natural pathways or human-caused), the severity of damage if introduction occurs, and the nature of control options. International authorities must also consider whether their role involves only the provision of public goods – such as surveillance, research, etc. – or also involves establishing and coordinating protocols and control efforts.

The primary goals of any control programme against transboundary disease are to establish the 'optimal' level of disease presence to meet a country's goals, and then choose the most cost-effective way to achieve that level of control. For instance, a policy of disease freedom is a high standard that can impose significant costs on a country. This standard is reachable if the following criteria are met:[2]

- a review of costs and benefits suggests the standard is desirable
- there is a realistic assessment of export market potential
- the distributional impacts within the country are acceptable
- means to fund the necessary control actions and institutions are identified.

Lower standards are more efficient if the above criteria are not met. The 'optimal' level of control can vary from one country to another, depending on the results of analysis and will change over time as production systems and control options evolve.

The primary responsibility to control the spread of animal disease belongs to both the country of origin and the receiving country. Both face a burden of elaborate quarantine systems, as well as a risk of production losses and worse if introductions occur. Yet, the capacity of countries to provide these services is highly variable.

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[2] "Socio-economic Impacts of Freedom from Livestock Disease and Export Promotion in Developing Countries," McLeod, A. and J. Leslie, VEERU, May 2000, Livestock Policy Discussion Paper, No. 3, FAO/AGAL.

In regions with a good veterinary infrastructure the movement of livestock and derived products is regulated and controlled to prevent entry and subsequent spread of exotic disease agents. Furthermore, disease surveillance systems with good laboratory diagnostic backup are maintained to ensure early detection of disease outbreaks and contingency plans are in place to rapidly respond to an epidemic. In addition, emergency funds have been set aside and farmers usually receive at least partial compensation for the losses incurred. In many countries, however, public funding of veterinary services is insufficient and even declining. Diagnostic capacity is poor, livestock movements are uncontrolled and farmers are usually not compensated for disease losses, which undermines their willingness to actively participate in disease control programmes.

III. Economic Impacts of Transboundary Animal Diseases

Types of economic impact of animal diseases

The economic impacts of transboundary animal diseases can be complex and go beyond the immediate impact on the directly affected agricultural producers. In specific cases, the actual economic impact will vary depending on factors such as the type of transboundary animal disease, but the complexity of the effects often make the precise measuring of the economic impacts very difficult.

Production The most direct economic impact of transboundary animal diseases is the loss of or reduced efficiency of production, which reduces farm income. The severity of the economic effect will depend on the specific circumstances. If the farm economy is relatively diversified, and other income opportunities exist, the burden will be reduced. Conversely, if the local economy is heavily dependent on one or a few vulnerable commodities, the burden may be severe and local food security impaired.

The impacts of reduced productivity of animals can be long-lasting and diseases can have lasting effects on livestock output in a number of "hidden" ways (such as delays in reproduction leading to fewer offspring and the consequences of a reduced population) which often exceed the losses associated with clearly visible illness.

Although the loss of output from transboundary animal diseases may appear easy to identify, it can nevertheless be difficult to measure in precise economic terms. Indeed, such an economic evaluation should not simply measure the value of lost output multiplying estimated physical loss by the market price. This may indeed exaggerate the likely economic impacts of damage. Actual economic impacts will also depend on adaptation by farmers as well as possible market adjustments. Among the ways in which farm communities can respond are releasing stocks or selling assets, engaging in non-farm income earning activities etc.

For these reasons, the welfare loss may be less than the value of lost output. Only if the farmer livelihood responses are very restricted, or the community economy is heavily dependent on the commodity affected by the disease are the welfare losses likely to exceed the value of lost output.

Further, the difficulty of distinguishing the production impacts of diseases from other impacts, such as climate, has not been effectively overcome. Often disease epidemics coincide with changes in climatic conditions, such as drought, early rains, and other output-reducing events. Lack of record-keeping by farmers in developing countries adds to the uncertainty about how much a given change in production is attributable to diseases, how much to weather, how much to farm management, and other variables.

Price and market effects Along with production impacts can come variations in prices, determined by the *supply* and *demand* effects induced by transboundary animal diseases. Market effects can similarly induce variations in wages for farm and processing employment and can otherwise spread through to upstream and downstream activities. Depending on the market for the affected agricultural products, an infestation or outbreak can lead to suddenly higher prices, if most production is domestically consumed, or to lower prices, if most production is exported and quarantine prevents such export but not domestic consumption.

The relative effects on producers and consumers of the production shortfall will depend on the relative elasticities of demand and supply (that is the responsiveness of demand and supply to price changes). Negative price effects can also occur where consumer health concerns leads to reductions in demand.

Trade Through the demand channel introduced diseases can have major implications for farmers and countries producing for export or wishing to export. Countries which are free from major diseases will tend to protect their local agriculture by totally excluding the importation of livestock products from areas affected by specific animal diseases or by making importation conditional upon a series of precautionary measures. These trade implications of transboundary animal diseases can cause a greater economic impact than the direct production losses themselves. Conversely benefits of elimination of transboundary animal diseases can be very large. The desire to gain access to high-value export markets is, indeed, the driving force behind many animal disease eradication efforts.

Food Security and Nutrition Transboundary animal diseases can often have significant negative impacts on food security and nutrition in developing countries. The growth of international trade in agricultural produce buffers the potential impacts of transboundary animal diseases on food availability, but there can still be major impacts on poorer communities that do not have access to substitute supplies. The food security impact is the paramount concern of many national policy-makers in developing countries and provides one of the main arguments in favour of international assistance for control programs.

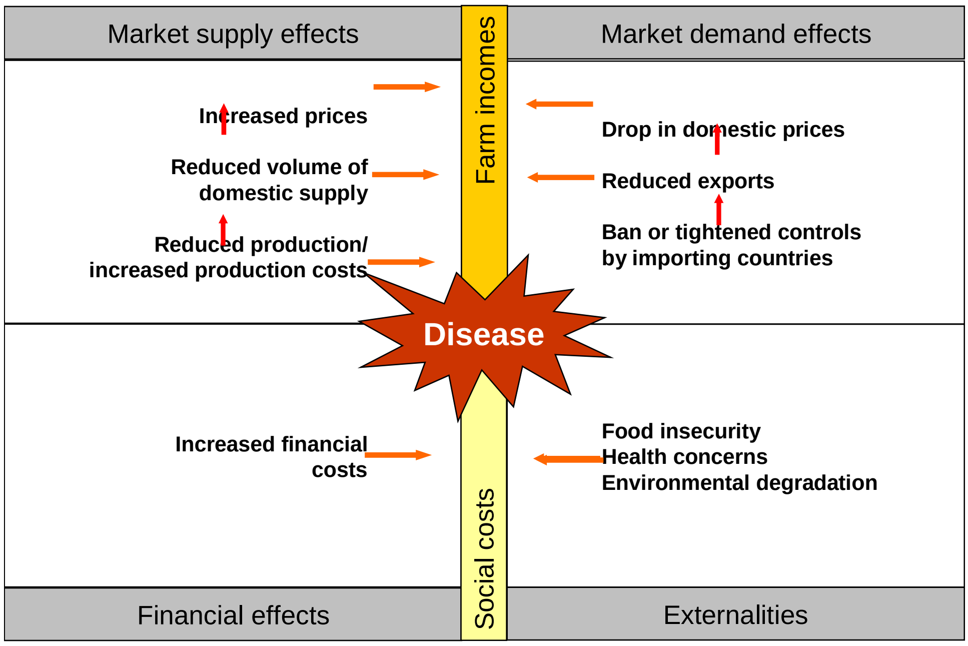
Health and Environment The main threat to human health arises from zoonotic diseases. Such transmission of diseases from animals to humans appears to have increased in recent years, perhaps due to increasingly intensive livestock production in areas of proximity to human populations.[3]

Increasing concern is arising over threats to the environment, either from diseases themselves, which might move into domestic wildlife, or from the control measures used combat diseases (e.g. disposal of risky tissues of cattle affected with BSE).

Financial Costs There are also budgetary implications of transboundary animal diseases. Control measures generally involve budgetary outlays. These include costs for inspection, monitoring, prevention and response. Also, demands are often put on Governments to extend financial assistance to the affected producers. The costs of some of these measures are proportional to the size of the agriculture sector being protected, while others are less closely related. As for the benefits of control measures, generally the benefits of prevention and emergency preparedness are not directly apparent and depend on assumptions about avoided costs of infections and disease outbreaks.

[3] "Livestock to 2020: The Next Food Revolution," IFPRI Discussion Paper 28, 1999

Figure 4: Types of disease impacts



Empirical studies of economic impacts

Published literature on the economics of transboundary animal diseases and their control is relatively scarce.[4] The existing literature is generally focused on individual countries, frequently from a small number of developed countries, concentrated on one affected commodity, and specific to a particular outbreak incident. It suffers from several serious omissions. Economic impact studies often limit their analysis to production impacts, saying relatively little about subsequent impacts on prices, trade, or secondary and tertiary market effects. Neither do they include farmer adaptation to the disease problem. Studies rarely include costs of international control activities, externality costs either of outbreaks or control efforts, and infrastructure costs. Universally lacking are longer-term impacts, dynamic response to outbreaks and farmer or community adaptation.

The results of the existing studies almost always demonstrate a net benefit from control of transboundary animal diseases; but for a number of reasons such conclusions may be premature. The first reason is that studies of transboundary animal diseases usually examine a choice between control/no control. This is not necessarily an appropriate method of analysis because it tells nothing about the marginal decision faced by policy-makers: whether to carry out one more or one less unit of control. It can thus not ascertain which *level* of control is appropriate.

Further, studies generally measure production losses rather than reduction in farm income. Production losses are defined in terms of final yields or output; whereas the change in farmer's welfare is measured by loss of income, which depends on farm management choices, possibility of compensation, and other socio-economic factors. As an example, in the USA,

[4] McLeod and Leslie, 2001 p. 46

farm production declines due to weather or pests, but farm income may increase because of a combination of higher prices and government compensation.

Studies which carried out cost-benefit analysis for transboundary animal disease control generally dealt only with direct costs and benefits. External costs or benefits to others not directly involved (nearby farmers, consumers) and the environment are generally omitted. In the following, studies are reviewed that report economic impacts from the presence or threat of transboundary animal diseases and control efforts. The studies reviewed are of two types: estimates of losses from the effects of diseases and cost-benefit studies of control efforts. The first type of study measures the proportion of potential output lost from infestations and outbreaks of diseases, sometimes with monetary values attached. The second type measures the monetary value of control costs and estimated benefits. The following sections look at economic studies of the different types of impacts from animal disease. The results of some of these studies are also summarised in the table below.

Table 2: Results of selected studies on economic disease impacts

DISEASE	YEAR	COUNTRY	LOSS ESTIMATE	TYPE	REF
Rinderpest	Different periods	Ethiopia, Kenya, Tanzania and Uganda	$21.3 m (potential)	Net benefit	1
CSF		Haiti	$2.7million/y (potential)	Prod.	2
FMD	Early 1980s	Kenya	230m KSh (of 1980)/year loss	Prod.	3
RVF	1997/98	Somalia	75% exports loss	Trade	
FMD	1996	Uruguay	$90m/y additional revenue	Trade	4
BSE	2000	UK	ε 5 billion	Trade+Prod. + Financial.	5

Sources:

1 An economic assessment of the costs and benefits of rinderpest control in East Africa, Tambi E.N. *et al*., 2000
2 Otte, 1997
3 Ellis and Putt, 1981
4 Leslie *et al*., 1997
5 Food Safety Agency, UK. Review of BSE Control Final Report, December 2000

Box 2: Three Steps to Analyse Impacts of Animal Diseases

The expected economic impact of introduced animal diseases is the main basis for making decisions about their exclusion or control. In some countries, the law requires economic analysis of costs and benefits as part of this decision process. Since 1995, the SPS Agreement of the WTO requires countries participating in international trade to base their SPS measures on international standards or risk assessments. Three types of analysis have been used or proposed to inform the decision making process for management of transboundary pests and diseases:

- *Risk analysis* identifies and quantifies risks and uncertainties as inputs into decision making
- *Cost-benefit analysis* quantifies the costs and benefits of specific management options
- *Risk acceptability* evaluates the preferences regarding risk, which may either guide cost-benefit analysis, or in extreme cases may preclude any formal analysis

a) Risk analysis

Risk analysis is done to identify and assess the risks and uncertainties associated with a hazardous activity and to identify management options that mitigate that risk. It consists of two stages: risk assessment, which is a positive, or descriptive operation; and risk management, which is normative, that is, essentially subjective.

In risk assessment two major components of the problem need to be determined: the *probability* of an event (such as introduction and establishment of a disease) and the *consequences* of that event. In the risk management stage the *expected outcomes* of various management options can be examined in relation to *objectives*.

Risk analysis allows comparisons of the risks in the presence of mitigating efforts, such as pre-entry treatments, vaccination campaigns, inspections and post-entry control measures. In each case, the benefits of reducing risk can then be balanced against the costs. The results of risk analysis must confront the set of identifiable objectives. This step is subjective and depends on the risk attitude of the decision-maker. All major commodity-importing countries undertake some risk analyses for the most serious pests and diseases they face.

b) Cost-benefit analysis

Cost-benefit analysis is an objective process intended to show the economic merit of specific management options. Costs and benefits are projected over the relevant time period and for the population affected. Among the management options examined might be the level of exclusion, detection or response for a potential introduced species or disease. Cost-benefit analysis is important for assessing the economic returns from options that have impacts over time, or affect different populations.

A cost-benefit analysis may be expected to indicate the management option with the greatest net benefit, but it doesn't by itself determine the best management choice. Non-economic criteria may be imposed, or the risk analysis limit the available choices. For example, even an option with a benefit/cost ratio of less than one may be desirable if it reduces an even very small risk of an unacceptable outcome. Insurance is an example of this.

The period of time considered in a cost-benefit analysis and the discount rate are significant when there are high initial costs (for instance in establishing a detection system or undertaking eradication) and long or delayed benefits. The longer the period the greater the opportunity to gain benefits that recover the initial costs. However, a longer time period also has more uncertainty associated with the losses or benefits.

Intangible costs and benefits include aesthetic, option, existence and bequest values, all of which may apply to aspects of introduced organisms. The presence of a destructive animal disease not only reduces yields for existing livestock keepers but it also reduces the option of keeping livestock for new entrants. The preservation of the existing natural environment in its original state may have an intrinsic value to many people. And finally, people may wish to pass on that natural environment in its original state to future generations.

These values may be significant compared to directly identifiable economic values for many introduced organisms, particularly in natural environments, and cost-benefit analyses may need to take them into account. Contingent valuation, in which interested groups are asked to indicate their willingness to pay to prevent the loss of value, is one method that has been used to determine these values. Other methods used to determine such values include calculating the expenditure people make to obtain or avoid similar benefits or losses.

c) Risk acceptability

In many cases decisions regarding the exclusion of unwanted organisms are based on the view that practically no risk is acceptable. This “precautionary approach” is sometimes taken when subsequent eradication of a pest or disease is unlikely to be achieved, since an introduction would be irreversible. The use of “clean” lists is an example of this – only organisms determined to have an economically acceptable impact are allowed to enter a country, all others are excluded. Such an approach may be taken in cases where the costs of undertaking a risk analysis are likely to be high relative to the marginal costs of exclusion. Alternatively some introductions may be considered inevitable and not worth delaying, or are acceptable for some other reason.

Reported economic impacts of animal diseases

<u>Production and Price Impacts</u>

All transboundary animal diseases have the potential to kill affected animals, but the severity of the disease will vary depending on factors such as species and breed of animal, age, nutrition, disease agent etc. Many transboundary animal diseases have 50 to 90 percent mortality rates in susceptible animals. Rift Valley fever (RVF) normally produces only a mild infection in local, African breeds of cattle, sheep and goats while exotic breeds of the same species may experience severe outbreaks of abortion. Under experimental conditions, some ‘mild’ strains of classical swine fever (CSF) virus kill less than half of the infected pigs while other, ‘virulent’, strains may kill up to 100%. The first outbreak of rinderpest (RP) in East Africa in 1887 was estimated to have killed about 90% of Ethiopia’s cattle and more than 10 million cattle on the continent as a whole; widespread famine resulted.

Reduction in mortality and improvements in animal productivity are the traditional goals of disease eradication programs. Access to export markets is becoming an equally important reason. Improved response to outbreaks and increased access to vaccine has reduced the likelihood of many disease epidemics, but this experience is countered by increased trade, smuggling, and susceptibility of small poultry and ruminant populations raised in intensive conditions.[5]

The only international cost-benefit analysis of animal disease control is a study of the Pan African Rinderpest Campaign in Ethiopia, Kenya, Tanzania, and Uganda.[6] The study estimated the production losses attributable to rinderpest with and without the control campaign and found benefits exceeded costs in each country. The benefit-cost ratio ranged from 1.35:1 to 2.55:1. As mentioned previously, there are many variables not considered in a simple evaluation of costs and losses that might lead to an underestimation of costs and/or an overestimation of benefits of a control campaign.

Most analyses of animal disease do not include the costs of treatment, perhaps because it is regarded as minor. On the other hand, the economic loss from animal mortality continues to accrue even after the disease episode is over due to the lost production over the time period until the original population size has been re-established[7]. For example, the continued presence of CSF in Haiti with recurring outbreaks has been estimated to result in a reduction of potential offtake in the order of 10% or 38,000 pigs per year. At an average price of US$70 per slaughter pig this would amount to an annual reduction in income of US$2.7 million for the local smallholder producers (Otte, 1997).

Productivity losses can persist even in individual animals that survive disease. Abortions due to RVF do not only entail the loss of offspring but also the loss of one lactation and thus reduced milk supply for human consumption in the year following an outbreak. Foot-and-mouth disease (FMD) leads to considerable loss in milk production in dairy cattle. In Kenya, losses caused by FMD in the early 1980s were estimated at 230 million KSh (of 1980) annually, approximately 30 percent of which was due to a reduction in milk production. (Ellis and Putt, 1981).

The transitory effect of outbreaks on prices of livestock and livestock products can be exemplified by the most recent CSF, CBPP, RVF and FMD epidemics in Haiti, Botswana, the Horn of Africa and Taiwan respectively. In each case, the domestic price effects were sharply up or down, depending on the supply effect on the local market: where animals for domestic consumption were slaughtered, prices went up; where animals for export were sold domestically, prices went down. Consumer health fears in some cases also reduced demand, further depressing producer prices.

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[5] McLeod and Leslie, p. 11.

[6] An Economic Assessment of the Costs and Benefits of Rinderpest Control in East Africa, Tambi E.N. et al, 2000.

[7] If, for instance, a pig population remains stable at an annual offtake rate of 50%, then, over a two-year period, a population of 100 pigs will produce 100 pigs for consumption. If 50 pigs die due to CSF, then, in order to re-establish the original population size of 100 pigs, at the end of two years, only 12.5 pigs can be slaughtered for consumption, which results in a net difference in production of 87.5 pigs.

Trade Effects

The 1997/1998 outbreaks of RVF in eastern Africa severely affected the pastoralist economy of the Somali region although the region itself only experienced minimal incidence of the disease. The economic impact on the region stems from the ban declared by Saudi Arabia on all livestock originating from the Horn of Africa. Until 1997, approximately 3 million animals, mainly small ruminants, had been exported annually through the Somali ports of Berbera and Bossasso, generating more than 90% of all foreign exchange receipts of Somaliland. After imposition of the ban, livestock exports through the above ports dropped by more than 75%. The region's economy came close to a standstill because foreign exchange for the purchase of imports such as grains, sugar, medicines, fuel etc. was scarce. In urban centres, a large proportion of the shops closed and prices of commodities such as grain and sugar skyrocketed while the purchasing power of the general population dramatically declined.

Uruguay provides an example of a country gaining access to high-value markets after the eradication of foot-and-mouth disease (FMD). Uruguay was officially recognized as FMD-free without vaccination in 1996 and has consequently been able to take advantage of its export quota of 20,000 tons of beef to the USA. Exports by weight increased over 100 percent and by value 52 percent after the freedom from FMD declaration. The higher price obtained for its beef in the USA relative to its sale on the domestic market -- more than double in the case of chilled meat -- has been estimated to provide an additional revenue to the country in the order of US$ 20 million per year. In the medium term, access to Pacific Rim markets was estimated to provide Uruguay with the potential of additional revenues of above US$90 million per year. Prior to disease eradication, Uruguay was spending between US$8 and US$9 million annually on FMD vaccination (Leslie *et al*., 1997). Therefore, control costs may eventually be as low as 10 percent of revenues from exports alone.

Studies in Bolivia and Thailand found that FMD control would be financially worthwhile only if it allowed entry into export markets, thereby increasing prices to farmers.[8] The steps needed to enter export markets, and maintain an emerging export industry, can be costly. Countries need to impose Sanitary and Phytosanitary measures, such as inspection and testing of imported livestock, and prevent illegal smuggling of potentially diseased animals. However, once a country has reached a disease-free state, it is likely to take extraordinary measures to protect it. Based on a risk reduction strategy, the preferred response to an outbreak of contagious bovine pleuropneumonia (CBPP) in Botswana was slaughter and compensation for farmers, rather than vaccination, surveillance, and movement control – even though the latter cost only 78 percent of the former.[9] This is because slaughter was likely to re-establish disease-free status sooner than other control options thus providing opportunities to resume trade.

An *ex ante* evaluation of approaches to CSF control in Vietnam estimated that different stakeholders would be affected differently by the control measures applied[10]. Increases in production value from controlling disease would cover the cost of preventive vaccination and

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[8] McLeod and Leslie, p. 14.
[9] Ibid, p. 19
[10] Control of classical swine fever in the Red River Delta of Vietnam. A stakeholder analysis and assessment of potential benefits, costs and risks of improved disease control in three provinces. McLeod A., N. Taylor, L.T.K. Lan and N.T. Thuy. (2003). Phase 3 Report to the Strengthening of Veterinary Services Vietnam Project.

benefit pig keepers and traders. However, imposition of quarantine measures in the event of suspected disease would negatively impact on producers but create short term benefits for traders.

Community Development

In some cases, the agricultural sector in a community is extremely undiversified, and the threat or appearance of a particular pest or disease can undermine the entire economy. An example is the important link between cattle farming and the Botswana macroeconomy. The introduction of CBPP led to slaughter of more than 300,000 cattle in Ngamiland, the most affected province. The immediate result was the closure of the export meat processing plant, which employed over 200 people before cattle were destroyed. Exports came to a standstill. In Ngamiland, the livestock sector was a very important catalyst for the overall economy and a survey of the business sector after the eradication campaign showed that business turnover generally had declined by an average of 15%, which was attributed to the loss in disposable income from cattle. The indirect effects were further estimated to be more than seven times the amount attributed to direct losses (Townsend and Sigwele, 1998).

Food Security and Nutrition

Unfortunately, no quantitative information on the impact of transboundary animal diseases on food security and nutrition could be found in the published literature. As mentioned above, the food security impacts are expected to be minor and short-lived, as long as substitute food sources exist and the community has either purchasing power or emergency assistance. For those countries which can afford many sources of food supply, globalisation of markets reduces the impact of localized shocks from disease.

However, in poor countries and communities, threats to food security and nutrition can arise from animal diseases. Particularly in pastoral societies, livestock contribute directly and indirectly to food security and nutrition as sources of protein, micronutrients, animal power, and tradable assets. However, McLeod and Leslie (2000) caution against a conclusion that livestock disease control is always beneficial to the poor. It is necessary to study the production system, costs and methods of control before assessing the distributional impacts on sub-populations in a country.[11] They conclude that an export-oriented program of disease control will benefit the poor only if the sector is already export-oriented or targeted policies to include poor farmers are included.

Human Health and Environment

Some animal diseases can affect humans directly. The phenomenon of animals transmitting disease to humans occurs even in highly developed countries with high standards of sanitation, as was demonstrated by the increasing concerns with BSE and vCreuzfeld-Jakob disease in European countries. Areas with conflict or poor health controls pose a greater risk of human infection from zoonotic disease.

The majority of the transboundary animal diseases however do not cause epidemics in humans although occasionally humans can become infected. The viruses causing rinderpest, peste des petits ruminants, classical swine fever, as well as the causative agent of contagious

[11] Ibid, p. 32

bovine pleuropneumonia are not infective for humans. Foot-and-mouth disease (FMD) virus has been isolated from around 40 people worldwide following a mild course of disease.

Rift Valley fever virus can infect humans, where it causes a febrile illness, which is sometimes complicated by haemorrhage (bleeding), encephalitis, and blindness. Between animals and from animals to humans the virus is transmitted by certain species of mosquitoes, which gives rise to the distinct association of Rift Valley fever (RVF) epidemics with periods of high rainfall. Humans additionally appear to contract the infection through direct contact with infected tissues and fluids of animals at slaughter. In 1977/78, a major epidemic of RVF occurred in Egypt with an estimated 200,000 human cases of disease and about 600 deaths. It is believed that up to half a million people became infected with RVF during the 1997/98 epidemic in eastern Africa, of which some 500 may have died from the haemorrhagic form of the disease.

Avian influenza is caused by various subtypes of type A influenza virus (Types B and also C exist, but these are not know to cause serious disease in humans). Influenza virus type A also circulates in pig, equine and human populations and mutates constantly. At times, major antigenic changes, so called antigenic shifts, occur which may result in local epidemics or even pandemics. Three such pandemics in humans have occurred in this century in 1918, 1957 and 1968, and there is evidence that causative virus strains originated from animals (1918 and 1957 from pigs and 1968 from birds). In 1997, influenza A(H5N1) virus was isolated from a child who died in Hong Kong. Prior to this, the H5N1 virus was known to infect only various species of birds, including chickens and ducks. After the first human case, intensive surveillance was mounted fearing the possible scenario of another human influenza pandemic. Fortunately, the virus transmitted poorly to humans and the total number of cases, all in Hong Kong, remained at 18, of which 6 were fatal. Similarly, the current epidemic of avian influenza in Asia has affected (a so far limited number of) humans, most of which have died as a result of infection. Although the exact means of transmission of H5N1 to humans have not been identified, there is no clear-cut evidence of any human-to-human transmission and infection with the virus is believed to have come through contact with infected birds.

Animal diseases directly affect the size and composition of animal populations and thus indirectly have repercussions on the environment. In conjunction with other environmental factors, major livestock diseases determine which production system, species and breeds of animals will be adopted by livestock owners. Many thousand square kilometres of fertile land remain sub-utilized in Africa due to animal trypanosomiasis leading to increased population pressure on land in adjacent, disease-free areas.

Use of pesticides in an effort to control disease vectors, both introduced and indigenous, can lead to serious health effects in developed and developing countries. Concerns exist about worker exposure, residues in food, and harm to domestic and non-target wild animals. Fish and invertebrates are frequently vulnerable. Again, economic impacts of these health effects in humans have not been quantified.

Conclusions about economic studies of transboundary animal diseases

As mentioned previously, published economic studies on the impact of transboundary animal diseases and on their control are relatively scarce and generally limited in their scope, focusing on specific countries, commodities and cases of outbreaks. Also their frequent methodological limitations were mentioned: impact analysis is often limited to immediate production impacts without considering more indirect market effects, dynamic responses and farmer adaptation to transboundary animal disease outbreaks or longer term impacts.

There is no uniform and widely-used approach to the economic assessment of the impacts of transboundary animal diseases. Studies on animal diseases have focused on both production and trade impacts. For both, losses have been shown to potentially very large. There are also examples of the closing of export markets having major damaging overall economic consequences for developing countries. Studies on control efforts and eradication programmes have revealed instances of significant returns in terms of expanded trade opportunities. Although most animal diseases do not cause epidemics in humans, human health concerns can in some cases augment the damage from transboundary animal diseases. The spread of BSE in Europe is a case in point.

The results of the existing studies almost always demonstrate a net benefit from control of transboundary animal diseases. However due to the general methodological problems affecting many studies already discussed above, concluding that this will always be the case may be premature. The evidence may thus require further scrutiny due to problems of insufficient data, over-estimation of actual economic losses, neglect of secondary effects and externalities in transboundary animal disease control. Indeed, specific studies have revealed certain externality costs associated with eradication and control efforts.

IV. Management of Transboundary Animal Diseases and their Economic Impacts

Options for controlling transboundary animal diseases

A variety of management options exist when local, national, regional or international authorities face decisions on transboundary pests and diseases. The following sections focus on the procedures for choosing action against transboundary animal diseases.

Farmers commonly have to deal with disease incidence in their livestock. Modern disease management does *not* attempt to eliminate all diseases, but tries to create an environment which maintains the disease pressure at low levels. However, most transboundary animal diseases are too virulent or threatening to human health and trade relationships to tolerate, even at a low level. Therefore, prevention and subsequent elimination is a key element for the management of transboundary animal diseases

Table 3 shows the range of zoosanitary measures used to manage transboundary plant pests and animal diseases. The measures are shown according to where the risk occurs: exclusion measures to address the risk before it arrives in the regulating country; safeguards imposed to reduce the risk of spread; and the control of and adaptation to an introduction or eradication of the disease in the affected country.

<u>Reducing Probability of Entry</u>

Quarantine is the first line of defence against transboundary animal diseases, and countries devote considerable resources to ensure that they implement effective border and import quarantine policies and programmes to prevent introduction. Quarantine is seen as a public good and government responsibility since individual farmers and private veterinary services are relatively powerless to avoid or overcome introductions. Countries indicate their quarantine policy through lists of restricted or permitted organisms or articles.

The prevention, control and elimination of transboundary animal diseases is more than a national public good. Because of transboundary spread, effective protection is only possible through a concerted and coordinated effort among neighbouring countries. The control efforts of individual countries against pests and diseases may be continually frustrated by neighbouring countries not taking equivalent action. An international approach also allows better advantage to be taken of natural geographical barriers and broader biological and epidemiological patterns.

A key aspect of effective exclusion and safeguards is accurately estimating risk. Methods used include modelling to predict the ability of an organism to survive under the conditions of a geographic area that is not yet affected. Tools like geographic information systems (GIS) make it possible to combine and cross-analyze a large amount of visual and numerical data, such as satellite retreived images of the earth surface, climatological information, disease and livestock population data, and to produce predictions of disease spread. An example of GIS used in this way is the Programme Against African Trypanosiamiasis (PAAT) Information System which is designed to identify the impact of tsetse and trypanosomiasis on agriculture, to find the areas where control is technically feasible, and to find where animal and human trypanosomiasis occur together.

Table 3: Sanitary Measures for Managing Animal Diseases

Sequence of Control Measures	Reduce Risk of Entry	Verification of Compliance	Control or Mitigation	Adaptation or Acceptance
When to Take Measures	• Request to import new commodity, or from new country • Surveillance indicates change in pathway risk or epidemiology • Policy review on existing pathways or disease status.	• Entry and distribution points for commodities and live animals	• Outbreak or incursion detected and control options exist. • Natural pathway led to introduction and control deemed appropriate.	• Impact found to be less than predicted • Improved ability to adapt • Ineffective control ended • Disease not controllable with existing technology • Cost of control exceeds benefits.
Examples of Measures Aimed at Preventing Introduction of and Diseases	• Training, technical assistance, and surveys in country of origin • Network with officials and experts areas of risk • Review of interception lists • Development of restricted lists in accordance with SPS guidelines • Inspection in country of origin • Restrict imports to a designated free area in a country with disease • Require advance treatment for high-risk commodities • Analysis to find pathways for preventive action • Identify potential range of organism and survival parameters	• Inspection ➢ visual ➢ random sampling ➢ targeted by risk ➢ detector dogs • Review of permits, zoosanitary certificates, bills of lading. • Isolation for observation period. • Treatment, re-export or destruction in response to interception. • Limited ports of entry according to type of cargo and/or risk. • Limited market destination • Containerisation for transit through vulnerable zone • Public education	• Detection and delineation of infected zone • Monitoring of surrounding zone • Suppression, containment or eradication using: ➢ quarantine stations ➢ stamping-out ➢ vaccines ➢ pesticide applications ➢ sterile insect release • Systems approach using a combination of measures. • Treatment of animals leaving the area to avoid spread • Emergency reporting systems to inform of movement to new areas (leads back to risk reduction measures)	• Research new control options for producers • Registration of new vaccine that is effective in control • Create disease-free stock supply and certification • Control programme keeps disease at tolerable level • Addition of water treatment for water-borne diseases

Sequence of Control Measures	**Reduce Risk of Entry**	**Verification of Compliance**	**Control or Mitigation**	**Adaptation or Acceptance**
Reasons for Failure of Control Measures ***Note: All measures may fail with inadequate funding or political will to carry them out.***	• Information non-existent or misleading • Treatment options limited. • Pathway not yet recognised • Host not yet recognised • Inadequate data	• Inspection fails due to volume of entry, poor sampling, etc. • Cryptic life stage at time of entry or difficult to identify or diagnose • Natural pathway not regulated • Smuggling of high-risk items. • Transhipment obscures country of origin.	• Detection techniques not successful (i.e. disease not detected) • Insufficient monitoring • Vaccines not available	• Control methods used by some producers but not by all • Disease agent may become resistant to the control measures • New populations or strains cause outbreaks of non-indigenous disease
Problems from Relying on Above Measures	• Requirements to reduce risk become onerous • Trade dispute results from imbalance between risk reduction and free trade values • Consumers in importing country lose benefit of new supply	• Delays in release of cargo and passenger delays • Civil rights could be violated • Smuggling may increase	• More severe environmental impact from control versus prevention • Repeated introductions lead to high costs when the original pathway is not closed	• Secondary impacts from the disease may not be recognised initially • Existence of disease is accepted, ending control efforts

Adapted from Quinlan, 2000.

Remote sensed satellite data has potential as a predictor of insect-borne transboundary animal diseases, notably Rift Valley fever (RVF). RVF causes major disease outbreaks in parts of Africa at irregular intervals of 15 years or even more, when environmental conditions in risk areas (including unusually heavy rainfalls with filling of surface ponds, warm and humid weather and increased vegetation cover) favour the emergence and massive multiplication of the mosquito vector species for RVF. Prediction of El Nino phenomena and determination of normalised difference vegetation indices (an indicator of the amount of rainfall that has fallen in an area), through remote sensing may in the future be a cost-effective way of providing several months early warning for RVF, but has not yet been used in practice.

Directly transmitted transboundary animal diseases are less amenable to remote sensing. Early warning for diseases for which animal movements are a major factor in spread (such as foot-and-mouth disease, contagious bovine pleuropneumonia and rinderpest) depend on a good understanding of livestock movement patterns and on-ground intelligence of where disease is active, although there is scope to foresee risk by predicting movement as a result of climatic events and price differentials. GIS and predictive modelling has been very useful in predicting the windborne spread of FMD in Europe and thereby providing early warning. Several temperate climate countries have therefore incorporated such modelling in their contingency planning for FMD response. Such systems require good clinical and serological surveillance, access to diagnostic capability to confirm cases, plus good communication, collaboration and information sharing among countries.

<u>Response to Introduction or Outbreak</u>

The protection of livestock is the immediate objective for controlling animal diseases that enter a country. Farmers play a key role in implementing control operations, but frequently need the support of animal health services or regional organizations for technical advice, equipment and supplies. Support includes surveillance, reporting, and initiating emergency actions. These steps continue until a decision may be made to accept an introduction and abandon control activities.

The control of animal diseases may involve vaccination, movement control, at times achieved through the construction of major fences, chemoprophylaxis and therapy, slaughter of infected and possibly in-contact animals, disinfection, and vector control in the case of vector-borne diseases. The latter can be achieved through the application of chemicals, by biological means and by changing the natural habitat.

Preventive vaccination can routinely be applied on a national scale, as was the case with FMD in the EU prior to 1991 and in Uruguay before FMD eradication, or to certain areas with an elevated risk of disease introduction, often termed “buffer zones.” Preventive vaccination may reduce export opportunities. Disease-free countries are normally reluctant to import livestock and livestock products from countries allowing the use of corresponding vaccines. In addition, the application of vaccination will considerably prolong the time required until official recognition of disease freedom can be obtained or re-obtained in case of a declared disease outbreak.

Inter-regional and international reporting systems serve to inform officials of the entry and spread of pests and diseases of concern. This is done internationally through the Office International de Epizooties.

Options for managing the economic impacts of diseases

The socio-economic effects of transboundary diseases are mitigated through biologically based measures aimed at control, containment, or eradication. The economic impacts also might be contained through risk management which might include insurance schemes, increased agricultural production or improved infrastructure. Alternative sources of income and employment through rural development or financial aid will also help. Any combination of these measures might produce a more stable and/or higher income stream for a farmer than relying solely on biological disease control methods.

Insurance Protection

Risk can be shared among a large group of people through insurance. When the group includes people who face non-covariant risks, the averaging of risk can reduce the overall risk to the group and provide opportunities to manage risks. Private insurance schemes have been considered for crops subject to specific pest risks, but private insurance companies have not yet accepted this approach primarily because farmers face covariant risks of poor weather, pests, and economic forces. However, government agencies have provided crop disaster insurance in many countries through subsidized programmes.

In the animal health field, insurance systems exist in various forms. The first livestock insurance scheme was established in Germany, which in 1909 passed a national law on contagious livestock diseases enabling the establishment of "Compensation Funds". These aimed at collecting funds to support official measures against contagious diseases. The rationale behind the compensation funds relied on the combination of the livestock owners' will of risk-sharing with the state support for agriculture. The intention was to accumulate funds to compensate farmers for the losses incurred from the application of official measures. Those measures were (i) the control and fight of contagious livestock diseases and (ii) the application of prophylactic or preventive measures (prevent the outbreak and spread of diseases), which constituted the biggest bulk of the financing. Financing of (or contributions made to) the compensation funds comes from three different sources. First, membership is compulsory for all livestock holders and the annual fee is related to the number of cattle, horses, pigs, sheep and poultry owned. Second, the funds receive state grants to finance legally ordered activities like vaccinations and routine tests. And third, another source of income is revenue coming from financial investments and assets held.

Interesting examples of national livestock (hence animal health) insurance exist in Asia. The comprehensive rural insurance scheme in India, which includes livestock, illustrates the role of governments in the development and provision of livestock services. In 1973, the insurance industry in India was nationalised. This led to the establishment of the General Insurance Corporation (GIC). Its aim was (and still is) to insure farmers against the *"hazards of* [animal] *health and death"* (FAO, 1992). By introducing a master policy, all animals financed by bank loans were automatically covered by the insurance. A low cost insurance cover at a premium rate of 2.25% was introduced for animals subsidised by special development programmes. At the beginning of the 1990s, more than 20 million large ruminants were covered by the insurance scheme.

Increase or Adapt Agricultural Production

Farmers are well aware of the potential for diseases to harm their efforts. In various ways, they select production strategies that will mitigate these effects. Among their options are choices of where to locate, especially if they are pastoralists. Farmers can also choose production techniques and species or breeds that are more resistant to diseases and other risks. Another approach is diversification of output so that periodic damage to one product can be buffered by production of other products that are not afflicted by the same problems. Thus, farmers in certain areas engage in mixed farming systems of crops and livestock to spread the risk of infrequent and uncertain disease incursions.

Another alternative for farmers to reduce the impact of transboundary animal diseases is to increase their production or herd. It is likely that farm management strategies do incorporate some additional production when possible to serve as a buffer against losses.

Improve Infrastructure

Animal production losses and other increases in costs of production are often attributable to poor infrastructure and support services. In some countries, deteriorated or non-existent transportation infrastructure causes up to 30 percent post-harvest losses when products are taken to market. Lack of extension services to farmers reduces productivity in multiple ways, including an inability to respond to disease problems when they arise.

Public provision of infrastructure is justified by the public good nature of infrastructure services such as roads, marketing information, credit systems, extension and education, and irrigation canals. Investment in infrastructure has historically provided high returns, and is virtually essential for countries to achieve higher agricultural productivity. Improvements in such systems can reduce costs dramatically at the farm level, thereby compensating for losses from pests and disease.

Rural Development

Both private and public actions to improve opportunities in rural areas can help overcome losses from disease. The public sector can take action to develop rural areas by encouraging alternative industries, locating public facilities in vulnerable rural areas, and expanding adult education opportunities, such as job training and skills improvement.

Farmers can also engage in income-diversification strategies in order to reduce the impact of disease outbreaks on their household income. Reardon (SOFA 1998) has demonstrated that increases in non-farm employment and income have occurred in rural areas across all regions. Among the factors cited by Reardon for encouraging households to undertake non-farm employment is low food production due to temporary or long-term problems. This includes the loss of output from periodic disease outbreaks.

Food and Financial Aid

National governments and international agencies rely on emergency safety nets when disaster strikes farming communities. These are mainly donations of food or financial aid intended to carry the victims through temporary shortages. While such a response to emergency may in theory be the most direct and low-cost way to prevent localized famine or hunger from developing from a disease outbreak, it is less effective in practice, as emergency safety nets are often under-funded or non-existent in the places they are most needed.

V. Evolving and Emerging Issues

Global prevention of transboundary disease spread is being challenged by economic and ecological change. New technology is increasingly seen as the way to meet these challenges. The most dramatic change comes from the increase in trade and movement of passengers and the new trade routes that have opened. The globalisation of commodity trade is understandable when one considers that the unit costs of sea freight dropped by almost 70% in real terms in the past 10 to 15 years and air freight unit costs decreased by 3 to 4% over the same period (WTO, 1998). Biological and ecological transformations are increasing the virulence of some existing pathogens, as well as exposing animals and humans to previously-contained emerging diseases, and spreading invasive species into new territories. Consumers have grown increasingly wary about food safety and are demanding more information and more stringent regulation of food supplies. Demands on public authorities are growing without commensurate increase in resources.

Simultaneously, new technologies, new attitudes toward risk, and new trading principles may guide countries toward a more rational and comprehensive world system of animal health protection.

Increased likelihood of disease outbreaks

Increases in air freight, delivering fresher products more rapidly, allows for pathogens to survive the transit more readily. Totally new trade routes have led to new pathways for introduction. Increased trade in livestock and livestock products also puts larger numbers of animal and people at risk of disease. These new trade routes highlight the greater susceptibility in livestock, crops or native plants, or even in fish, to exotic pathogens when they have not co-evolved.

The last 30 years or so have been remarkable for the emergence of apparently new infectious human diseases. This includes the appearance of diseases such as AIDS, Lassa fever, and Ebola. The same has occurred with animal diseases. New zoonotic diseases have been emerging at a rate of at least one per year, including Avian flu, Nipah, bovine spongiform encephalopathy and disease caused by equine morbillivirus. Not only do new infections emerge, but also new biotypes or antigenic types of existing infectious diseases. A notable example has been the hypervirulent form of infectious bursal disease, which has swept across much of Europe and Asia in recent years causing devastating losses to poultry industries there. Vector-borne pathogens (e.g. West Nile fever virus) have expanded beyond their traditional range. Other examples include bluetongue in Europe and Rift Valley fever in Saudi Arabia for the first time.

In many countries there is a trend towards increased intensification and commercialisation of livestock production particularly in peri-urban areas. The higher concentration of animals, often under sub-optimal husbandry conditions, provides greater opportunity for transboundary animal diseases and other infections (e.g. Nipah virus) to move rapidly and cause economic losses.

In some regions of the world, tropical rain forests and other wilderness areas are being converted for livestock farming. This places human communities and their farm animals into close contact with a completely new range of infectious agents and vectors which may have previously only circulated in wild life reservoirs and which may be completely unknown. Some of these agents may be transmittable to humans and/or livestock, in which they may spread very rapidly being new, fully susceptible hosts.

Box 3: The Emergence and Spread of BSE

Cattle in Britain were first affected by bovine spongiform encephalopathy (BSE) - or mad cow disease - in the early 1980s but the disease, caused by a novel infectious agent called a prion, was only recognized in 1986. The disease has a long incubation period (on average five years in cattle) and therefore the UK epidemic expanded despite official control measures. BSE has since been detected in cattle in other European countries, as well as in Israel, Japan, and Canada.

BSE was apparently transmitted to cattle in feed supplements that contained meat and bone meal (MBM). There is strong evidence that a new variant of Creutzfeldt-Jakob disease (vCJD), a progressive, fatal neurological disease in humans, is related to the consumption of BSE infected tissues. Currently no method of diagnosis at early stages of infection and no cure for the disease, neither in animals nor in humans is available.

Concern has spread among consumers, and the economic impacts of the EU BSE outbreaks will be felt for years. Beef prices in the EU dropped 17 percent in the last months of 2000. By the end of 2000, the disease had cost the UK more than Euro 5 billion through slaughter of cattle and calves, loss of jobs and markets. Finally, it is impossible to put a price on the cost of the loss in public confidence in the livestock industry.

It should be stressed that the epidemic of BSE was probably the result of recycling and amplification of the causative agent through the practice of rendering offal and using it as protein supplement in animal feeds. Banning of MBM and regulation of the feed industry is curbing the spread of the disease.

Global warming trends may change rainfall and weather patterns in a number of regions, affecting particularly the global distribution of insect vectors, e.g. mosquitoes and *Culicoides* midges and the important transboundary animal diseases that they transmit (e.g. RiftValley fever, bluetongue, African horse sickness).

One reason for the growing concern about transboundary animal diseases is the increasing susceptibility of livestock industries to infection and magnitude of damage. Animal holdings are constantly increasing in size and animal industries are concentrating in certain areas, leading to unprecedented livestock densities. Introduction of a disease agent into these high density livestock producing areas leads to disease outbreaks requiring control measures that easily exceed what is socially acceptable.

New surveillance and monitoring technologies

A vast array of molecular biotechnology applications are available and emerging in animal production and health involving both on-farm and off-farm applications. Use of DNA biotechnology in animal health may contribute significantly to improved disease control. Advanced diagnostic tests make it possible to identify the disease-causing agent(s) and to monitor the impact of disease control programmes, to a degree of diagnostic precision (subspecies, strain, bio-type level) not previously possible. For instance, newly developed diagnostic tests are revealing cases of BSE that would previously have gone undetected. Enzyme-immunoassay (EIA) tests have the advantage of being relatively easily automated and have been developed for a wide range of disease agents. Their availability in developing countries however is still low.

Molecular epidemiology is being used to trace the origin of pathogens better than ever before. This is particularly useful for epidemic diseases which can be better controlled by earlier pinpointing of their source. The development of genetic techniques which allow the detection of pathogen DNA/RNA, rather than antibodies, in livestock also enhances animal health efforts. Finally, recombinant vaccines can offer greater safety and specificity, more stability, and distinctions between vaccinated and naturally infected animals. They may also offer possibilities for vaccines to be developed against diseases where conventional methods have failed.

An innovation that supports pathway analysis and could be used for liability actions in the future is the use of genetic "fingerprinting" to show the source of entry of a population of disease agents, as is already used extensively for FMD and rinderpest through world reference laboratories. By establishing the source of the entry, measures can be taken to close down the pathway or improve compliance. This may also be used to show if the population is a new introduction or a resurgence of an earlier introduction that was thought to have been eradicated.

An operational tool of great interest is the systems approach to compliance. A systems approach to quarantine security is much more complex than a system relying on shipment by shipment inspection, yet it will facilitate trade. These agreements are based on research showing the critical points of possible infection and demonstrating compliance with measures that, when carried out in total, reduce the risk of the product introducing a pathogen to a level acceptable to the importing country.

Other new tools and technologies that show promise or are already proving successful include:

- Improved detection and identification methods
- Improved reporting and data sharing to give more actuarial data for risk analysis
- Greater use of pre-programmed response systems
- More reliance on production systems or area clearances rather than individual checking
- Improved use of computerised statistical sampling techniques for greater reliability

At the same time, challenges that new technologies may impose are:

- More automated packing, processing and shipping which precludes visual inspection
- Sampling problems/costs at delivery point due to pre-packed goods in large or sealed packs

Emerging issues that will affect future regulatory approaches include:

- More vertical integration or control between suppliers, traders and sellers (better quality feedback)
- More produce source labelling and tracking through supply chain

- More specialised handlers for produce with greater volumes/values
- Greater co-operation in transboundary management of animal diseases
- Moves to demand full cost recovery for prevention and response (may oblige greater participation in planning from traders/shippers)
- Greater interest/demand for preservation of natural environments
- Increased legal responsibility for biodiversity preservation (Convention on Biological Diversity, national regulations)

The pressure to include environmental considerations more fully will force many nations to evaluate the relative advantages of creating a biosecurity approach across ministries and agencies that maintain their areas of expertise, rather than to continue with separate policy divisions and to cooperate on operational programmes on an *ad hoc* basis.

VI. Choosing and Implementing Appropriate Solutions

Roles of local, national, and international policies

The trend of the past two decades is for local and national policies on transboundary animal diseases to be guided by international standards, agreements and priorities. The risk assessments required under international obligations must still be based on local conditions. While the predicted risk for human consumption, for example, may be considered the same throughout the world, the probability of a pathogen surviving in a new environment varies from place to place depending on the climate, host availability and other factors.

Local participation, particularly in stakeholder consultation, is necessary for any successful project. There are increasing numbers of area-wide programmes around the world, either to stop an incursion of an exotic disease or to create a disease-free production area within an infected country and thereby open up new trade opportunities. In these cases, local policies and actions around the designated areas are as important as in border zones.

There are many compelling reasons why countries should cooperate in their programmes against transboundary animal diseases, either formally through regional organizations described below or informally through networking.

Neighbouring countries often have similar production systems and also have shared epidemiological and disease risk profiles. There will be mutual benefits and cost savings through joint preparedness planning. This includes not only co-operation in preparation of contingency plans, but also in activities such as training programmes, laboratory diagnostic facilities and international vaccine banks.

The rapid and frank sharing of information on disease occurrences and pest outbreaks and harmonization of quarantine and disease control programmes, particularly in areas adjacent to common borders, will also be of considerable mutual benefit. While this has been achieved or is progressing in some instances (e.g. rinderpest eradication campaigns in Africa and foot-and-mouth disease eradication campaigns in Europe, South America and South East Asia), lack of co-operation between countries in many parts of the world has been a major constraint to the successful control of transboundary animal diseases.

Existing agreements and institutions

International conventions, treaties, and agreements have an impact on animal disease programmes in several ways. There are currently around 20 binding agreements at either the global or regional level, as well as a number of technical guidance documents and non-binding legal instruments (Glowka and Klemm, 1999). There are also numerous private organisations dedicated to providing information about disease incidence.

The most important of these agreements for transboundary animal diseases are shown in Table 4.

Table 4: Some Major International Agreements and Organisations Related to Animal Health

International Agreements, Conventions, Treaties or Bodies	Objectives (in relation to transboundary pests and diseases)	Impact on Management of Transboundary Pests and Diseases	Contracting Parties
Animal Health: 1924 International Office of Epizooties (**OIE**)	Promotes international cooperation in control of transboundary animal diseases	Provides information about disease outbreaks, coordinates studies and surveillance of disease, and harmonizes trade regulations in animals and animal products	164 member countries
Trade: 1992 World Trade Organization (**WTO**) formerly GATT	To lower tariffs and prevent the use of other trade barriers in order to facilitate free trade. Recent rounds have moved beyond that to seek fair trade and trade in safe products.	Deviation from international standards must be scientifically justified through a risk assessment process in order to avoid charges of unfair trade practices. Establishes a dispute mechanism and SPS standing committee to adjudicate on regulation of plant and animal health when it affects trade. The standard setting bodies are Codex Alimentarius (joint FAO/WHO secretariat), IPPC (housed at FAO), and OIE.	146 member countries plus 30 observers
1994 Agreement on the Application of Sanitary and Phytosanitary Measures **(SPS)**	Establish a multilateral framework of rules and disciplines to guide SPS measures and to minimize effects on trade.		

WTO does not assume responsibility for the development of international standards and guidelines but assigned this responsibility to other international bodies such as the joint FAO/WHO Codex Alimentarius Commission in the case of food, the International Plant Protection Convention for plants and the Office International des Epizooties (OIE) for livestock and livestock products.

Although OIE has been designated to be the standard setting body in relation to animal health matters, it is not an enforcement body and has to resort to non-mandatory urging without being able to impose punitive sanctions for members not complying with their obligations. Thus, the respect of OIE codes is based on voluntary compliance by its members. Compliance with obligation relating to the reporting of disease incidence and response is often a problem. Furthermore, OIE relies solely on information reported officially by member states regarding disease outbreaks within their territory. On the other hand, countries, which comply with their reporting obligation, may at times feel unduly penalized by overreactions from trade partners. The above weaknesses lead to a situation where only partial trust is put into official OIE disease information and complementary, often ‘non-official’ information has to be sought to obtain a comprehensive view of the disease situation in some parts of the world. As a result, animal health related decisions on trade in livestock and livestock products are commonly based on bilateral agreements with inspection of the veterinary services of the exporting country by those of the importer.

In 1994 FAO established the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES) as a priority program to combat transboundary pests and diseases. The livestock diseases component aims to strengthen FAO's role in prevention and immediate response to emergencies caused by major epizootic diseases that cross boundaries. The plant pests component focuses on preventive control of the Desert Locust, leading to a reduced risk of catastrophic plagues's. The major thrust of the animal disease component of EMPRES has been to eradicate rinderpest. Progress on this goal has been rapid and effective. It emphasises proactive efforts to prevent emergencies by increasing early warning and early research, and through the application of research. EMPRES also aims to provide a catalyst for cooperation among countries in the fight against transboundary pests and diseases.

Box 4: WTO Agreement on the Application of Sanitary and Phytosanitary Measures

The Uruguay Round of trade negotiations under the auspices of the World Trade Organisation - WTO (formerly GATT) inaugurated an era of agricultural trade liberalization which affects farmers and agricultural policy in both developed and developing countries. The Round was concluded in 1994. The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) Agreement was instituted. The SPS Agreement came into force in 1995.

The objective of the SPS Agreement is to provide a framework for protecting human, animal, and plant health and life, while preventing unjustifiable barriers to trade. Therefore, any exceptions to free trade in food and agriculture must be supported by scientific risk assessment and cost-benefit analysis. Countries are allowed the right to establish their preferred level of SPS protection, but in the event of a dispute, the WTO convenes a panel to assess whether the measure is in conformance with the provisions of the Agreement, and the measures can be required to be changed or compensation to a damaged party ordered.

It is not always a simple matter to distinguish between justified SPS controls and restrictions arising out of consumer preferences or concerns. Developing countries sometimes believe that their inability to obtain access to developed country markets is more driven by the latter than the former. This perception is difficult to refute because the risk assessment process itself, that is a basic tenet of the SPS Agreement, is not fully established. The economic methods for defining appropriate socio-economic factors to be considered and for assessing effects on the environment have not been accepted by member countries.

Under Article 14 of the SPS, developing countries were provided a reprieve of two to five years from the market access provisions of the Agreement. This period is intended to allow creation and upgrading of mechanisms and provisions for meeting the requirements, without causing damage to their agricultural sectors from sudden competition. In 2000 the grace period expired for all developing countries. The main concerns that motivated this grace period are still valid: compliance costs are very high and developing country capacity to regulate is weak.

The *capacity gap* refers to the inability of some countries to afford the expense and provide the expertise to participate in the WTO procedures. Many developing countries lack the capacity (legal and scientific) to participate as full and equal partners in the open markets imposed by the Uruguay Round, and to formulate and implement fully effective SPS systems. They view the SPS as a burden or obligation rather than an opportunity for participation.

The *compliance gap* occurs when countries do not fully comply with the requirements of agreements they make with other countries. The primary reason is insufficient resources and the result is uneven application of the mechanisms called for in the agreements. In the case of animal health, the non-compliance on the part of some countries poses risks to other countries with consequent strains on the agreement itself. At present, even the largest and best funded countries are not in full compliance with the SPS Agreement. Measures have been enacted without a full risk assessment or agreement on an international standard. This uneven application of the standards leads to conflict over fairness issues that weakens the SPS.

Private organizations and technical associations

The leading organisation for biological control expertise and much of the taxonomic references in the field is CAB International with centres in the UK, Malaysia, and Trinidad and Tobago. Although a private organisation, CABI is directed by its member countries through annual meetings and consultations.

Trade associations in each country are an important contact point for gaining stakeholder support on prevention programmes since industry is often a major beneficiary of such efforts. In each area of expertise, technical associations exist. List servers, to which individuals can subscribe to receive messages within particular speciality fields, have proliferated, as have relevant Internet sites. ProMED is a private initiative to establish a global program for monitoring emerging diseases. The ProMED-mail electronic network was inaugurated in 1994 and is intended to enhance the access of developing countries to medical information, including information on animal diseases.

Financing

The final and indispensable condition for effective management of transboundary animal diseases is of course adequate funding and appropriate financing mechanisms. An important reason for uneven application of SPS standards is a country's lack of resources to implement effective control procedures. One of the functions of regional groupings is to try and overcome differences in ability-to-pay across countries where actions of one can impose costs on the other countries. Other reasons for cost-sharing include shared benefits and economies-of-scale in control operations.

However, incentives to cooperate are low, especially for non-exporting countries. This explains why some of the regional groupings operate better in theory than in practice. Typically countries give higher funding priority to their national animal health services than to cooperative associations. Countries have different levels of risk associated with disease infestations and may resist contributing if they perceive other countries gain more benefit from the effort.

In the long term, the current imbalance in control capacities among the countries can only be overcome if affected countries strengthen the cooperation among each other. All countries recognise that the effective control in a neighbouring country is as important as their own management efforts. However, current mechanisms for cooperation have suffered from weak financial and political support. Donor agencies sometimes provide funding for a regional eradication programme or similar activities, such as Caribbean programme for the eradication of *Amblyomma variegatum*.

The EU has been at the forefront of maintaining a "polluter pays" standard in matters of plant and animal health risk. European Union Member States have a mechanism for recovering costs due to the negligence of another Member State in carrying out its duties in plant and animal health. The Convention on Biological Diversity may further define mechanisms for payment for liability by a government when the government's officials do not carry out necessary phytosanitary measures in control of a new pest or, under the Cartegena Protocol on Biosafety, of a Living Modified Organism released into the environment. The concept of legally-binding liability is new in this field. It will be some years before the individual, legal entity or government that is responsible for an entry or outbreak will be paying for the costs of the negligent actions.

Questions regarding who should pay for which services also arise within the national setting. Financing of national programmes of quarantine, plant and animal inspection, disease eradication and other SPS programmes is typically done with government funds. The economic rationale for public funding is elaborated on in other publications (Mumford *et al*, 2000). However, some countries charge user fees to cover costs of activities with clear beneficiaries. Costa Rica has achieved full cost recovery on plant health services, for example. Cost recovery through user fees is particularly common for export certification schemes since the beneficiary is quite clear and the activity is closer to market promotion, rather than risk reduction for the consumers in the producing country.

Another possible source of finance for plant and animal health is from enforcement penalties or liability payments. Fines and penalties have not been consistently used as a deterrent to lax compliance because the burden of proof prevents effective enforcement. With tighter government budgets, improved monitoring tools, and greater demands on quarantine systems, this situation could change.

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