SOCIO-ECONOMIC IMPACTS OF FREEDOM FROM LIVESTOCK DISEASE AND EXPORT PROMOTION IN DEVELOPING COUNTRIES

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Preface

This is the third 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.

This paper explores the benefits and costs of freedom from OIE List A diseases and the benefits from and hindrances to international trade in livestock products in order to highlight the complexity of the link between disease freedom and export. It suggests that proposed disease control policies need to be examined within a broad context, to capture the full impact on different parts of the livestock sector and different groups in society. This is especially important in developing countries, which need to ensure financial and economic viability of any investment and to countries and funding agents with an equity agenda. Even where disease freedom and export expansion are technically possible and economically attractive, they are likely to have different effects on different stakeholders, gains to one corresponding with neutral effects or even losses to another. The paper therefore particularly examines two wider effects: impacts on the livelihoods of poor livestock keepers and multiplier effects through the economy.

Further issues covered by the paper are the role of the public and the private sector in disease control campaigns, cost-sharing mechanisms developed in various situation as well as the strengths and limitations of the most commonly used appraisal and evaluation tools.

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

Access to global livestock markets has theoretically been facilitated by the ending of GATT, establishment of the WTO and signing of the SPS Agreement, but dissolution of trade barriers may be limited by the presence of specific diseases in a national livestock population, and such diseases may appear to be the major barrier to export development. However, for countries contemplating a policy of disease freedom in order to improve export potential, it is important to be aware of the costs and technical difficulties of establishing export markets. The paper explores the benefits and costs of freedom from OIE List A diseases and the benefits from and hindrances to international trade in livestock products in order to highlight the complexity of the link between disease freedom and export. It suggests that proposed disease control policies need to be examined within a broad context, to capture the full impact on different parts of the livestock sector and different groups in society. This is especially important in developing countries, which need to ensure financial and economic viability of any investment and to countries and funding agents with an equity agenda.

Productivity gains, often considerable, can be expected when a major infectious disease is eliminated from a livestock production system. However, the size and sustainability of productivity gains are highly dependent on the nature of the livestock production system and the market for its products. When these and the cost of eradication are taken into account, it becomes evident that only a limited number of situations justify disease eradication purely in order to boost domestic offtake. In a number of instances it has been shown that while disease eradication alone would be economically marginal and risky, introducing an "animal health package" aimed at general productivity enhancement appeared to be economically viable.

The costs of eradicating a specific disease depend on a number of factors including the current epidemiological state of disease, the capacity of the veterinary service, the availability of reliable vaccine and diagnostic tests and the risk of re-introduction. Costs incurred during the eradication programme must be balanced against later cost savings from reduced or changed needs for control measures. Sufficient examples exist to make possible a reasonably accurate assessment of eradication costs for a given country and disease, but there is less experience in assessing the cost of maintaining disease freedom. Moreover, this latter cost must be met from the recurrent budget and is less likely to be eligible for development assistance.

The benefits of developing or expanding an export market can be considerable, including increased volume and value of livestock offtake, greater variety and quality of production, diversity of market opportunities and increased capacity in the national livestock sector. At the same time, the difficulties and risks of export trade should not be underestimated. Since the replacement of GATT by the WTO, there has been a reduction in tariff barriers to trade, to the point where they are largely insignificant, but an increasing number of non-tariff barriers have been introduced in the form of SPS and TBT measures. These can be expensive to implement, may vary with different trading partners, are subject to change over time, and tend to be designed for the convenience of developed country production systems. Moreover, freedom for disease and compliance with SPS measures do not in themselves guarantee an export market. Additional effort and cost must be incurred in seeking markets and, therefore, disease freedom as an incentive to trade is best implemented as part of a long term export

strategy when a number of other measures to promote export have already been put in place. Efficient operation of the input supply and product marketing chains are crucial if products are to be produced at a price, quality and timeliness suitable for export. If small and middle sized producers are to be included in the development of export markets, this may require a co-ordinated effort by more than one government ministry to deliver a package of economic incentives to livestock producers, traders and processors.

Even where disease freedom and export expansion are technically possible and economically attractive, they are likely to have different effects on different stakeholders, gains to one corresponding with neutral effects or even losses to another. It is therefore important to examine impacts from the perspectives of different groups and to look at the indirect and multiplier effects of a change in livestock policy. The paper examines two wider effects, impacts on the livelihoods of poor livestock keepers and multiplier effects through the economy. It concludes that there can be benefits in disease control for poor livestock keepers but disease control policies and programmes must take account of their circumstances if they are to achieve full participation and impact. Participation of the poor in export markets varies by country, but the stringent sanitary and technical requirements may exclude them if export policies are not designed to promote their participation. Multiplier effects are illustrated with a case study from Botswana, where the livestock sector is strongly linked to other sectors in the economy and an interruption of export markets resulting from a CBPP outbreak had widespread economic effects.

Low excludability, low rivalry and the potential for externalities all make disease eradication eligible for some element of public funding, and for public regulation. Some elements of disease control may be suitable for private operation and financing with public subsidy for establishment of facilities. Others may be financed largely through the public sector, but delivered under contract by the private sector. The paper discusses cost sharing, regulation and delivery and compensation. Three international cost sharing models are identified, typified by the approaches to rinderpest eradication in Africa, FMD eradication in the Southern Cone of South America and Newcastle disease control. The viability of public-private cost sharing through cost recovery schemes depends on individual national circumstances but can usefully be assessed using an analytical framework composed of: sustainability; equity; efficiency of resource allocation; effectiveness of disease control; economic cost of recovery; and financial efficiency. Delivery of disease eradication programmes, once the province of national veterinary services, is now characterised by increasing diversity. The role of private veterinarians and government or private paraprofessionals is becoming more important, although a thorough evaluation of their potential has yet to be carried out. Compensation schemes, although normally a part of eradication programmes, have not always captured the full value of losses experienced by producers, and generally exclude others in the livestock sector.

The strengths and limitations of the most commonly used appraisal and evaluation tools are assessed. Those most frequently encountered include farm financial analysis and economic cost benefit analysis, combined with herd and epidemiological models. Limited use has been made of whole economy models, whilst economic surplus models have been used for animal health research prioritisation. The methods most commonly used are robust, widely understood and well designed for analysing direct impacts of disease control. However they are less effective for assessing wider economic and social impact. Qualitative and semi-quantitative approaches and methods would be useful additions to the evaluation process. It is

also apparent that there are still major gaps in data even for conventional analysis, especially related to the less commercial production systems and smallstock.

The review has identified analytical and data gaps and areas of potential interest to policymakers in developing countries. In order to broaden the current knowledge base, the authors believe that the following would be of value:

a) Development of a multi-criteria framework based on a series of case studies carefully chosen to illustrate key differences in economic and trade development, veterinary services capacity and livestock production system characteristics. The framework developed to serve these examples should evaluate practicality, cost and speed of different analytical methods as well as quality and detail of outcome;

b) A review of different approaches to delivery of vaccination and surveillance, including an institutional assessment as well as comparative assessment of the effectiveness and cost-efficiency of existing strategies under different land/animal densities;

c) Livestock export development advice for low-income countries including: institutional and technical analysis to identify the most effective means to assist producers and those involved in livestock trade and marketing to cope better with changing markets; a review of means to secure existing markets in the face of disease outbreaks; increased training material on key elements of an assessment of an export market; development of an accessible centralised information base on trade and other impacts of disease eradication.

1 Introduction

Policies to promote export growth represent one of a range of options for developing countries seeking to expand livestock sector production and improve productivity. Delgado, Rosegrant, Steinfeld, Ehui and Courbois (1999) predict continued growth in demand for livestock products for the next 20 years or so. Part of that demand will continue to come from developed countries, but an increasing proportion will stem from the developing world. Since national demand and supply will not necessarily balance, international trade will be essential. For some countries, therefore, decisions about developing export markets will form an increasingly important component of livestock policy. For others, maintaining or increasing domestic self-sufficiency in livestock products will be a preferable strategy, since the ability of a country to achieve growth through export, and its impact on different parts of the economy, are dependent upon a number of interacting factors that will be discussed in this paper.

Ending of the General Agreement on Tariffs and Trade (GATT), establishment of the World Trade Organisation (WTO) in 1994, the signing of Agreement on Sanitary and Phytosanitary measures (SPS Agreement) has theoretically opened the global trading area to all countries. Improvements in communication networks, bio-security and surveillance systems, and introduction of the concept of disease free zones within infected countries are all comparatively recent developments with the potential to diversify and expand global livestock trade. However, compliance with the SPS Agreement can impose strict technical requirements and add considerably to the cost of establishing and maintaining an export market.

One barrier to export may be the presence of specific livestock diseases, in particular the epidemic diseases making up OIE's List A[1]. Trading countries may be called upon to demonstrate freedom from specific diseases, either to promote export to disease free countries, or to reduce the risk of importing new diseases by limiting imports of livestock and their products. A policy of disease freedom may have the objective of achieving disease free status[2] for a defined area of a country, for the nation, or a region, in order to increase participation in global trade.

There are several reasons why countries or regional groupings might wish to invest in a policy of freedom from specific diseases:
♦ As part of a national policy to improve the agricultural and livestock sectors, led by an export focused strategy;

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[1] List A diseases are those which have the potential for rapid spread, have serious socio-economic or public health effects, and are of major importance in international trade. The list currently comprises: African horse sickness; African swine fever; bluetongue; classical swine fever; contagious bovine pleuropneumonia; foot & mouth disease; highly pathogenic avian influenza; lumpy skin disease; Newcastle disease; peste des petits ruminants; rinderpest; Rift Valley Fever; swine vesicular disease; sheep pox and goat pox; vesicular stomatitis.
[2] A "free zone" is defined by the OIE as "..a clearly defined territory within a country in which no case of a disease included in the Code has been reported during the period stated for such a disease in the Code, and within which and at the borders of which official veterinary control is effectively applied for animals and animal products, and their transportation" (International Animal Health Code – 1999 Edition). A free zone can thus refer to part or all of a country.

♦ To alleviate threats to existing trading partnerships, created by changing health standards of existing trading partners or changing health standards and status of trading nations competing in the same market;

♦ To expand existing trade in livestock and livestock products by strengthening links with established trading partners and creating new markets in countries with higher health standards;

♦ To protect domestic production and promote national food self-sufficiency by removing disease losses and controlling imports;

♦ As an equity or poverty alleviation measure, to reduce costs and threats, particularly for small livestock producers who cannot or do not take preventive action;

Each of these situations is associated with different benefits and costs. The effort required to eradicate a disease may be considerable and hard to justify politically without with the incentive of potential export earnings. However, while export growth presents an attractive goal, it can also be a difficult and expensive one. Trade related benefits from a policy of disease freedom are most likely to occur in a country with an established livestock export market. Where this is not the case, there may be constraints in the domestic situation, national "spirit" or the trade environment, which can only be removed at considerable cost. Moreover, export-led growth may not be immediately compatible with poverty alleviation.

For many countries the decision to undertake efforts to achieve disease freedom is based on a set of favourable conditions resulting from previous disease control policies, pressure to change policy from commercial producers or processors, or pressure from neighbouring countries. As a result of the policy change, the incidence of costs or benefits may be shifted significantly between different stakeholders. While every developing country aims to achieve economic growth, issues of equity may be at least equally important, yet the link between growth and distribution of national wealth is not always clear-cut. A livestock policy that is effective in boosting economic growth through export may not be uniformly beneficial throughout the livestock sector, or equally beneficial for producers and consumers. Often the full social and economic effects of such policy changes are not adequately considered: expected benefits may not occur, dis-benefits are undervalued or ignored. Ex-post analysis, when made, concentrates on the immediate and easily measurable, and lacks the detail and attention to socio-economic impacts required to evaluate the full impacts of such changes.

This paper examines separately the benefits and costs associated with freedom from List A epidemic diseases and the factors (including disease freedom) affecting promotion of export markets in developing countries. Since there are 15 List A diseases, affecting large and small ruminants, pigs, poultry and equines, and distributed throughout the developing world, this is a large subject and any attempt to draw general conclusions must be treated with caution. Nevertheless, existing literature on disease control and on livestock trade shows that:

♦ investment in freedom from major infectious diseases can generate significant net productivity benefits for the livestock sector, although these vary considerably with the production system, disease effect and state, and type of control initiative;

♦ achieving disease freedom can form an important part of an export-led strategy but will only be effective if preceded and supported by other measures to boost export;

♦ impacts of disease freedom and export growth are often unequally distributed, and will only benefit the poorer members of the economy if supported by explicit policies to promote their participation in the market.

2 Potential impacts of disease freedom

The disease control continuum

It is convenient to view disease control as a continuum (Figure 2.1). At one extreme is the endemic state, meaning that the disease is usually present in the population at predictable levels. At the other is eradication, where first clinical disease and then the infectious agent are removed from the population. In between is a an epidemic state, where periods of apparent freedom are punctuated by outbreaks of varying severity. In theory it is possible to move in either direction along the continuum, which can apply at sub-national, national or regional level. Only the endemic state and global eradication can be considered inherently stable. The distance to be moved in achieving disease freedom affects the magnitude of both costs and benefits of disease control.

Figure 2.1 The disease control continuum

ENDEMIC   EPIDEMIC/SPORADIC   ERADICATED

strengthening of control
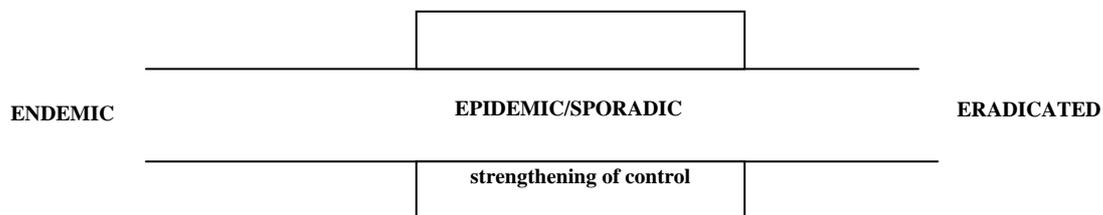
Within the continuum certain key states can be identified. The OIE pathways for freedom from disease specify states during the process of eradication. Figure 2.2 shows the pathway for rinderpest. For CBPP, two similar pathways, with the same states but different timing, have been defined. For FMD, three states are recognised: infected, FMD free where vaccination is practised and FMD free where vaccination is not practised. A complete list of disease states for a rinderpest- or CBPP-like disease is shown in Table 2.1 and can serve as a basis for examining many List A diseases. The state of disease has a direct effect on the cost of having it in the population, through productivity losses and direct control costs, and hence on the potential benefits of controlling it. The measures required to achieve and maintain a particular disease state also have associated costs. A country in a particular disease state and contemplating a move to another state, should compare the benefits and costs of the proposed change of state.

Figure 2.2: OIE pathway for freedom from rinderpest
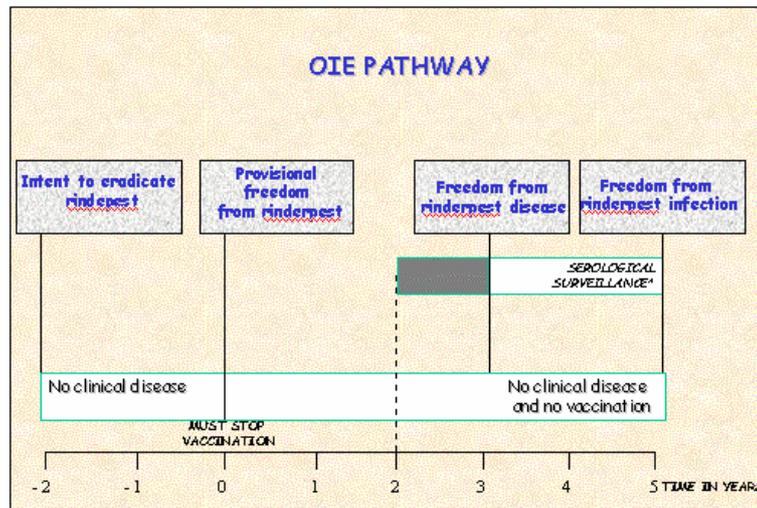
Source: OIE (2000)

Since all states of disease can be seen in developing countries, any of three types of change may be under consideration, to achieve disease freedom for the country as a whole or for specific zones:

♦ Moving from an endemic to a disease free state. e.g. FMD in South America and potentially in parts of South East Asia, CBPP potentially in Africa. This can be a long and costly programme and is most appropriate in a regional context, with trade or other motives;

♦ Moving from an epidemic to a disease free state. e.g. the few remaining pockets of rinderpest in Africa and parts of Asia This step may be appropriate to be contemplated by an individual country to expand trade, to reduce long term costs of control, to reduce risk for domestic producers, or to improve harmony with disease-free neighbours;

♦ Controlling a single outbreak of a disease that has long been absent, e.g. CBPP in Botswana, FMD in Mongolia. Here an attempt at control is unquestionable, since loss of disease-free status can have severe domestic and international consequences.

Table 2.1 States of disease and associated control measures (e.g. rinderpest or CBPP)

State of disease	Characteristics	Measures likely to be in place
Endemic	Outbreaks regular/frequent or no apparent disease – i.e. subclinical	Limited or no strategic control
Epidemic, high incidence	Outbreaks over wide geographical area	Irregular vaccination campaigns, limited disease reporting, ineffective movement control
Epidemic, low incidence	Outbreaks sporadic or over limited geographical area	Regular vaccination campaigns, effective disease reporting, effective movement control
Declared intention to eradicate.	Outbreaks sporadic or over limited geographical area	Regular vaccination campaigns and/or effective disease reporting. Stamping out measures, effective movement control, measures to prevent re-introduction eg import restrictions, quarantine
Provisional freedom, without vaccination	No clinical disease	Clinical, sero-and abattoir surveillance as appropriate for disease, preparedness for stamping out
Freedom from disease, without vaccination	No clinical disease	as above
Freedom from infection, without vaccination	No disease agent	as above
Long term freedom from infection	Disease agent is not re-introduced	as above, but possibly at a reduced level

Strictly speaking, disease eradication refers to the removal of the infectious agent from the population, and not to freedom from clinical disease alone. However, there is no convenient term for "achieving freedom from clinical disease", and the description "disease control" is rather ambiguous. With apologies to purists, this paper will use the term "eradication" to refer to programmes which achieve either freedom from clinical disease or freedom from the infectious agent, on the assumption that eventually they will all be aiming at true eradication, i.e. freedom from infection.

Benefits and costs of disease freedom

Some possible consequences of disease freedom are shown in Figure 2.3. Some are clearly negative (costs), some clearly positive (benefits), while others may be positive, negative or neutral for different stakeholders. The generic relationship between the benefits and costs of control is illustrated in Figure 2.4 with the most attractive policies located in the top right quadrant. Table 2.2 lists the key factors that should be considered in assessing the viability of a disease control scheme. Both the figure and the table may appear to be stating the obvious, but they lay out the framework for a substantial work of analysis. Many of the published studies of the impact of disease control have included only the direct effects, and the relative paucity of published data on benefits and costs of disease control presents a constraint to accurate assessment.

Figure 2.3 Impacts of disease freedom on livestock sector stakeholders

Quality
incentives

Effect on
producers

Environment

elasticity of supply
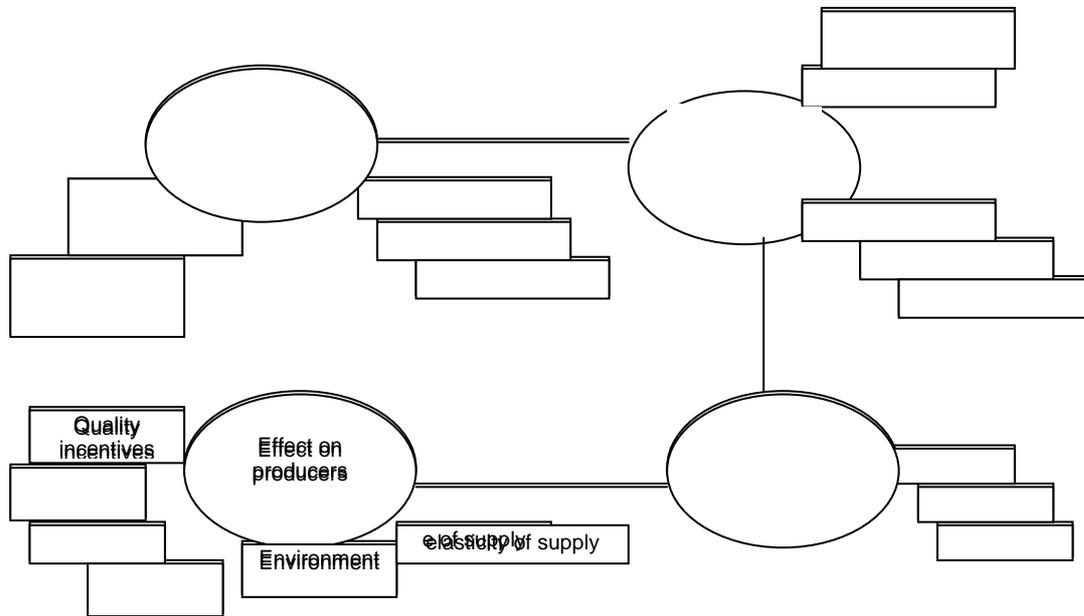
Source: Leslie and Upton (1999)

Figure 2.4 Viability of proposed disease control policies

HIGH

benefits
from
disease
freedom

possible   viable

low   possible

LOW

HIGH   LOW

cost to achieve freedom
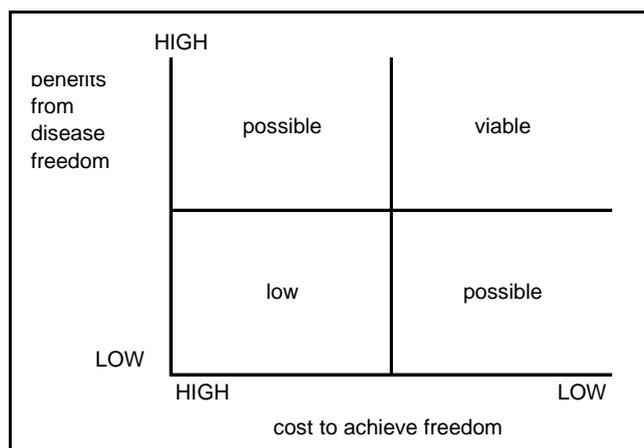
The diverse list of effects summarised in Table 2.2 suggests that to assess the impact of
disease freedom requires a careful and holistic analysis, which should encompass:
♦ a review of all the benefits and costs that can realistically be expected from a policy of
   disease freedom, including those less easily valued;
♦ a realistic assessment of the potential for export market development;
♦ identification of the potential distributional implications for the different stakeholders;

♦ review of the implications for and alternative means of funding the policies;

**Table 2.2 Important factors in evaluating the viability of
a programme for freedom from livestock disease**

a) potential benefits from control

DIRECT ECONOMIC EFFECTS
- ♦ Increased productivity or production
- ♦ Increased value of exports
- ♦ Reduced human medical costs for zoonotic diseases
- ♦ Costs saved from current control programme

INDIRECT, SOCIAL AND POLITICAL EFFECTS
- ♦ Contribution to livelihoods of the poor
- ♦ Contribution to the wider economy e.g. employment
- ♦ Higher quality or choice to consumers
- ♦ Increased sense of security for livestock owners
- ♦ Increased ability to participate in social functions requiring ownership or gifts of livestock
- ♦ Positive environmental effects e.g. reduced use of chemicals for disease prevention
- ♦ Prestige of successful control programme
- ♦ Improved relationship between veterinary service and farmers creating improved management of other diseases
- ♦ Improved relations with regional neighbours

b) potential costs of control programmes

DIRECT
- ♦ Costs of establishing and maintaining eradication programme
- ♦ Costs of establishing and maintaining an export scheme

INDIRECT, HARD TO QUANTIFY AND POLITICAL
- ♦ Negative environmental effects e.g. wildlife fences
- ♦ Higher prices to consumers
- ♦ Risk of failure

The values of benefits and costs from disease freedom, with or without associated export trade, are country and situation-specific. Factors affecting the magnitude of individual benefits and costs in developing countries are discussed in sections 3 to 6. Section 3 examines the direct benefits of increased livestock productivity that might be expected as a result of achieving freedom for a specific disease, without considering increased prices or offtake from export. Section 4 considers the direct costs of implementing a disease eradication campaign. Section 5 discusses factors that influence the benefits and costs of establishing or expanding a livestock export market. Section 6 then considers the indirect and equity effects of such strategies, first discussing the impacts of disease freedom and export on the livelihoods of poor livestock keepers and then examining potential knock-on effects to other sectors. Even when a policy of disease freedom is politically and economically attractive, there is still the question of financing and delivering it, and these issues are discussed in section 7. Section 8 then reviews the methods used for socio-economic analysis of disease control programmes and discusses their limitations in delivering the information needed by policymakers.

3 Factors affecting productivity benefits from disease freedom

Sources of productivity gains

Freedom from disease may result in two direct benefits: those from increased productivity within existing systems of production and trade, and those from exploitation of new markets, normally as a result of export. For convenience the different elements will be discussed separately and the discussion will be divided between the present section and sections 4 and 5. Productivity is equal to output value per unit of cost to produce that output, and changes to productivity resulting from disease control may have the elements shown in Table 3.1.

Table 3.1 Potential productivity effects of disease control

Benefits	Costs
Increased output value (volume x price)	Increased production costs
Reduced costs of clinical treatment	New costs to achieve disease eradication
Costs of previous control programmes saved	Recurrent costs of maintaining freedom

Relationship between disease freedom and price of outputs

An increase in output value may arise from an increase in the volume of outputs, an increase in price, or both. When disease is controlled in livestock, two effects on price might in theory be observed. One relates to the relationship between supply, demand and price. If the supply of livestock products to the market is greatly increased relative to the existing demand, this will eventually cause a fall in price. This may act as a disincentive to producers, unless the cost of production is sufficiently reduced by disease eradication to allow profits to be retained even at a lower output price, or production can be expanded sufficiently to allow farmers to profit from economies of scale. However, predicting the price effect of a change in the output of livestock products requires a macroeconomic model and several years of accurate data. Unless the change in supply is anticipated to be very great, it is safest to assume that domestic "farm gate" prices (prices to the livestock producer) will be unaffected by disease control.

The second potential effect is one of increased product quality resulting from disease control. Theoretically, animals from proven disease free stock might command a higher premium during the initial stages of an eradication campaign. Those known to be from an infected herd might even be unsaleable as in the case of the British BSE epidemic. If the effect of disease freedom was to create a new market niche by expanding export potential, prices of export animals could certainly be expected to rise. In the present section, it will be assumed that the price effect of disease freedom is neutral, and the discussion will focus on output volume and reduced disease costs. The impact of export will be covered in section 5.

Relationship between disease freedom and volume of outputs

Volume of livestock outputs depends on two factors, the biological potential of the system to produce more output (its productive capacity), and the willingness of farmers to expand production.

Productive capacity

Planned expansion of production can result from increased use of land and expanded herd sizes, still possible in some parts of South America and with tsetse and trypanosomosis control in some parts of Africa, but a vanishing option elsewhere in the world. Alternatively it can be achieved through improved productivity per animal, by improvements in production parameters such as reproduction and mortality rates. Many developing countries are experiencing land pressure from human population growth, making improvements in per animal productivity increasingly important as a production strategy, both through removal of constraints from traditional system, and by replacing traditional systems based on indigenous livestock with more intensive production using "upgraded" animals. Inevitably, intensifying livestock systems are changing from users of surplus and waste resources to competitors for agricultural products (Steinfield, de Haan and Blackburn 1997). Expansion through increases in per animal productivity depends on the extent to which systems are working below their potential and production technologies are available and suitable for adoption.

The main production effect of the majority of the List A diseases is to raise mortality rates. African horse sickness, African and classical swine fever, bluetongue (young animals), Newcastle disease, PPR, sheep and goat pox, rinderpest and Rift valley fever (young animals), all result in high mortality rates, between 50% and 90% in susceptible animals affected. Reduction in mortality through disease control creates the immediate effect of preserving saleable animals and draught animals, and long term effects on herd/flock growth through preservation of breeding females and their replacements. Historical assessments suggest enormous losses from introduction of infectious diseases into naïve populations. For CBPP in the late 1800s, losses were reported of 187,000 cattle in Britain valued at £2 million annually, 65,000 cattle in the Netherlands, 100,000 cattle in two years in South Africa, and 1.4 million head valued at £8.5 million in Australia (Egwu, Nicholas, Ameh and Bashiruddin, 1996). Similarly huge losses were reported for rinderpest at around the same time: up to 75% mortality among Egyptian cattle and buffaloes, 90% of Ethiopian cattle and 95% of Ugandan cattle (Felton and Ellis, 1978; Tambi, Maina, Mukhebi and Randolph, 1999). Increasing experience of outbreak control and access to vaccine make such pandemics less likely in the 21st century, but poultry and small ruminant populations still suffer intermittent, local but very serious losses. Spradbrow (1994) cited by ACIAR (1998) suggests that annual outbreaks of Newcastle disease can kill 70-80% of unvaccinated village chickens in most developing countries.

For foot and mouth disease in cattle, mortality may be the least important effect but there is considerable potential for loss of milk and draught power and some fertility loss. It therefore affects productivity in dairy systems or systems dependent on draught power and with a shortage of draught animals. For example, FAO (1997a) analysing the effect of FMD in Thailand found that the economic viability of FMD control in the village buffalo population depended on whether the area had a surplus or a shortage of draught power. In pastoralist systems, mortality of small ruminants may occur through starvation if foot lesions restrict access to grazing. Some strains of FMD cause high mortality in pigs.

Lumpy skin disease also causes high milk losses and disfigurement of hides and skins but is not noted for high mortality. Upton (1990) used a model to assess the effect of viral diseases on Kenyan livestock systems. He demonstrated that the small-scale dairy sector, while containing only 20% of the country's cattle, accounted for almost half of the total value of livestock production, owing to an unsatisfied national demand for milk and a resulting high

price. Productivity under these price conditions was highly sensitive to milk yield and so Lumpy Skin Disease could potentially cause considerable losses in the dairy sector.

Where the population affected is markedly heterogeneous, separate analyses need to be made for each production system. For example, Upton (1990) noted that while lumpy skin disease control was potentially attractive for dairy production systems, the traditional cattle sector was more sensitive to diseases affecting growth rate in young animals and carcass value. FAO (1997a) predicted different impacts to FMD control in dairy and buffalo systems and within buffalo systems, with returns per head to FMD control ranging from US$0.2 to $0.5 per head in village buffaloes and US$9 to $29 per head in smallholder dairy cattle. An assessment made of the potential for FMD control in Bolivia (FAO, 1995) concluded that for the smallholder dairy sector, the reduction in production losses would outweigh the costs of control. In the beef rearing systems, the predicted productivity increase at existing domestic prices would not outweigh the cost of vaccination. As the latter was predominant in the cattle sector at the time, overall the costs of control would be greater than the benefits. Perry, Kalpravidh, Coleman, Horst, McDermott and Randolph (1999) also recommended the use of a production system framework. Modelling the potential impact of FMD control in Thailand, they made separate assessments for dairy, large scale pigs, village pigs and village cattle and buffalo based on differences in productivity effect and vaccination coverage and predicted that the commercial pig sector would capture the majority of the benefit (61% in one predicted scenario without increasing exports).

National productivity increases are related both to individual herd or flock effects and population size. Tambi et al. (1999) estimated increased revenue from "avoided losses" due to rinderpest vaccination under PARC which they reported as ranging from ECU 0.5 to ECU 1.83 per head in the ten countries analysed. Because cattle population sizes were large, national estimates of benefit ranged from ECU 0.6 million to ECU 35.4 million and outweighed the costs of vaccination. Awan (1993) cited by ACIAR (1998) listed village poultry numbers in 17 developing countries and Africa as a whole, and estimated that village chicken flocks, usually the least protected by systematic vaccination against Newcastle disease, made up between 13 and 97% of the national flock, 60% or above in 12 of the 17 countries.

While a disease may have potential to cause considerable losses, its actual effect on productivity relates to current incidence, which may be reduced by an existing control campaign. Clearly, productivity gains in moving from endemic status or high incidence, to provisional freedom, will be very much greater than moving to that point from a state of low incidence. The African rinderpest pandemic of the late 1800s is estimated to have caused 75%-95% mortality among cattle and buffaloes of affected countries (Felton and Ellis, 1978, Tambi *et al*, 1999). A century later, following JP15 and PARC, a study of the effect of rinderpest on pastoralist herds in West Pokot found that while a single outbreak could result in heavy losses requiring several years for herd recovery, no such outbreak had been experienced for a number of years and so current disease impact was negligible in the herds studied (Ngotho, McLeod, Wamwayi and Curry, 1999 and modelling by the authors of unpublished survey data).

The effectiveness of the disease control technology (vaccine) or strategy (sero-surveys and clinical surveillance) influences the impact of a control campaign on production parameters. Not all vaccines are equally protective, or equally easy to administer, or viewed equally

favourably by livestock owners, so that benefits from an intensified vaccination campaign may take time to accrue. One example is the "tail reaction" induced by CBPP vaccine which is unpopular with livestock owners and can reduce attendance levels at vaccination campaigns (pers. comm. members of Ugandan field services; and E. Twinamasiko). Another is the potential for new strains of FMD to appear, against which the employed vaccines do not offer sufficient protection. Disease and sero-surveillance in some countries is hampered by lack of resources or lack of effective communication between non-government and government animal health practitioners so that, for example, a new strain of FMD may take some time to be identified.

Estimating the benefits from control of a single livestock disease can be problematic. Control of one disease may be followed in the rise in incidence of another that has previously been "masked", so that in *ex-ante* analysis there is a tendency to over-estimate the gains that will be achieved by control of a single disease. Additionally, since the costs of delivery (including packaging) are often a major component of the total cost of control, it may be more effective to combine campaigns. Okuthe (1999) studying free-range poultry production in Western Kenya, heard reports that Newcastle Disease caused serious flock losses, but during the two years of his study observed only low incidence and found regular vaccination against ND to be economically marginal. Other diseases such as fowl pox appeared to cause more losses and a combined control programme might have been more cost-effective. A study carried out in Rukwa Region of Tanzania (Tyler, Kapinga, Magembe, Ellis and Hedger, 1980) showed that the effects of FMD were mainly reflected in loss of draught power for ploughing and therefore depended more on the seasonality of the disease than its annual incidence. It was estimated that while FMD eradication alone would be economically marginal and a risky investment, introducing an "animal health package" aimed at general productivity enhancement rather than FMD eradication, appeared to be economically viable.

Factors influencing marketing of livestock and their products

While the relationship between removal of disease constraints and increased productive capacity can easily be demonstrated, this must eventually be translated into sales of animals and their products in order to have an impact on economic development and avoid problems of excessive herd sizes. Decisions to sell livestock appear to be driven by three factors. Price and market accessibility are "pull" factors. The main "push" factor is related to seasonal cash requirement. Any or all may operate in a single production system. Decisions to sell draught power or livestock products are balanced between the farm family's need for the product and their need for cash.

It seems obvious that in intensive systems, the pull factors will be paramount. They can also be very important in traditional systems. An analysis of Somali livestock marketing (Abulahi and Jahnke, 1990) showed a strong relationship between price and sales, with the highest sales occurring when export demand created the highest prices. Jabbar (1995) noted a difference in orientation between small ruminant markets in northern and southern Nigeria. Southern producers were more subsistence oriented and sold animals throughout the year according to cash needs. Northern producers appeared to be more commercially oriented and targeted festival times when prices were higher. Oakeley and Al-Tabini (1996) found both price and cash requirements affecting sales of small ruminants in Jordan. A low but steady sale rate of female lambs year round supplied cash needs, but a high proportion of both lambs and kids were sold for high prices at festival times, and male lambs, commanding the highest

prices, were sold into the export market. Workman, Phiri and Coppock (1998) suggested that cash related sales were the most important in traditional systems in Malawi.

The full effect of price responsiveness by producers will not be attained if the market is inaccessible to them. Nkosi and Kirsten (1993) noted that in South Africa, inequality in market information between producers and consumers posed a constraint to sale of livestock by rural producers, and proposed an improvement in accessibility of information as well as the removal of various other difficulties in marketing channels. In Kenya, in the early 1990s, controls on milk marketing were largely abolished and the main milk purchasing agency, Kenya Co-operative Creameries (KCC), has collapsed. The effect has been to create a dual market for milk. In peri-urban areas, private processors and traders have proliferated and owing to the urban demand for milk, prices to the producer are high. Even in areas where tick and tsetse control are necessary to maintain dairy animals, smallholder dairying is flourishing. In rural areas, on the other hand, transport prices are too high to make sales to urban consumers a viable proposition. Faced with a stagnant market, many producers are choosing not to manage their dairy cattle for high production. This might be expected to confine Upton's (1990) predictions on the benefits of control of FMD or Lumpy Skin disease to the peri-urban dairy production system.

Growth in both the size of the economy and average income will affect demand for livestock products. Edible and wearable livestock products, which are luxury goods compared to crop staples like maize, tend to be income elastic and therefore responsive to growth in general prosperity. Table 3.2 shows estimates of income and price elasticities for dairy products in the Kilimanjaro area. Elasticity indicates the size and direction (negative or positive) of the effect that a change in one variable produces in another variable. A positive income elasticity of demand as shown in the table means that a rise in income can be expected to result in a rise in demand for the product in question, while a negative price elasticity of demand means that a rise in the price of a product can be expected to produce a corresponding fall in demand.

Table 3.2 Elasticities of demand for dairy products in the Kilimanjaro area of Tanzania

	Income elasticity	Price elasticity
Rural	1.14	-0.19
Urban	0.91	-0.32

Source: Ndoe and Wiggins (1996)

Delgado *et al* (1999) compared national incomes and consumption of livestock products worldwide between 1983 and 93 and found that demand for livestock products grew fastest in the developing countries where income grew the most, and outpaced growth in demand for cereals. They predicted that demand for livestock products will continue to grow until at least 2020, mainly in developing countries. Eventually demand will level out because income growth and urbanisation will slow, and there is a finite demand for meat and milk in the diet of an individual. Since demand and supply will not be balanced in every individual country, international trade in livestock products will be essential. Perry *et al* (1999) predicted that FMD control in Thailand would not be viable purely for the domestic market, but only if it enabled pig producers to enter high-value Asian export markets. The Bolivian study previously described (FAO 1995) also predicted that national FMD control would only be viable if beef producers could gain access to higher prices through export. The smallholder dairy sector was quite small and on a national scale the benefits generated by FMD control would not be expected to cover the costs to the remaining, less productive livestock sector.

The control scheme would be economically viable only if higher prices could be generated by expanding into a higher value market, but this could only be developed by adding the cost of an additional "export" project.

Relationship between disease freedom and production costs
The greatest direct effect of disease on production cost is seen with diseases that cause prolonged debilitation and loss of production. In these cases, disease may cause the animal to need more forage and feed, or prolong the period over which it is raised to sale weight, or incur high costs of clinical treatment and care.

FMD, which can cause delays in reaching maturity and reduced fertility, may increase the level of inputs needed to raise animals until they become productive, as well as incurring treatment costs. When it affects draught animals, there may be an additional cost of animal hire or lost crop production. The majority of epidemic diseases cause mortality, often quite rapidly, so that their main effect might be expected to be loss of the animal. However, in certain cases therapy is applied because it is perceived to be effective in increasing survival rates and this incurs both treatment and management costs. For example, a recent survey in Uganda (Twinamasiko, forthcoming PhD thesis) suggested that antibiotic treatment against CBPP was fairly common, although livestock owners were undecided about its impact, and also that caring for sick animals created extra work for women. Even where treatment is not used, a disease outbreak may still cause additional management costs. The survey described by Ngotho *et al* (1999) found that in Turkana and West Pokot an owner whose animals were affected by an infectious disease might be required to graze separately from others, which could impose an extra labour requirement. It was also necessary to alert authorities to the presence of disease, and sometimes the communities would request emergency vaccination, all requiring inputs of time and effort.

If disease freedom reduces mortality and increases the number of animals being raised, total production costs may also increase, even if per head costs are unchanged. Changes to per head input costs might occur if livestock numbers in an area were to rise, resulting in more expensive inputs (import required from a greater distance) or less expensive inputs (economies of scale, or movement of service providers into an area). Alternatively, the removal of disease threat might encourage farmers to invest more in their animals or to intensify, raising both input costs and output values.

Production and clinical treatment costs appear to have been excluded from some analyses, possibly because of lack of data, or possibly because they are considered to be an insignificant proportion of total impact. Exclusion of basic production costs from an expanded herd will have the effect of overvaluing net benefits of disease control, while exclusion of family labour costs saved by removal of disease may under-value the impact of disease control to poorer families and women.

Conclusions about productivity gains from disease control
In all of the studies reviewed, where a List A disease existed within a livestock population productivity gains, often large, could be anticipated from its removal. However, the size and sustainability of productivity gains were highly dependent on the nature of the livestock production system and the market for its products. When these and the cost of eradication are taken into account, it becomes evident that only a limited number of situations would justify

disease eradication purely in order to boost domestic offtake. Examples might include FMD eradication from a peri-urban dairy system with a growing urban demand for milk, participation in a regional eradication programme by a country with only a small export sectors, or eradication of a newly imported disease from a susceptible domestic population. In many situations where export is not the primary aim, planned eradication may not offer any economic advantages over long-term control by strategic vaccination. The factors influencing the costs of achieving and maintaining disease freedom are discussed in the next section.

4 Factors affecting direct costs of disease eradication

Introduction

In moving from a state of presence of disease to one of freedom from disease, changes can be expected in both the magnitude and nature of costs of disease control. This section is concerned with the direct costs of establishing and implementing a disease control programme. With reference to the disease control continuum described in section 2, costs are incurred in moving from one state to another and also in maintaining a state. New costs are added with each stage of control, but at the same time, some costs from the old state may no longer be applicable and their saving is counted as a benefit from the programme.

In predicting cost changes, it is always necessary to bear in mind what would happen without the programme. Could the disease *status quo* be maintained or improved by maintaining the current level of expenditure on control, would an ever-increasing level of expenditure be required, or might the disease in time naturally die out allowing costs to fall? If disease incidence was expected to increase, would this be countered by increased expenditure to control it, or by maintaining expenditure and accepting the costs of reduced productivity? Several factors contribute to the magnitude and nature of costs, and these will now be examined in turn.

The starting and final states of disease control

In section 2 it was suggested that a developing country might conceivably be planning to:
♦ Move from an endemic to a disease free state;
♦ Move from an epidemic to a disease free state;
♦ Control a single outbreak of a disease from which the country was free.

Common sense suggests that the further a country has to go towards disease freedom, the more expensive the process will be. Table 4.1 derived from Table 2.1, identifies some of the direct costs incurred and saved in moving from a state of epidemic disease towards eradication. It shows a progression through vaccination, sero- and clinical surveillance and stamping-out, and finally long-term surveillance costs. Costs build up towards the point of provisional freedom, after which the costs of eradication are replaced by those of maintaining disease freedom. Should freedom from disease contribute to a new or expanded export market, there are likely to be additional infrastructure and legislation costs, but strictly speaking these are export-related and not disease-related and so they will be examined in section 5.

The precise costs of each component of a disease control programme will vary considerably with national circumstances and may be affected by:
♦ the process required and technology available for disease control;
♦ the existing infrastructure and veterinary services capacity;
♦ the livestock production system;
♦ the perceived danger of re-importing disease
Each of these factors will be examined in turn.

Table 4.1 Progress from epidemic, low incidence state to freedom from disease

State of disease	Measures likely to be in place	Cost changes
Epidemic, high incidence	Irregular or ineffective vaccination, limited disease reporting, ineffective movement control	
Epidemic, low incidence	Regular or strategic vaccination, effective disease reporting, effective movement control and quarantine	+ vaccination, extension, staff training, diagnostics; movement control
Declared intention to eradicate.	Strategic vaccination campaigns, stamping out measures, effective disease reporting, effective movement control, measures to prevent re-introduction eg import restrictions, quarantine	+ compensation, slaughter & quarantine, border protection if appropriate - vaccination (if moving from mass to strategic vaccination)
Provisional freedom, without vaccination	Clinical, sero-and abattoir surveillance as appropriate for disease, readiness for stamping out	+ field, lab., training & data management for surveillance; - vaccination , stamping out
Freedom from disease, without vaccination	as above	

Process required and technology available for disease control
Eradication of an epidemic disease may involve quarantine and movement control, vaccination, slaughter and compensation, and disease and infectious agent monitoring, each with their attendant costs. Control strategies for rinderpest, CBPP and FMD will be compared to illustrate the effect of technology and process. In theory, the three diseases can be eradicated in the same way, but in practice the variation in efficacy of their vaccines and diagnostic tests is likely to lead to very different costs. In addition, the geographic extent of control will affect costs and here two practical options are possible. Either a country will be part of a regional initiative, in which case success or failure of control in neighbouring countries will impact on national costs; or, it may establish a disease free zone in the area of the country where disease control is likely to be most effective and produce the greatest benefits.

Rinderpest is being eradicated in Africa by vaccination and surveillance. It is becoming apparent (e.g. van t'Klooster, 2000) that strategic campaigns focussed on vulnerable areas are the most effective for eradication. Since the vaccine confers protection for life, in theory only one vaccination campaign a year should be necessary, focussed on young animals and those previously missed and over time herd immunity should build up to a high level. In practice not all vaccinated animals are marked, and not all animals are presented for vaccination so that sero-survey results can show disappointing levels of protection. Notwithstanding these problems it is at least theoretically possible to use vaccination in a highly cost effective manner as part of a rinderpest eradication campaign. As disease incidence wanes, strategic clinical surveillance becomes increasingly important, combined with movement control in the event of an outbreak. Since this requires good links between farmers, non-government and government animal health practitioners, investment in communication and public relations is likely to be at least as important as investment in government surveillance and stamping out capability.

CBPP control in some countries is limited to vaccination, but the recommended strategy is at least two measures out of quarantine and movement control, vaccination, test and slaughter

and slaughter with compensation (Benkirane, 1998; Domenech, 1995). The vaccine confers protection for one year only and can cause a tail reaction on the first vaccination that may lead to loss of the tail, which makes it unpopular with cattle owners. Since the most likely effect of this is to reduce coverage, it can prolong the period when vaccination is required and reduce the effectiveness of passive disease surveillance if the expectation is that a disease report will be followed by vaccination.

FMD vaccine confers protection for only a short time and depending on challenge may require vaccination two or three times a year. Several sero-types exist so that a multivalent vaccine may be needed, and vigilance over introduced sero-types and strains is necessary. Vaccination over several years combined with strict movement control may be needed to reduce incidence to zero, especially if neighbouring countries represent a risk. Even in theory, it is clear that eradication of FMD is likely to be an expensive process, and in practice it is very difficult to achieve.

Examples of vaccination costs against rinderpest and FMD are shown in Table 4.2.

Table 4.2 Annual costs of vaccination per animal

Item	Cost/head ECU	Vaccine as % of cost (estimate)	Assumptions
Rinderpest vaccination cost per animal under PARC (1) ▪ minimum ▪ median ▪ maximum	▪ 0.27 ▪ 0.47 ▪ 1.71	▪ 33% ▪ 19% ▪ 5%	Vaccine US$ 0.09/dose(2). ECU 1 = US$ 1. Includes capital investment.
Rinderpest vaccination campaign costs, West Pokot, Kenya (3)	0.15 – 0.18	56%	Excludes capital investment
Rinderpest vaccination campaign costs Masaka, Uganda (4)		32% - 46%	Excludes capital investment
Average national rinderpest vaccination cost, Uganda, 1997-8 (5)	0.07		ECU 1 = USh 1,030. Presumed not to include vaccine cost
Hypothetical FMD vaccination costs for EU cattle, 1987 (6)	0.74-2.66		assumed to be per year. ECU 1= US$1
Farm-level FMD vaccination cost, extensive cattle system, 1999 (7)	3.08		per year, for two vaccinations

Sources: (1) Tambi *et al*. (1999), (2) March 2000 cost for non-thermostable vaccine c.i.f Entebbe, provided by PARC co-ordinator Uganda; (3) Ngotho, unpublished survey data 1997; (4) 1997-8 vaccination records, Masaka district and PARC co-ordinator, pers. comm; (5) PARC annual report for Uganda, 1998;(6) Horst *et al*. (1999); (7) Rushton, Thornton and Otte (1999)

It has been suggested (McLeod, 1993; Benkirane, 1998) that to control epidemic disease by vaccination requires that a high percentage (80 or more) of the population be protected, therefore the cost per protected animal is important. Since rinderpest vaccine has been shown to be have high efficacy and to protect for life, costs per protected animal are very close to those per vaccinated animal (in practice, sero-montoring suggests that less than expected protection levels are often achieved). The FMD vaccination costs were estimated at annual dosages assumed to give protection, but the threat of emerging new strains is always present. The range of costs per animal per year is higher than that for rinderpest, because more vaccinations are needed. All costs are presented for the years in which they were estimated,

so the hypothetical EU cost for FMD vaccination might be higher still in today's prices. CBPP vaccination costs per dose should be similar to those for rinderpest if the same number of animals were presented for campaigns, but if distrust of the vaccine kept cattle owners away, costs per animal would be higher.

The per animal costs of sero-monitoring and sero-surveillance can be assumed to be higher than those of vaccination. Sero-monitoring in Uganda during PARC (Twinamasiko, forthcoming PhD thesis) indicated that one serum sample for rinderpest could be collected and tested at a cost of US$ 5, exclusive of the cost of setting up the testing facilities. Where an effective serological test is available e.g. for rinderpest, the number of herds and animals tested will be quite small and so the transport component of cost would be expected to be smaller than for vaccination. The cost of transport to an individual herd could be high because of the need to locate specific, randomly chosen herds, which might be widely scattered, but the total number of site visits would be small. OIE (1997) suggests that a 95% probability of detecting evidence of rinderpest if present in 1% of herds could be achieved with a sample size of approximately 300 herds. Where the available serological test is less accurate, e.g. for CBPP, to detect the presence of the infectious agent at very low prevalence, very large numbers of herds would need to be sampled (OIE 1998), making the process both time consuming and expensive. Abattoir surveillance for lesions could be expected to be more cost-effective than sero-surveillance.

Costs of surveillance for clinical disease are much harder to estimate because establishing an effective surveillance system is a complex process. Van t'Klooster (2000) identified five types of surveillance including "passive disease surveillance" and "active disease search". The former will be affected by government relations with the private sector and community animal health workers. For active disease search, van t'Klooster estimated that the annual cost for the rinderpest surveillance zone bordering southern Sudan, Kenya and Somalia would be Euro 231,500, involving 44 veterinarians for 100 days per year. All forms of disease surveillance must be financed from the recurrent budget.

A possible problem with surveillance costs is their recurrent nature over many years. Although eligible for assistance, they also require national inputs, and the necessary funds must be provided, against competing demands, even after the disease has been eliminated and appears to present a very low risk.

The existing infrastructure and veterinary services capacity
Vaccine production, vaccination, sero-monitoring, disease surveillance and border control all have high establishment costs if they are not already part of a veterinary service's routine operation, or if they need to be expanded to meet the demands of an eradication programme. Where a well-maintained public infrastructure exists, or where there is a flourishing private sector in regular contact with livestock owners, it may be possible to reduce control delivery costs.

Rinderpest vaccination under PARC was accompanied by extensive investment in infrastructure, capital equipment and training for a number of African veterinary services. The appraisal of FMD control in Bolivia (FAO, 1995) recommended establishment of a co-ordination unit, training, an epidemiology unit and an information system, rehabilitation of

border controls and boosting of field and laboratory facilities were all considered necessary prerequisites.

The cost of emergency preparedness is another item, for which published data are not readily available. Twinamasiko (forthcoming PhD thesis) points out that this is a relatively 'new' cost in the planning of CBPP control programmes. Countries that are free from the disease but at risk from neighbours are recommended to have emergency preparedness and contingency plans as a component of their national Natural Disaster Plan to prevent the disease or be able to deal with it in the shortest possible time (FAO 1997b). Costs may include staff training, publicity, employment of experts, surveillance, border control and stock registration.

Where the existing public veterinary service has insufficient capacity to cope with the demands of prolonged vaccination and surveillance, one option may be to contract the private sector to perform some of these functions. Delivery of epidemic disease control is discussed in section 7.

Even when the veterinary service is well equipped to handle vaccination and laboratory testing, it may not be equipped for the information monitoring and analysis required for surveillance and risk assessment. Computer equipment and software are now available and relatively cheap in most capital cities, but the costs of training and retaining data analysts can be high.

Effect of livestock systems on disease control costs

The size of the population obviously has a considerable effect on the total cost of vaccination and surveillance, but the per animal cost, and the relative value of costs to benefits, is more likely to be affected by the nature of the system. The density, remoteness and mobility of the population could be expected to have an impact on costs of vaccination and surveillance, partly because of the transport and other costs involved in reaching livestock owners and partly because of the possibility of achieving low coverage and needing to continue the programme for longer. A remote and scattered population could also incur relatively high costs of establishing an effective surveillance programme, which would depend on co-operation from livestock owners, requiring initial dialogue, training and publicity.

The perceived danger of re-importing disease

Disease freedom, once achieved, has a high political and economic impact and is not readily relinquished. Therefore, even a very low risk of reintroduction may be unacceptable. The case is strengthened if an outbreak could jeopardise an emerging export industry. Two types of strategy may be necessary to minimise it. One involves imposition of SPS measures, inspection and testing of imported livestock products. The other comprises the measures needed to prevent unofficial cross-border movement of livestock and wildlife. High levels of risk arise from:

♦ cross-border movement by unofficial or unguarded routes from neighbouring countries affected by livestock disease. This may be a result of nomadic groups spanning an international border, e.g. the Boran of northern Kenya and Southern Ethiopia, or for purposes of trade, e.g. between Kenya, Uganda and Ethiopia, where the direction of movement is dictated by livestock prices in each country and many animals do not pass through official border posts. In both of the above examples, international co-operation

has been necessary to co-ordinate rinderpest vaccination. Topography has a considerable influence on the severity of risk, for example Chile has a very long border but much of it is blocked by the Andes mountain range with few crossing points and so it has been able to maintain FMD freedom even while the disease was present in neighbouring countries;

♦ the presence of a wildlife population capable of harbouring disease. The considerable cost of Botswana's wildlife fence is incurred because of the need to maintain an FMD free zone between buffalo and cattle. It has also resulted in a high indirect cost to the migrating wildebeest population.

The cost of surveillance and/or border vaccination to prevent reintroduction may turn out to be quite high, particularly for a country implementing a unilateral policy. This cost is inflicted by an infected country on its disease free neighbours, providing a convincing argument for regional disease control policies and regional cost-sharing.

Risk modelling provides one decision support tool that can help to compare costs and benefits of risk reduction strategies. It was used, for example by de Melo (1994) for African swine fever in Portugal, but he points out the very high data requirements. Risk assessment is and will be an important component of decisions about import under the WTO although it may not always require modelling. Few quantified risk models have as yet been presented to WTO for trade dispute purposes.

The unexpected introduction of an epidemic disease after years of freedom can be so disruptive to a country's economy that even very costly measures are justified to stamp it out. Risk reduction may play an important part in determining the eradication strategy to be followed. For example, Townsend, Sigwele and MacDonald (1998) modelled the cost of two control strategies against CBPP following the outbreak in Botswana, one based on slaughter and compensation and the other on vaccination. The vaccination strategy was based on three vaccinations in the first year, one annually thereafter for five years, as well as surveillance, testing and movement control. Although the total cost of eradication by vaccination if all went as planned was estimated to be only 78% of the cost using slaughter and compensation, the total cost in case of failure would be far greater, including permanent loss of the export market.

Conclusions on disease control costs

The costs of an eradication campaign can be considerable if the incidence of disease is high, the veterinary infrastructure is run down or factors exist that increase the risk of re-introduction of disease. Regional disease eradication may reduce the long-term costs for each country involved. Estimates exist for FMD and rinderpest control costs, to the point of provisional disease freedom, but there is less information available on the costs of maintaining disease freedom. This is of particular concern for developing countries since it may be a recurrent cost of many years' duration and, unlike the initial costs of infrastructure and vaccination, may not be eligible for development assistance. For a country attempting disease eradication as part of a policy of export promotion, there will be specific costs associated with demonstrating freedom from disease as well as additional costs related to export. These, and the benefits that may result from export, are explored in the next section.

5 Trade benefits of a policy of disease freedom and costs of developing export markets

Introduction

The success of some countries in improving their animal health status and export performance has encouraged others to undertake disease eradication policies. The changing global trade environment, in particular the development of regional trading blocks or expansion of existing ones, has reduced tariffs for members and increased the number of members and the potential scale of the market. However, in most cases more than a status of disease freedom is required to achieve new benefits from trade. This section will discuss the issues involved in developing an export oriented livestock policy and review some of the potential opportunities, which might stem from disease freedom, as well as the constraints to their achievement,

The benefits which a trade oriented country might hope to realise will be examined using examples from South America, Africa, the EU and the USA. The factors that may hinder the development of export markets in developing countries, or add considerably to its cost, can be divided into issues affecting the supply side and issues affecting international demand. Demand side factors include tariffs and non tariff barriers (NTB's), and export market and export price stability. Supply side factors include the potential to expand or intensify livestock production, and a variety of marketing issues such as the importance of the market, the communications infrastructure, cost effectiveness and competitiveness of the market chain, and the conditions of the wider economic environment.

The benefits from trade realised by countries achieving an internationally recognised disease free status

In 1996, Uruguay was internationally recognised to be free of FMD without vaccination. As a result of Uruguay's changed sanitary status, new markets opened for trade and existing markets were willing to accept a wider range of products. The advantages of this development included:

- the increased value of exports resulting from the increasing quantities of meat exported;
- the possibility of realising better prices in FMD free markets;
- the greater flexibility to adjust and maximise returns/carcass[3]
- the greater potential to attract outside investment within the sector;
- improved export market stability.

These advantages *may* in turn result in changes in the dynamics/structure of production and a greater number of more diversified ancillary support enterprises, which fall under the multiplier effects to be considered in section 6.

Table 5.1 shows the number of animals slaughtered and carcass weight of exports before and after achieving FMD-free status. Although one must be careful about oversimplification,

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[3] In general terms FMD free markets purchase cuts as compared with whole or half carcasses. Different cuts can therefore be sold to the market with the best price.

variability between years, and attributing all of the change to a single factor, the table shows that exports by carcass weight have increased by over 100%, and by 52% in value terms. Slaughter numbers have increased by only 25%, suggesting that beef may have been diverted from the domestic market.

Table 5.1 Animals slaughtered and export carcass weight in Uruguay

	1991	**1995**	**1999**
National cattle herd	8.9 million	9.5 million	10.5 million
Nos. slaughtered	1.3 million	1.5 million	1.7 million
% Offtake	14.6	15.7	16.2
Average carcass weight (kg)	244.3	228.5	236.3
Export (tonnes)	117,313	142,595	243,524
Value of exports in US$	171,810,000	224,784,000	342,292,000

Sources: INAC web page, DI.CO.SE Faena Nacional 1992/93, Annuario Estadistico de Existencias Faena y Exportation 1995, INAC, FAO Production year books

Exports to Brazil, in some years a very important customer, were extremely variable before freedom from FMD (Table 5.2). From 1988 to 1995, beef exports ranged from a minimum 3.2 thousand tonnes to 75.3 thousand tonnes/year. Obviously this can disrupt market stability, causing problems for planning future capacity, production, and profitability. Access to a wider range of markets reduces this instability.

Table 5.2 Beef exports from Uruguay to Brazil 1988 -1995 by weight ('000 tonnes) and value (US$ millions)

	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Weight	14.6	45.3	75.3	16.3	4.05	3.22	22.5	20.9
Value	9.94	40.4	89.3	18.6	4.7	4.8	30.1	33.5

Source: Informes de las Consultorias, Apoyo Institucional al MGAP, 1994 and Annuario Estadistica De Existencias Faena Y Exportacion 1995 INAC

Uruguay already had an established meat trade with a variety of countries prior to the eradication of FMD. These included a country quota to supply 6,500 tonnes of high quality cuts to the EU, a quota with the USA, which due to disease status was not implemented, as well as trade with Israel, the Canaries, Brazil and Chile. Institutionally it had established a parastatal marketing body, which regularly attended international trade shows, was involved in monitoring international market tenders, and was involved in negotiating and tendering with and on behalf of national meat processors.

In parallel, and following the eradication programme, a programme was instituted to improve standards in its abattoirs to ensure they were equipped and certified to EU and USA standards. Laboratories were equipped and staff trained to be able to monitor residues to meet EU and USA requirements. The processes, installations and standards in place for disease surveillance, from production through to point of export, were visited and inspected by veterinary delegations from USA, EU and Japan, amongst others, to verify the equivalence of the systems in place in Uruguay with the importers' requirements.

As more countries in the region become FMD-free, there is pressure for neighbouring countries to achieve the same status. When meat from FMD-free countries is exported to higher value markets, local shortages may create unsatisfied domestic demand for meat,

possibly enabling neighbour country members of regional trade agreements, (e.g. within MERCOSUR) to export more within the region. It is likely that they also will eventually be required to demonstrate disease freedom. However, disease freedom is not the only or the most important prerequisite to livestock trade

Demand side factors constraining international trade

Tariffs and domestic price policy of importing countries

Tariff barriers have the effect of reducing trade by increasing the cost of imports by the value of the tariff, and diverting trade to other markets. Once an important factor in shaping the patterns of international trade in livestock products, this effect is diminishing with recent initiatives towards global trade freedom. International tariffs on meat and meat products have been reduced on average by 32% and on dairy products by 26% (UNCTAD, 1996). In addition to this, a series of measures in the EU, aimed at reducing EU support prices, and reducing the quantity of EU surplus and the value of export restitutions, has reduced the amount of surplus low price animal products on the world market. EU Intervention stocks fell from 713,187 tons in 1991 to 6,068 tons in 1995 (Gasparri, 1996)

The effect of changes in EU domestic policy has been to reduce competition from low price EU surplus on the markets in third countries. The impact of this has been seen e.g. on regional trade in West Africa. Trade of livestock from Burkina Faso to Cote D'Ivoire diminished in the mid 1970's due to drought and increased demand from Nigeria. This source of supply was replaced by imports from Latin American countries, which became major meat suppliers to the area. These in turn were replaced by the cheap subsidised imports from the EU. In 1990-92, EU imports accounted for approximately 60% and 40% of Ghana's and Cote D'Ivoire's market share. However, changes in EU policy, and devaluation of the currency in francophone areas (the CFA) reduced EU trade, which it is judged has been replaced by regional trade in live animals. For example, in Togo, Ghana and Cote D'Ivoire, total EU meat imports fell from 49,700 tons in 1993 to 17,350 tons a year later (Quarles van Ufford & Klasse Bos, 1996).

The impact of tariffs is seen as less serious by developing countries than other issues such as transport and other direct export costs, sanitary and phytosanitary (SPS) requirements and other technical requirements (Henson *et al*., 2000), which are discussed in under non-tariff barriers. One reason for this may be that many countries have implemented GATT requirements to convert quotas into tariffs and for progressive tariff reductions. In other cases many exporting countries have regional trade agreements in place. For example, under the Lomé agreement, EU will import from Africa (Botswana, Zimbabwe, and Namibia) at reduced tariff rates. CARICOM has regional agreements with members for an internal rate of 0% and an external rate of 5% to 20% according to the type of good. Similar agreements are found in other trade groups. Quarles van Ufford and Klasse Bos (1996) state that in Cote d'Ivoire and Burkina Faso "since the end of 1992, practically all import-export taxes relating to cattle have been removed".

Non-tariff barriers to trade

Non-tariff trade barriers include TBT (technical barriers to trade) and SPS (sanitary and phyto sanitary) requirements. Roberts (1997) explains that "the TBT Agreement covers all

technical regulations and conformity assessment procedures, except when these are sanitary and phytosanitary measures as defined by the SPS Agreement. Knowing the objective of a measure is thus critical to the determination whether a measure is subject to the disciplines of the TBT or SPS Agreement. For example a measure which proscribes use of an additive might be adopted to safeguard human health (an SPS measure) or to ensure the compositional integrity of a product (a TBT measure). TBT measures are based on national and international standards and include technical product standards, conformity assessments and other legal requirements (e.g. labelling regulations, packaging material types, weight measures and permitted ingredients)

Unlike the TBT Agreement, the SPS Agreement requires that SPS measures are based on an assessment of risks posed by the import and provide an "appropriate" level of protection i.e. one which does not unjustifiably vary from levels of health or environmental protection provided by other measures. The WTO's definition of an SPS measure is shown in Table 5.3. SPS requirements may be directed at risk reduction, for example for animal health or food safety, or may reflect consumer demand or national government regulation for product quality (hygiene), compatibility or conservation (e.g. maintaining bio-diversity). This may not necessarily require disease freedom, alternatively disease freedom may be a necessary but not sufficient condition. There may be a multitude other costs for compliance with TBT and/or SPS measures.

Table 5.3 Definition of an SPS measure

Any measure applied to protect	From
Human or animal life	Risks arising from additives, contaminants, toxins or disease-causing organisms in their food;
Human life	Plant- or animal-carried diseases (zoonoses)
Animal or plant life	Pests, diseases or disease causing organisms
A country	Damage caused by entry, establishment or spread of pests or diseases

Source: WTO (1996a)

OECD (2000) provided a case study of the types of measures and procedures required to export dairy products to the US and to the EU. The measures cover methods of production, end-product quality, and may apply requirements which are above those applied to domestic production in the exporting country and at times may be greater than those applied by certain producers in the importing country. Both areas have different standards and requirements. The EU directive 92/46/EEC (summarised in Table 5.4) specifies detailed production procedures from animal health to packaging, storing and transportation of end products, and dairy processing plants are required to implement HACCP based systems of quality control. Furthermore, premises which plan to export produce must be licensed and the equivalence of the national certification body needs recognition by the EU. Milk quality standards covering microbiological quality and antibiotic residues are defined and procedures for sampling are prescribed by the Directive. Individual consignments require a sanitary certificate, and exporters must produce the documentary evidence of milk test results and of plant approval. Checks at the border are made of import documents, product identity, and an examination of the products. Physical examinations are made on 50% of products of animal origin. Importers are charged for inspections on a cost recovery basis. Once imported to the EU the product must comply with regulations on product and nutritional labelling and packaging. In some cases national standards apply, in others EU standards are harmonised.

Table 5.4 Standards laid down for production of dairy products in the EU under directive 92/46/EEC

	Process standards	Product standards
Raw milk	Animal health Hygienic conditions of holdings Hygienic conditions in milk collection	Raw milk quality (Plate count, cell count, freezing point, antibiotics/ml)
Dairy products	Approval of processing plants Hygienic conditions of processing plants Hygienic conditions of collection centres Processing methods Hygienic conditions of storage and transportation	End product quality Packaging Health marks

Source: OECD (2000) page 44

SPS measures can effectively impose a ban on imports, or can increase production and marketing costs to non-competitive levels. Costs associated with technical requirements and customs procedures in the EU have been estimated to be equivalent to a tax of 2% of the value of goods shipped (Hoekman, 1998).

The number of non tariff measures has increased hugely over the last 20 years as measured by notifications of new technical measures to the World Trade Organisation (WTO). Notifications to the SPS Committee Secretariat should be made if measures are to be implemented where an international standard does not exist, or if the measure is not the same as the international standard. In 1984 less than 500 notifications per year were received. By 1992 this figure was approximately 1,500 and by 1999 it was in excess of 2,750. Some changes may be unofficial and may bypass the WTO notification system. Keeping abreast of these changes in export requirements can be difficult, especially for developing countries. Fewer low and middle income countries are members of WTO, in these countries communications infrastructure can be poor and slow, and there may be insufficient experience or expertise to assess the implications of developed country SPS and technical requirements.

Even when a country has implemented measures sufficient for export to one trading partner, this still may not ensure access to a global market, since standards and procedures vary in different countries. For example the EU has stricter standards on plate and cell counts than the USA, required sampling methods differ, and raw milk testing and documentation is required by the EU. Production of similar products with different milk quality is separated and the end products have to be stored separately. This obviously adds to the costs requiring more sophisticated types of plant, reducing economies of scale, and increasing the variable costs for example in documentation and testing.

Conformity assessments also differ between countries. The EU emphasises prior approval and requires process monitoring and certification, whilst the USA and many other countries have more intensive border inspection. Whilst the cost of process upgrading and certification can be high, it can reduce the costs of rejections at the border. For example the cost of up-grading hygiene standards in abattoirs in Hungary between 1985 and 1991 is estimated to have amounted to US$41.2 million (Finger and Schuler, 1999). In one US factory the cost of introducing testing and record keeping to comply with EU standards is thought to have cost

the firm US$35,000. However, since then it has had no border rejections. The cost of a border rejection to this firm could be US$5,000 per batch. Rejection costs include additional storage, re-exportation and disposal costs. There is also a risk of more intensive border inspections on future imports. The total cost of inspections is much greater than the direct cost of the inspection. It takes a week before products are inspected, leading to additional storage costs and reduction of product shelf life, which can result in wastage. The procedure is risky as products tested prior to export can undergo change in transit.

Additionally, customer compositional requirements (e.g. thickness of meat cuts, use or prohibition of particular anti-microbials, additives or flavouring or colouring) and specifications in the importing country may be more demanding than or differ from the standard technical requirements.

Developed countries are moving away from product compliance or border inspections towards process based procedures as used increasingly by the EU. To meet these criteria, producing countries will have to undertake very costly modifications to upgrade processes, and will need to make institutional changes throughout the regulatory chain. The costs are likely to be far greater for developing countries, whose production processes can differ greatly from those of developed countries. The costs of implementing such schemes are relatively larger for smaller firms with lower levels of throughput.

For example, increasing traceability is required in UK products. Meat purchased in a supermarket must be traceable from storage to the processors, the meat packer and slaughterhouse, and increasingly to the farm of origin, the specific animal and its parents. These types of changes are only recently being introduced into the EU, but will soon be required of all suppliers. Similarly, permitted residues of antibiotics, heavy metals, and other toxics are set at very low levels. Only the most sophisticated of testing equipment can detect some of these levels. Developing countries face high costs to replace test equipment and retrain staff.

Many of the SPS and TBT measures are defined by developed countries with their own large scale, automated production systems in mind. The movement from product compliance to one of process compliance may cause significant problems for developing countries. Unless already actively involved in trade to developed countries, they are likely to be unaware of the specifications and complexities of the current and changing requirements, and do not possess the expertise, skills and knowledge to make the necessary changes. Moreover, the costs and difficulties of standardising procedures in smallholder production systems, are likely to exclude many small producers from the export market, or force more "industrialised" systems to emerge. These may well be inappropriate for local social and economic needs.

Supply side factors influencing the development of export markets

The market chain: production, processing and distribution
If countries are to succeed in meeting international prices, and take advantage of reduced tariffs and improved disease status to increase trade they must have a competitive market chain. They must be able to produce, process, transport, distribute and market livestock and livestock products at competitive prices and at the time and to the quality demanded. Price competitiveness of livestock products in international markets is a function of domestic

wholesale prices (i.e. at slaughter), as well as other costs in the marketing chain. The importance of marketing costs compared with wholesale prices depends on the level of processing and value added to the final product to be traded. All parts of the supply chain need to operate efficiently. This includes suppliers of inputs to production (feed, grass seed, fencing wire, animal health inputs, credit, extension, financial advice), the production units, marketing, slaughter of animals and finally, processing and shipping.

Livestock productivity is only one factor affecting the wholesale price, and is obviously more important in situations where the market chain is shorter and the product less processed. For example, in West African trade the wholesale price of beef is approximately 73% to 82% of the final cost, or sales price at destination (Quarles Van Ufford and Klasse Bos, 1996). By comparison, imported meat to the USA costs US$99-US$104/cwt (Table 5.5), or approximately US$2.2/kg whilst countries supplying the USA, which include Uruguay, Argentina and New Zealand, have wholesale slaughter prices of approximately US$1.4/kg, so that the wholesale price is approximately 63% or less of the final landed value.

Table 5.5 International livestock prices and livestock product prices in February 2000

Description	Country	Price US$/kg	
Fatstock > 380kg	Uruguay	0.74 LW	1.39 CW
Cow >370kg		0.60 LW	1.23 CW
Steer 280kg	New Zealand		1.40 CW
Feeder cattle 300-400lb	Mexico border	0.74 LW	
500-600lb		0.35 LW	
Average all carcass	S. Africa		1.36 CW
Products		**Price US$/cwt**	
Chuck Roll Frozen Box Beef	US export to	145-130 /cwt	
Strip Loin Frozen Box Beef	Japan	360-405 /cwt	
Chuck Chilled	Australia	187.0 /cwt	
Chuck Frozen	export to	143.7 /cwt	
Chilled Strip Loin	Japan	375.7 /cwt	
95% Bull meat	Import price	104 cwt	
Cow meat	USA	99 cwt	
Chuck		89.5 cwt	

Source: aginfo.aust.com/htms/meatlinx.htm , Ams.usda.gov/lsg/mncs/ls_int.htm

Note: LW live weight, CW carcass weight, short cwt =100lb=45.4kg.

Box beef are specific cuts of beef packaged or boxed

Productivity and scales of production vary considerably in the countries in Table 5.6, yet differences in relative costs, marketing costs and market requirements allow them all to compete in the world beef market.

Table 5.6 Comparative productivity and slaughter parameters of three countries at different intensities of production (1995)

Parameter	Argentina	Australia	Uruguay
National herd (millions)	58.0	24.6	9.5
Number slaughtered	12.5	7.3	1.2
% slaughtered	21.5	29.7	12.6
Cows as a % of slaughter	33	34	31
Age at slaughter (months)	22-30	18-30	40-60

Weight at slaughter (kg)	230-290	180-320	220-260
Age of at first calving (months)	24-30	15-24	36-42

Source: Informes de las Consultorias, Apoyo Institucional al MGAP, 1994

The efficiency of the input supply chain has a considerable impact on the costs of livestock production and the competitiveness of producers. Many middle income countries, and countries with small populations, face relatively high labour costs compared with low income countries, thus encouraging mechanisation and more intensive methods. However, this can require a greater proportion of imported or manufactured inputs such as fencing wire, machine parts, tractors, imported seeds or chemicals. The investment costs can be high for producers in such countries (e.g. Belize and Argentina). Unless more marginal producers can increase their productivity, they are in danger of being forced out of business. Constraints in the availability of foreign exchange can also result in shortages of basic agricultural inputs. High import tariffs can increase the costs of introducing technology and cause delays in adoption. This in turn limits producer ability to improve productivity, intensify or adapt to changing circumstances. Inappropriate policies of sales taxation and high rates of interest can discourage investment, and minimise incentives and farm profits.

Margins in the livestock marketing chain depend on remoteness, infrastructure levels (investment in roads, trucks and refrigeration, communications and processing facilities), competition, throughput and scale economies. A 5% or 10% change in price due to a change in tax or cost of transport can make the difference between being able or unable to sell into a competitive market. Recent liberalisation has reduced tariff barriers and increased the real impact of transport costs. Limao and Venables (1999) estimate that being landlocked, on average, increases transport costs by about 50%, and may reduce trade to 30% of that of a coastal economy.

WTO (1996) points out the importance of an enabling economic policy environment if trade opportunities are to be taken up. Long term changes in national policy, or a temporary package of relief measures and incentives may be required to assist producers, transporters, processors and marketeers, if they are to be able to invest sufficiently to meet international standards and cost competition and so be able to take advantage of a disease free status.

This can be equally true for other members of the market chain, for example owners of abattoirs and meat processors who must modernise to meet export requirements and may be deterred by the high costs of investment. Langsam (1997) illustrates the importance of high throughput in economies of scale, continuous improvement to reduce costs and adoption of cost effective changes such as "boxed beef". He points out that on average, in Argentina, between 60%-70% of the slaughter capacity is used. The 10 largest packers exported 71% of meat exports (by value), and the largest plants kill on average 800 to 1,000 head per day each of 205kg. By comparison in the USA a number of plants kill 4,000 to 5,000 head per day of 300 kg. In the USA the costs are US$ 22 per head slaughtered and US$ 27 per head for cutting. In Argentina these costs are US$ 30 and US$ 34 respectively. Improved productivity and new methods, such as boxed beef, which is less costly to transport and distribute than traditional cuts, are of key importance in improving price competitiveness. Langsam also emphasises the importance of the domestic supermarket which has brought in the use of marketing methods of brands, quality grades, and different levels of processing. This has forced a greater integration between producers, packers and distributors, and increased direct sales by the farmer to the packer.

A government wishing to encourage export growth may need to consider a package of economic incentives to assist all parts of the sector, as well as removing disease constraints and meeting international health requirements. Examples of packages that can be made available include tax relief or exemptions for key inputs, attention to foreign exchange availability or special or subsidised credit packages, and attention to the availability of important inputs in a number of well distributed outlets. This implies that a co-ordinated effort from various departments of the Ministry of Agriculture may be required. To be effective this must include close liaison with the private sector and local authorities.

The benefits of scale economies and increased throughput must be balanced against the market regulation of competition from numerous producers. In Uruguay there are 39 abattoirs in the country, 19 of which are certified to export cattle and or sheep meat (INAC web site). A review of the industry in the late 1990's identified problems of over-capacity, and the cost and efficiency implications in terms of low throughput and higher costs per unit processed. However, the sector is privately operated and the industry was concerned with the potential for collusion and domination that a few buyers and processors might exert.

Typically, the smaller the market and the more isolated it is from outside intervention, the greater the possibility for specific interests to dominate and distort market competition and determine and set prices. One example of this is recorded by Khalifa and Simpson, (1972) in Sudan. Collusive behaviour of traders was able to deprive Leibigs, an international meat packer, of inputs for its new meat canning factory. Market imperfections, namely an oligopoly of the main local buyers, bought surplus animals at high prices, often exporting them at lower prices, to starve the factory, seen as a threat to local buyers. After 5 years running at a loss and with insufficient throughput the company shut down in 1975. Countries with large meat and livestock export markets may not face such problems as international price competition may make up for any lack of domestic market competition.

Competition in the market for live animals and carcasses differs from that in the market for meat (cuts and quarters). Countries with live animal exports have limited outlets and are less able to diversify from market dependence on traditional markets, often in neighbouring countries. For example Saudi Arabia, concerned about Rift Valley fever, prohibited import of sheep from the Horn of Africa for a year, causing very serious problems for the Somali economy, which is dependent on revenue from live animal exports (app 3 million animals, mainly small ruminants had been exported annually through the Somali ports of Berbera and Bossasso). Saudi Arabia is the major importer in the region and it is difficult to find alternative markets for this large number of live animals. Although sudden loss of a market is also a problem for exporters of cuts and quarters, flexibility is greater, the product is more widely marketable, and can be stored if necessary.

The potential to expand herd offtake to meet potential increased demand
It is important that a country interested in developing its export market is able to provide a consistent, regular and dependable supply of animals of given quality. The potential to expand production and offtake at short notice depends partly on whether the national herd is growing, stable or in decline. If the herd is growing or stable, surplus animals may be available for sale if market conditions are suitable, and it may be possible to increase offtake rates without affecting the breeding herd base. This might, for example, apply to pigs in

much of South East Asia, where a growing domestic demand from urban consumers has already stimulated peri-urban pig production. If the national herd is in decline because producers have been downsizing, diversifying or leaving livestock production (e.g. in Belize from 1994 to date, where cattle producers were discouraged by lack of markets), a policy of disease freedom may be seen, politically, as a way of reversing the trend. A recent trend of declining real livestock prices, declining national herd size and declining producer numbers will suggest serious market problems. In making forecasts of potential production for export it is important to remember that measures will be needed to improve confidence and investment in the sector, sufficient to induce producers to reverse their decisions and to re-build their herds. There will be a considerable lag between the policy being implemented and an increase of animals on the market because of the need for producers to retain breeding animals.

It is easier to reverse herd decline in small ruminants, pigs or poultry than in large ruminants because they reproduce faster and, in the case of pigs and poultry, can occupy small spaces. Delgado *et al* (1999) noted that the greatest increase in numbers of livestock 1982-94 was seen in poultry, with an increase of nearly 50% in numbers of birds, notably in China. This was a response to growing demand but presumably also reflected the flexibility of the production system.

WTO (1996) identified a series of aspects required to enhance export performance including technical assistance aimed at strengthening the institutional infrastructure for trade and trade policy, and also initiatives aimed at enhancing the outward orientation of the private sector, to underpin efforts to improve international marketing and business development focusing on product and market development, trade finance, export quality management, export packaging, and training in international purchasing and supply management. These comments apply to livestock sector trade as well as to other sectors.

Main conclusions on export trade

Major changes in international tariffs, and in the domestic agricultural policies of influential trading areas, mean that there is now greater incentive for countries to trade livestock products. However, at the same time the number and complexity of non tariff barriers has been increasing. These can significantly reduce the ability of a developing country to expand into new high value markets, and limit potential benefits of trade from a disease free status. In particular, regulatory practices are changing from border point inspection of products compliance, to more detailed process based procedures requiring regular certification of systems and institutions. The standards set may change frequently, and can differ between trade partners. Participation by developing countries in the process of setting these standards is low, hindered by poor communications, difficulties of translation, and the costs of dedicating personnel both overseas and at home, to be involved in this.

If low and middle income countries wish to expand into new and often higher value markets they may find that this requires a high level of investment in new infrastructure and institutional improvements. Unless throughput is high, the costs of production may not be competitive. It can be difficult to develop suitable products without the experience of a strong developed home market which will also provide the important element of market stability. The home market, though, is only likely to develop with improved national incomes. Finally

and most importantly, to break into new markets a good, strong and well developed market infrastructure with well trained personnel is required.

Disease freedom, therefore, is only one of many requirements to be met before a country can reap the potential benefits of increased sales, improved prices offered through new and high value export markets. However, disease freedom combined with strong surveillance and animal health standards, could provide the opportunity to attract outside investment with complementary skills to make better use of sector production.

6 Indirect effects of disease freedom and increased livestock export

The potential indirect effects of disease freedom identified in Section 2, Table 2.2 were
♦ impact on the livelihoods of the poor
♦ impact on the wider economy
♦ greater security from reduced disease risk
♦ contribution to social functions
♦ prestige of successful control programmes
♦ improved relations with regional neighbours
♦ environmental effects (positive or negative)
♦ higher prices to consumers or change in quality and availability of products
♦ risk of failure

This list comprises a number of significant items that tend to be omitted from quantitative analysis although they may well be discussed within a report. Two examples will be used to illustrate the importance of indirect effects and the problems of drawing them into the analytical framework: contribution to livelihoods of the poor and contribution to the wider economy. While these are the most "economic" of all the factors listed, it will become clear that even these examples pose problems for the analyst and the policy-maker.

Impact on livelihoods of the poor

There are many definitions of the meaning of "livelihood". Here we use that of Miriam-Webster (1998): 'the means of support or subsistence', in other words the source of products for domestic consumption, barter or sale. Within a subsistence or semi-subsistence household, livestock represent both a direct source of consumable and saleable produce, and also a capital asset to be saved towards future production or sale. Freedom from major infectious diseases can make livelihoods more sustainable by removing a threat to a major capital asset and increasing individual animal productivity.

Livelihoods aspects are increasingly being considered and researched by the donor community, in recognition of the fact that increases in national production and food self-sufficiency are not always evenly distributed throughout society. As the wellbeing of most of the population improves, there may be some groups whose welfare is disadvantaged. When considering a change in policy, such as one for disease control or export promotion, it is important to assess how the benefits and costs of the policy will be distributed between the many stakeholders. This was illustrated in section 3 in relating different net benefits or losses to dairy producers and extensive cattle systems resulting from proposed FMD control in Bolivia. However, such analysis can and should be widened to consider consumer groups, processors and exporters, to provide the basis of a discussion on how the disadvantaged groups can be included, and how policies should be modified to ensure that the situations of the disadvantaged are not worsened. This section will concentrate on impacts on the poor livestock owner. Impacts on others employed in the livestock industry are included among the multiplier effects that will be discussed separately.

Contribution of livestock to the livelihoods of the poor

Heffernan (1999) pointed out the difficulty of defining or identifying poor livestock owners and the variety of absolute and relative definitions of poverty in current use. National livestock population data tend to be aggregated by administrative district, species and broad definitions of production system, rather than by wealth category of owner. Data on large ruminants are likely to be more accurate than those for small ruminants, backyard pigs or poultry. Therefore, accurate statistics are not easy to assemble. Nevertheless, published studies, of which only a few are cited here, increasingly point to the positive link between livestock and livelihoods. There is some debate as to whether large ruminant owners should be included in a discussion on poverty. While accepting that large ruminants may not be the property of the truly destitute, they are owned by a great many families who are far from rich, and small herd owners will be included in the following general discussion.

The contribution of livestock to household income was summarised by Delgado *et al*. (1999) from a variety of surveys. In Kenya, Pakistan, the Philippines, Sahelian and Sudanian Senegal and Sudan, livestock contributed a higher percentage to household income of the "lowest" income than the "highest" income percentiles surveyed. In Egypt and Pakistan, livestock contributed more to the incomes of the landless than large landholders. In Brazil, Pakistan, the Philippines and Sri Lanka, they contributed more to the incomes of "malnourished" than "not malnourished" people. While not comparative in a quantitative sense, the figures shown do indicate that in many countries of the developing world, livestock make a significant contribution to the incomes of the poor. Different species contribute in different ways. Fratkin (1991) writing about the Ariaal pastoralists of Kenya noted that small stock contributed up to 40% of a household's cash needs. It is also common in a mixed African smallholding for small ruminants to contribute significantly to cash needs such as medical bills and school fees.

Many farm systems typically thought of as crop systems in fact may obtain a large proportion of their income from livestock. For, example farm systems characterisation in Bolivia in 1982 showed that households in all 6 systems identified obtained 21% or more of their farm income from livestock (Maxwell, 1984). In an area with problems of soil leaching and rapidly decreasing yields, livestock production, in particular pig production, was one of the main alternative means of income diversification both for small mechanised producers and for slash and burn producers. Livestock supplied 78% and 56% of farm income in both these systems.

The contribution of livestock to nutrition has also been reported. Huss-Ashmore and Curry (1992) highlighted the positive contribution of livestock disease control to household nutrition in small mixed farms in Kenya. The point hardly needs elaborating for households in livestock-dependent pastoralist systems. By supplying food, or the means to buy it, livestock have the potential to contribute to the development of healthy and productive humans. A number of authors, e.g. Latham (1997), suggest that consumption of milk and meat by children is beneficial in providing necessary variety in protein and micro-nutrients. The problems stemming from over-consumption of livestock products that plague the developed world are not an issue for the poor. In poor families, effective demand for livestock products may be low and sale may take precedence over household consumption. The contribution of species varies by geographical location and season. McCabe (1987), with two years of recordings from Turkana, found that camels contributed to milk yield

throughout the dry season, goats and sheep contributed at the beginning and mid of each dry season, while cattle made hardly any contribution in the dry seasons.

Livestock also contribute to crop production and there are many references on this subject. Townsend *et al*. (1998) suggested that the value of draught power of cattle in rural Ngamiland, Botswana, represented 75% of the value of their annual contribution to the household. Holden, Ashley and Bazeley (1997) in reviewing the literature on livestock and poverty, identified the role of livestock as a household asset and a buffer against risk. Upton (1990) pointed out that approximately 95% of all cattle, sheep and goats in Kenya were owned by pastoralists, who were dependent on ruminant livestock for their livelihoods – these livestock were, in fact, their chief capital asset. Livestock are also a means of access to common resources and as such offer potential for diversification and risk reduction. Landless families or those with small plots and limited options to expand crop production may be able to house an animal and feed it on cut forage.

As livestock demonstrably represent a significant asset to many poor families, it seems likely that reducing disease risk, morbidity and mortality by epidemic disease control will be beneficial. However, it is unwise to generalise, because production system, method of control and species all affect the final impact of the control policy.

Disease control effects on poor livestock owners

Several reports suggest that epidemic disease control can benefit the poor. One example is the economic viability of FMD control in smallholder cattle systems and village buffaloes in Thailand, demonstrated to be positive by FAO (1997a). The FAO study has interesting implications in that control was more viable in areas of draught power scarcity. It is possible that in these areas, the buffalo owners might be richer, but the hire of buffaloes might be done by poorer farmers, to whom the availability of draught power at critical periods would have a positive impact on rice yields, income and food security. This indirect effect was not included in the analysis, although it was probably reflected in hire values of animals.

One important effect of disease control may be to sustain a fragile system. Frequent disease outbreaks can have the effect of making a system unsustainable. Table 6.1 lists parameters that were used by the authors to model a herd in decline and one in a state of growth. The "growth" herd parameters based mainly on Masaai cattle, were taken from Peeler and Omore (1997). They were run through a dynamic herd model for a sufficiently long period to create a steady-state population (one with a constant population structure and rate of growth). The same starting population was used for the "decline" herd but the annual mortality and reproduction rates were altered as shown in the table. Small changes in average annual fertility and mortality rates made the difference between a growth state and a declining state. This suggests that regular disease outbreaks in a low-productivity system can render it unsustainable, affecting the long-term contribution of livestock to household food supply and household income. If a large ruminant herd is in decline because of disease, it may take several years to reverse the effect.

One effect of disease control may be to remove the burden of caring for sick animals from women. For example, a recent survey among Ugandan pastoralists (Twinamasiko, forthcoming PhD thesis) found that although cattle husbandry is normally the province of men, sick animals including those affected by CBPP came under the care of women.

Livestock disease and the search for animal health care has an important impact on people in remote communities. McLeod and Heffernan (1999) found that one effect of a community animal health worker programme was the number of days of travel saved by making drugs more accessible.

Table 6.1 Productivity parameters from model of declining and growing herds

Productivity parameters		Herd in decline		Growing Herd	
		Female	Male	Female	Male
Mortality	**0 – 1 Years**	0.25	0.25	0.25	0.25
	1 +Years	0.09	0.06	0.06	0.06
Calving rate		0.50		0.65	
Culling breeding animals		0.10	0.10	0.10	0.10
Average annual herd growth			- 0.08		0.04

The preceding examples suggest that epidemic disease control can have favourable effects on vulnerable rural people. However, the design of a control programme has implications for its socio-economic impact. Mullins, Fidzani and Kolyane (1999) analysed the household level effects of cattle depopulation for CBPP stamping-out in Ngamiland, one of the poorer areas of Botswana. It was planned that full compensation would be paid to owners whose animals were slaughtered. A choice was offered between compensation in cash, compensation by restocking or a combination of the two. Many livestock owners chose cash or mixed compensation. The survey found that part of the cash compensation appeared to have been used to meet household expenses and not for restocking, which may result in a long-term depletion of the household asset base.

However carefully planned, a disease control programme may not be equally accessible to all livestock owners. The nomadic and transhumant pastoralists who are most dependent on their livestock are also hardest to reach, with distance, weather and physical security contributing to the chances of excluding them from vaccination campaigns. Muir (1994) surveying herders in Ngorogoro, noted that herders, who were expected to pay for vaccination, would only bring their livestock when there was a disease outbreak in the area. It is not clear from the report whether perceived impact of vaccination against a variety of diseases was less than the cost to individual producers of routine prevention, or whether there was genuine inability to pay. PARC has recognised accessibility as a problem in the eradication of rinderpest from Africa and recent work of PARC and PARCVAC in the Horn of Africa has focussed on provision of vaccine at times and places suitable to the livestock keeper rather than dictated by the government funding cycle.

Many disease control initiatives are and have been cattle-centred. Two of the three diseases for which pathways to freedom have been elaborated (rinderpest and CBPP) affect only cattle and buffaloes (among domestic livestock) while the third (FMD), although it affects a wider range of species, does have important effects on cattle and buffaloes. Regular control programmes for diseases of small ruminants are limited to countries that rely on them for export and control programmes for pig diseases have had limited success outside the commercial sector. Salia (1990) observed that endemic PPR caused occasional very high mortality among small ruminants in northern Ghana, and that access to vaccine was a constraint to preventing the disease, this at a time when serious attention was being given to rinderpest control in cattle.

The lack of clear control strategies for some diseases has implications for the link between disease control and poverty in systems where the poorest livestock owners have few cattle, smaller livestock are kept in low-input backyard systems or in peri-urban rapid-throughput systems, and there is limited contact with animal health professionals. A different approach to disease control will be required with more involvement of the owners in decision making, since the mobility and disposability of animals will make monitoring extremely difficult. This is being recognised in attempts to develop easily delivered vaccine for Newcastle disease, and in pilot projects to involve paraprofessionals in vaccination programmes.

Clearly, disease control policies and programmes must take account of the circumstances of poor livestock owners if they are to achieve full participation and impact.

If the purpose of a disease eradication programme is to promote export then it is important to examine the effects of export-led growth on the poor, which will be the subject of the final part of this discussion.

Export promotion and poverty alleviation

In theory, benefits to poor livestock keepers could come from direct participation in the export market, or from a general increase in national prosperity.

Impact appears to be highly country-specific. For example, in Somalia, which is both export-dependent and livestock-dependent, a reduction in exports to Saudi Arabia for a year following an outbreak of Rift Valley Fever undoubtedly had widespread effects in the national economy. In less export-dependent economies, the difficulties and costs of compliance with process-based SPS regulations, already discussed in section 5, may constitute a potential barrier to participation of smallholder or pastoralist livestock owners in production of animals for export.

Smaller producers may gain a share through trickle down, if local prices increase or a more reliable and constant demand develops. Livestock-related industries, such as leather and hides, leather products and other processing industries are stimulated by export growth and may create increased employment. The impact on poorer members of society is one of the multiplier effects discussed in the next section. Leslie (1997) found that in Northern Ireland where 900 people were employed directly in poultry production, a further 4,600 jobs were provided in the processing of poultry and packing of eggs. This was equivalent to 20% of the people employed in the food and drinks sector. The incomes generated by poultry production and processing also generated demand for goods and services produced in other sectors. However, a general trickle down of prosperity through the economy cannot be assumed. Adelman and Taylor (1990) noted that export-led growth in Mexico from 1970-81, while increasing per capita incomes, had not alleviated nutritional problems among poor people.

From this admittedly patchy evidence a tentative conclusion can be drawn that a programme for disease freedom intended to boost exports may benefit the poorer members of the livestock sector, but only if the sector is already highly export-oriented, or if policies are specifically designed to include them. These might include legislation and practical help to encourage the formation of production and marketing groups, which may be able to benefit from economies of scale, as well as timing and logistics to encourage participation in

vaccination campaigns and carefully thought out compensation policies. They should certainly exclude input subsidies designed to benefit the more industrialised producers.

Employment and other multiplier effects

Development of the livestock sector creates impacts on those not immediately involved in livestock production but who form part of the input and marketing chains, such as the input suppliers and advisers mentioned in section 5, the traders, transporters, slaughterhouse employees, shippers and regulators involved in marketing and export, the wholesalers and retailers of meat, the restaurant and hotel trades, and so on. One effect may be creation of employment. Others, harder to capture, may represent development of wealthier rural communities that can support better health and education and other kinds of growth.

Townsend *et al.* (1998) analysed the impact of the 1995 CBPP outbreak in Botswana and its eradication using a Social Accounting Matrix (SAM). This consists of a database of economic transactions and a model to capture the effects of linkages between commodities, factors, activities and institutions. Their analysis is an interesting case study of the relationship between direct and indirect costs of disease and disease control and worth examining in some detail.

Botswana depends heavily on its livestock sector, which at the time of the study was the third largest exporter after diamonds and tourism. Livestock had the strongest links with other sectors of any sector in the economy, including agriculture. Linkage was expressed by the extent to which a change in output of one sector changed output in the whole economy. For the cattle sector, an increase in output of 1 million Pula was estimated to cause P8.89 million of total output growth. It was also especially important as a source of rural income.

Since Botswana's access to its main export market, the EU, was threatened by the presence of CBPP in the country, the effect of an uncontrolled outbreak was simulated by a 60% reduction in cattle meat and products exports, with production methods and relative prices of goods and services assumed for the purposes of calculation to be unchanged. Accepting the limitations of the assumptions, the broad effect of the outbreak was predicted to be a total loss of approximately 980 million Pula, only P118 million of which (12%) was a direct loss of export value. The effect of the stamping-out programme was also simulated. It involved slaughter of 310,000 cattle, movement restrictions, closure of a meat processing plant, and loss of an estimated 5% of export. When the impact of a 5% loss in export was estimated (excluding the costs of the control programme) the total loss to the economy was estimated at P82 million, including a total loss in household incomes of P9.6 million, of which a disproportionately high amount was borne by rural households. The direct cost of the lost export value was only P9.8 million (12%) while the indirect losses of business and production were P72 million. Taking into account the costs of the stamping-out programme, the full cost of eradication to the economy were estimated to be P852 million, of which P360 million (42%) were stamping-out costs, including compensation, and P491 million the economy-wide losses resulting from loss of export.

Clearly, the figures produced by Townsend *et al.* were influenced by the assumptions in their model, and the figures would vary with the disease and production system, but their report is a useful illustration of the importance that indirect and multiplier effects may have in the impact of disease and disease control. The majority of analyses of disease or disease

eradication impact do not use whole-economy models and thus usually are unable to capture these effects.

7 Financing and compensatory mechanisms to be considered in funding a policy of freedom from disease

The economic theory related to cost recovery for veterinary services has been discussed by a number of authors and developed from the early work of Umali, Feder and De Haan (1992). In this they applied economic theory of private and public goods to consider which services might be privatised. Public goods are those which exhibit low "excludability" (that is, one person cannot easily exclude another from their effects) and low "rivalry" (use by one person does not prohibit use by others). A policy of eradication by this definition creates a public good. Additionally, a policy to eradicate a disease may create "externalities". Externalities or spill-over effects, occur when the actions of one farmer, community or nation affect others, but the cost (or benefit) of the externality is not reflected in the market cost of the action. Stamping-out measures, for example, may incur severe costs even for those whose herds are not infected. They may also have knock on effects, which would not all be included in an assessment of the cost of stamping out. The magnitude of externalities depends on the characteristics of the disease and the existing control policy.

Low excludability, low rivalry and the potential for externalities all make disease eradication a candidate for at least partial public funding, and for public regulation. However, it is important to separate issues of financing and delivery. For example, Holden (1999) suggests that some elements of disease control such as production of vaccine may be suitable for private operation and financing with public subsidy for establishment of facilities. Even if control is financed largely through the public sector, this does not exclude the option of contracting the private sector to deliver it.

The remainder of this section examines three key issues in disease eradication, namely:
- cost sharing
- regulation and delivery
- compensation for those who suffer losses

Allocation of the costs of disease eradication

International cost sharing
One form of cost-sharing is international, justified when the control of disease in one country benefits neighbours by reducing risk and control or surveillance costs, or where economies of scale can be realised in development or supply of disease control technology. Diseases which are strong candidates for regional control are also candidates for international cost sharing. There are a number of cost-sharing models of which three have been identified by the authors and will be described here.

Model No. 1 is the Pan African Rinderpest Campaign (PARC) model. It is strongly regionally co-ordinated and, since many of the countries in PARC have endemic status for other List A diseases, PARC is likely to have a greater impact on regional productivity and regional trade than on wider export potential. Rinderpest control fulfilled all of the above criteria for a regional initiative. If the eventual objective of global eradication is achieved,

there will be benefit to developing countries, harbouring the disease, and to other countries, which have eradicated rinderpest but still regard it as a threat.

A limited number of vaccine types (thermostable and non thermostable) and only one sero-surveillance model were applicable to many sites, making regional co-operation feasible. In addition, since the African rinderpest eradication initiative needed to include a number of the world's poorest countries, development aid funding was justified. In the PARC model, multi-lateral funding has supported a regional disease eradication initiative, which over time has encompassed all infected countries in the region. International contributions have included definitions and regulations (OIE), diagnostics (IAEA; FAO through the World Reference Laboratory, Pirbright), technical guidelines (FAO and IAEA) and vaccine development. Cost of campaigns has been shared between the EU, FAO (TCP programmes, PANVAC), Japan (PANVAC) and participating countries. Tambi *et al* (1999) estimated the EU's contribution to PARC in ten African countries at approximately 30 million ECU or 56% of the total, varying from 42% to 74% in individual countries. This has been divided between regional-level contributions to meetings, scientific developments and training, and contributions to individual participant countries to strengthen their efforts. Disease confirmation and vaccine development are restricted to a very few internationally recognised centres. Planning of the mode of operation has been consultative between countries and concerted technical efforts have also taken place to control outbreaks on international borders.

Model No 2 is illustrated by FMD control in the southern cone of Latin America. This initiative is more loosely co-ordinated than PARC and constitutes a regional agreement between interested countries rather than a concerted regional campaign. It has been more strongly motivated by the desire to increase export potential than local productivity. As with PARC, international support has been provided in development of regulations, diagnostics, training and vaccine. Eradication efforts in individual countries have been supported by international funding, but national stakeholders have also been closely involved in design and funding of programmes, as the next section on national public-private cost-sharing will show.

Model No 3 is exemplified by attempts at Newcastle disease control in Africa and South East Asia. Although a disease of global interest, it has been the subject of a series of national control efforts rather than any regional eradication initiative. Since a number of efforts to date have been with village poultry, the main motivation appears to be improvement of local productivity and rural poverty eradication rather than boosting export. International donors have supported vaccine development for countries wishing to initiate control, for example, funding from the Australian Poultry Research Fund and the International Foundation for Science contributed to the development of the V4 vaccine (thermostable, deliverable via feed), with involvement of Universiti Pertanian Malaysia and the Arthur Webster company in research and development. The research was seen as potentially beneficial to Australia should control of an outbreak ever be required (ACIAR, 1998). Control efforts initiated by individual countries have also been supported by international aid. With the international growth in demand for poultry products, it is possible that export potential may become a stronger motivation for Newcastle disease eradication, but even in this case individual country programmes, focussing on commercial poultry units, are likely to be more appropriate than a regional initiative because of the difficulties of involving keepers of scavenging poultry.

The costs of a regional initiative may initially be very high, and if different countries become fully active at different times then both costs and benefits may be greater for those initiating the programme than for those that join later. However, in the long term, there should be both reduced maintenance costs and sustained disease freedom for all participants. Projects such as PARC and FMD control in the Southern cone of Latin America were able to reduce risks of disease spread by enlarging the area working towards disease freedom. As a result, all countries are working to a common goal, and have active surveillance. The risks of introducing disease from outside have been minimised as the disease free area is increased and good communications and working relations between member countries are developed.

National public-private cost sharing

At the national level there is usually expected to be some cost sharing between the public and private sector for a disease control programme. However, there will be varying costs and benefits from a strategy of cost recovery. James (1998) suggested that an assessment of a cost-recovery strategy should take six main factors into account: sustainability; equity; efficiency of resource allocation; effectiveness of disease control; economic and financial efficiency of cost of recovery. His framework provides a useful checklist for a balanced assessment of the viability of a proposed cost recovery scheme.

Sustainability of funding is an important component of sustaining disease freedom. Where the government animal health budget is small and shrinking, cost recovery may be attractive as a sustainable way to fund an eradication programme, since revenues may be derived from the scheme for as long as it operates. Financing of disease eradication has two distinct components. The actual process of eradication takes place over a defined period, and may include epidemiological studies and planning, intensive vaccination campaigns, or other costs such as those discussed in section 4. This component, which is for a limited duration, can be considered as an investment which will generate future long–term benefits and may attract external donor funding. The second and less clearly defined component is that of maintaining the area disease free, which includes activities such as border control and surveillance, sustained over a long period. These costs may be met from public funds, in which case they are sensitive to budgetary shortfalls or sector reprioritisation. Alternatively, sources of sustainable funding, increased efficiency, cost effectiveness or long-term cost saving may be identified, subject to careful risk assessment. For example in Uruguay, expenditure on publicity and awareness creation, movement control, animal identification and the fact that animals are normally slaughtered in abattoirs has meant that smuggling of animals is more difficult and less lucrative than before. In the EU, harmonisation of disease standards across member countries has meant that animals can be moved freely within the region, thus reducing the cost of inspection. Other alternatives include charging for inspection by licensing, storage and holding charges, or funding of quarantine recurrent costs by those wishing to import animals. Trade agreements may reduce the flexibility to charge for some of these services.

On **equity** grounds, it can be argued that the beneficiaries of a service should be asked to pay for it. However, it can be difficult to estimate the relative costs and benefits to different stakeholders in the livestock sector. In addition, the identification of beneficiaries and the quantification of benefits is not always clearly defined, and may require an analysis of supply and demand and the

estimation of their elasticities[4]. This is also a problem in assessing compensation levels, as will be discussed in the relevant section.

The examples previously given of control of FMD in Thailand and Bolivia, in both of which FMD is currently endemic, demonstrated that different production systems may expect to realise a different net benefit from disease freedom. In Bolivia, producer groups recognised this and suggested that the cost of vaccine should be borne by producers with herds of, perhaps, 5 or more animals, through higher vaccine payment charges. Small producers (with less than 5 animals), who would not be expected to benefit, would not be charged. Godana (1988), assessing the potential impact of two different methods of CBPP control in the marketing and fattening chain for Ethiopian cattle, concluded that neither was cost-effective at the level of the individual production system, but that externalities of the existing level of disease, which included increased risk for other production systems, did justify control measures. Consequently, the fattening system should not be expected to bear much of the cost.

Consumers are stakeholders in disease control, and may benefit through safer food or food of higher quality or in greater quantity, but they are not normally expected to participate directly in financing disease control programmes. They may contribute to the cost of eradication through intermediary incremental costs. For example, as vaccine manufacturers are required to assure their product and are charged for inspection and licensing this cost is passed on through the cost of the vaccine to the producers. The producers in turn must either meet this cost, through more efficient production, or will require higher prices per kg live weight when they sell their animals to wholesalers and the slaughter house. The higher prices are eventually passed onto the consumers since, provided there is no intervention in the market. If there is a general tax on food products, some of the revenue could conceivably be diverted towards disease control.

It is possible to make an assessment of the relative impacts of a disease control programme to consumers and producers. *Ex ante* analysis has been carried out on the livestock research programmes of the Kenya Agricultural Research Institute (KARI) and the International Livestock Research Institute (ILRI) using an economic surplus model, which allocates the expected returns from investment in research into consumer and producer surpluses (Kristjanson, 1997; McLeod, Mulinge, Mbabu and Rushton, 1997). In theory this approach could provide a basis for designing a tariff system to provide funds for livestock disease control.

In terms of **resource allocation**, services provided to users at less than the economic cost may not be used optimally. One possibility is that a subsidised input such as feed or fertiliser may be applied at a higher rate than the economic optimum thus distorting the production process. A more serious problem for animal health services is that a free service may be under-valued and ignored. Therefore, one argument for requiring an element of cost recovery from livestock producers is that they will value the service more highly if they have to pay for it.

Balanced against the issue of resource allocation is that of **campaign effectiveness**. If the charges for vaccination are set too high, this may reduce cover, prolonging the campaign,

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[4] Supply (or demand) elasticity refers to the percentage change in the quantity supplied (or demanded) resulting from a percentage change in the price of the commodity.

reducing its effectiveness and raising its total cost. This is not an insurmountable problem in most systems, it simply requires a very careful herd-level analysis of appropriate charges, and possibly the introduction of differential charges for different production systems or herd sizes. If the level of cost recovery is set appropriately, the government charge for vaccination is likely to be of less importance than other costs such as the time, inconvenience and loss of productivity suffered in assembling animals for vaccination, distrust of the vaccine, or the fear of infection from other diseases when several herds are brought together.

Finally, there is the question of **economic and financial efficiency**. Since cost recovery only transfers costs from taxpayers who provide the bulk of government finance to other stakeholders (producers, or product consumers) and does not directly increase productivity, it does not change the overall economic cost of the resources used in the programme. However, as James (1998) points out, collecting fees from many small-scale livestock owners can be very difficult and expensive, especially where the treatment cannot be withheld from those unable to pay immediately. It may often be the case that the financial cost of collecting the revenue is greater than the revenue itself, meaning that the cost-recovery programme actually has an adverse effect upon the government budget.

Modes of delivery

Even where disease control has a large component of public funding, if the private sector is sufficiently developed it may prove to be an efficient delivery mechanism, contracted to carry out vaccination, surveillance and diagnostic services to government standards and subject to government quality checks. Holden (1999) cites the example of Morocco, where delivery of vaccination services by contracted private suppliers is estimated to have reduced costs by 40% and increased coverage by 27%. On the other hand, analysis of a government animal disease control campaign in Senegal showed that vaccination cost per head came to 110 CFA by government veterinarians and 84 - 97 CFA by private veterinarians, but to make sufficient profit the private vets needed to charge 125 CFA (Ly, Kane, Diop and Akkapo, 1996). Undoubtedly in some cases there will be value in contracting private services, where the infrastructure is such that they can operate efficiently. The use of contractual arrangements may also be a way of establishing a fledgling private sector in places where the client base is insufficient to support animal health providers purely for clinical services. Contract surveillance work is an important component of veterinary incomes in rural Britain.

In many countries where eradication of a disease has occurred the costs of control have for long been incurred by the private sector. Examples include annual FMD vaccination costs in Bolivia, Uruguay and Argentina, and annual CSF vaccination in Chile. These countries have a network of private veterinary services. The change from a policy of control to eradication, has been undertaken with the participation of all stakeholders. The significant role already undertaken by most producers and the private sector veterinarians in annual vaccinations was recognised and built on.

In Uruguay, national, regional and local committees of producers, private sector, government members were formed to plan the eradication strategy and implement it. The first stage was to create an effective vaccination programme. Steps were taken to ensure the quality of the vaccine, and vaccine availability was reduced to two periods of the year to allow greater control over sale and monitoring of coverage. Local veterinarians and committees were used to identify areas of risk and poor vaccine cover. Receipts were used to show that vaccine had been purchased, and those farmers not vaccinating were generally known to local members.

Enforcement costs could therefore be minimised. A compensation fund was developed as described below. The second stage was to withdraw vaccination, prohibit work with the virus for vaccine or investigation purposes, and strengthen border surveillance (Gasparri, 1996).

With growing interest in the role of paraprofessionals in animal health delivery, it is inevitable that they will be considered as candidates for delivery of vaccination and sero-surveillance and become involved in both passive and active disease surveillance. Community animal health workers have been involved in vaccination against epidemic diseases in Sudan and Kenya (Jones, Deemer, Leyland, Mogga and Stem, 1998; Leyland, Akabwai and Mutungi, 1998). In Sudan, they also play an important role in disease surveillance. A pilot scheme has recently been run in Indonesia, through the DFID DELIVERI project, with para-veterinarians working alongside government veterinarians

Compensation

The most obvious case for compensation is for animals slaughtered as part of an eradication programme with a stamping-out policy, and all campaign budgets should include a compensation element. A good compensation policy encourages rapid disease reporting. Without this, the consequential spread of infection may result in control costs much higher than the savings in the compensation policy. This was demonstrated by Machado (1990) who combined results of an exercise identifying producer willingness to report under different circumstances with a model of the spread of African Swine Fever in Brazil. However, it is only possible to move to a position of eradication with compensation for stamping out once control is sufficiently good to have minimised the number of outbreaks to levels which can be compensated.

Farmers however often suffer other uncompensated losses and it is easy to under-estimate their necessary compensation. In the 1997/8 epidemic of CSF in the Netherlands, farmers were compensated for the value of destroyed herds, but not for lost production from idle facilities (Horst, de Vos, Tomassen and Stelwagen, 1999). Mullins *et al* (1999) suggested that even though compensation was paid to Ngamiland farmers for cattle slaughtered to control CBPP, it may not have been sufficient to restore their herds or their livelihoods. If restocking by the government is chosen as an option (this was one of the options offered to the Ngamiland farmers), this can create its own problems of locating and purchasing appropriate animals, potential distortion of local markets and trader livelihood, maintenance costs of animals brought in from distant areas and not adapted to local conditions and diseases.

In Chile, pig farmers can insure their production against disease outbreak (Pinto, 2000). Different levels of premium can be used to reflect the care taken to prevent disease (buying practices, bio-security levels etc). In Sweden, poultry are free of *Salmonella enteriditis.* Producers are insured against introduction of the disease and are required to undertake certain preventive practices. Insurance claims will only be reimbursed if these practices have been undertaken.

In parts of Latin America where there are large and strong producer groups, they have been active in the financing, planning and implementation of disease control programmes. Producer groups have contributed to funds to be used for compensation in the case of outbreaks. Levies of 1% or more are placed on the sale or slaughter of animals, this money

being held in readiness for compensation should the need arise. This has been done in Brazil for pigs, and in Argentina, and Uruguay for cattle. In Uruguay it was agreed as a condition to an Inter American Bank loan to fund FMD and tick borne disease control.

Others in the marketing chain may also suffer losses, as the section on multiplier effects in section 6 suggested, and may not be compensated at all for their losses. In the CSF stamping-out in the Netherlands, Horst *et al*. (1999) suggested that slaughterhouses, traders and feed suppliers within the quarantine zone suffered losses from idle production factors, for which they were not compensated. The only compensation mentioned by Mullins *et al*. (1999) or Townsend *et al.* (1998) in Botswana was to the farmers, yet the multiplier effects were large.

A sudden increase in exports following disease control could result in shortages and higher prices to consumers. This may affect poorer people more as they spend larger proportions of their income on food. Attempts in the past to include disadvantaged groups have been made by examining additional "compensatory" projects targeted specifically at this group. For example, in Bolivia, as well as considering FMD eradication a complementary project to fund community based animal productivity or input sales for small holder producers was also considered.

8 Methods for appraisal and evaluation of disease eradication programmes

The analytical methods used to appraise and evaluate disease control programmes affect the utility of conclusions derived from the assessments. This section will identify the methods most commonly employed and discuss their advantages and limitations.

Strengths and limitation of the most commonly used analytical methods

Similar analytical methods can be used for both appraisal and evaluation. Rushton, Thornton and Otte (1999) described a range of methods available for analysing the economic impact of livestock disease control, at farm/herd level, sector level and national level.

At herd and farm level they identified gross margin analysis and enterprise budgets, break-even analysis, partial budgets, decision analysis, investment appraisal used with dynamic herd models, optimisation, and simulation. These can be used to identify financial impacts on different producer groups, therefore highlighting potential problems in implementation and highlighting effects on priority groups. Farm level analysis also forms a first step toward sector or national level analysis. All of the methods identified are robust and relatively easy to apply and have the potential to be both accurate and informative. The economic techniques are standard ones in farm financial analysis and have been documented in numerous textbooks. Many existing herd and epidemiological models, whether deterministic or stochastic, are based on sound biological premises and their assumptions are well documented. The chief shortcoming of these methods in the present context is likely to be a lack of accurate data, discussed in the next section.

At the sector, national and international levels, Rushton *et al* (1999) identified as appropriate tools: cost-benefit analysis (economic and social); economic surplus models; mathematical programming; simulation and systems analysis. Economic cost-benefit analysis (i.e. using economic prices), increasingly combined with herd and/or epidemiological models, is the most widely used technique. It provides an assessment of the viability of a disease control project from the point of view of the national economy, removing any pricing distortions to evaluate the best use of the nation's resources. In addition to the more conventional appraisal and evaluation of disease control projects, it may also form part of a risk analysis, used for example in designing import legislation. The strength of economic cost-benefit analysis is that it is well understood, highly structured and relatively straightforward to apply. It is, therefore, an accessible method in a wide range of circumstances and is good at estimating direct effects of disease control. Its weaknesses lie in the estimation of values for non-traded items, which rely on the thoroughness and skill of the analysis, and in the potential to exclude indirect effects. Since it is designed to assess economic efficiency, projects benefiting groups which are less economically efficient may be assessed as non-viable, even when socially or politically they would be favoured.

Social cost benefit analysis (described e.g. by Little and Mirrlees, 1974) attempts to make up for the shortcomings of economic CBA by including adjusted discount rates or weightings to adjust for social preferences. By this process it can, for example, be used to give a higher value to projects that serve groups of people targeted for development. Its strength lies in the attempt to be holistic and to take social priorities into account. Its weaknesses lie in the

complexity of the analysis, requiring a very thorough understanding of economic principles, and the difficulty of deriving objective weightings from expert opinion. It was not used in any of the reports reviewed for this paper, the tendency being instead to use investment appraisal of different stakeholders to make an equity assessment.

Economic surplus models apply economic cost-benefit analysis and in addition apportion net benefits between producers and consumers and have been used in prioritising animal health research (e.g. Kristjanson, 1997). They are subject to the same strengths and limitations as any other economic CBA, with an additional analytical burden arising from the need to include price elasticities for the main output commodities and to analyse each output commodity separately.

Whole-economy models, such as the SAM used by Townsend *et al* (1998), allow multiplier effects or changes to the livestock sector to be estimated and have the potential to make a more thorough assessment of equity impacts than any of the previous analytical tools. This may be important in an economy which is highly dependent on livestock. However, they require skilled analysis and economy-wide data so that their utility may be limited in evaluation of livestock disease programmes for developing countries.

The emphasis found in the present review was been primarily economic and quantitative, with farm level analysis and economic cost benefit analysis, combined with herd and epidemiological models, the most widely used tools. There are good reasons for this in the limitations imposed by time, skill and data, and the need for structured and well understood analytical frameworks,. However, re-examination of the factors from Section 2, Table 2.2, suggests the following concerns:

♦ while these tools are well suited to evaluation of the direct productivity benefits, cost savings and additional direct costs associated with disease control, they are less well suited to analysis of indirect and hard to value impacts. This may distort the conclusions from analysis and make the information of less use to policymaker. In particular, impacts on livelihoods of the poor are likely to be imperfectly assessed. Data on their production systems are likely to be less reliable than those for commercial systems. Non-traded and social contributions of livestock to livelihoods are not well understood in many systems, and even where detailed social assessments have been documented these have seldom been translated to economic values. Knock-on effects on the farming system, nutritional and social impacts, and environmental impacts, have tended to be ignored in quantitative analysis. Cost benefit analysis can be used in a way that includes societal welfare and environmental effects, but this is demanding of data and analytical skills, problems that do not appear to have been overcome in even the most comprehensive analyses to date.

♦ Because of imperfect understanding of the logistics and costs discussed in Section 5, an overly optimistic assessment may be made of the potential impact of the export trade on prices and offtake volumes, and an under-assessment of the true costs involved in establishing an export industry. This will apply particularly to low-income countries wishing to establish export to developed or middle-income countries free of various diseases.

♦ Knock-on effects and linkages between livestock production, other parts of the livestock sector and other sectors may be imperfectly assessed.

Exploration of alternative methods of analysis

These concerns suggest a need to examine a wider range of analytical methods and approaches. To take account of equity issues it may be important to include socio-economic, as opposed to purely economic, approaches. These may include attempts to use social CBA, or the use of additional techniques drawn from the social sciences such as the household nutrition and gender frameworks described respectively by Huss–Ashmore and Curry (1992) and Curry, Huss-Ashmore, Perry and Mukhebi (1996), which could contribute to a more complete understanding of the impact of disease control. The sustainable livelihood set of approaches described for example by Ashley and Carney (1999) proposes an holistic framework and the use of a variety of tools, and might provide a suitable starting point, but it has so far only been tested in a small number of planning activities and would need considerable development to be used as a tool for appraisal or evaluation. Combining a wider variety of tools and approaches from the social sciences with conventional quantitative methods does not appear to have been attempted for economic assessment or policy planning in disease eradication. It could help to bridge the gap between easy- and hard-to-value factors, and prevent important factors from being unnecessarily excluded from economic analysis.

To address the problem of trying to make the analysis more holistic, while at the same time admitting an imbalance in data and methods available for different components of impact, the authors experimented with a semi-quantitative scoring and weighting system for assessment of multiple criteria. Such systems have been used in research prioritisation (Norton and Pardey, 1987; KARI, 1991) and have two potential advantages: they can make use of data from a variety of qualitative and quantitative sources; and if applied in a consultative manner they can directly involve a number of stakeholders. A scoring and weighting of benefits of an imaginary eradication programme is shown in Table 8.1.

Table 8.1 Scoring & weighting of an hypothetical eradication programme

Potential benefits	Score	Weight	S x W	Max S x W	Possible sources of score
DIRECT ECONOMIC					
1. Increased productivity	8	2	16	20	herd + epidemiological model; livestock population statistics
2. Increased export potential	6	3	18	30	analysis of export market potential
3. Reduced human medical costs	0	0	0	0	not a zoonotic disease
4. Costs saved from current control programme	7	3	21	30	analysis of current cost
subtotal			55	80	69%
INDIRECT, SOCIAL + POLITICAL					
5. Contrib. to livelihoods of the poor	4	3	12	30	gender analysis; household nutrition + income survey; sectoral model
6. Contrib. to the wider economy	4	1	4	10	sectoral model
7. Higher quality / choice to consumers	4	1	4	10	projection of export effects
8. Psychological impact of reduced risk	6	1	6	10	key informant survey
9. Contribution to social functions	4	1	4	10	key informant survey; published literature
10. Positive environmental effects	2	1	2	10	environmental impact assessment + economic valuation
11. Prestige of successful programme	0	0	0	0	
12. Improved relations with regional neighbours	8	1	8	10	
subtotal			40	90	44%
total			95	170	56%
Score = 1-10 where 10=highest Max. score = 10 x weight		Weight = 1-3 where 3=high priority 0 score and/or weight = not applicable, exclude from analysis			

Each factor representing a potential benefit was assigned a score from 1 (minimal impact) to 10 (very high impact), which could have been derived from expert opinion, or from a variety of sources as suggested in the table. Each factor was also given a weighting of 1 (low priority), 2 (moderate priority) or 3 (high priority), which would relate to national economic and social priorities. In the imaginary example shown here, export potential, cost saving and contribution to livelihoods were assigned a very high priority, reflecting perhaps a need for foreign exchange, a shrinking public sector budget and a growing population. Increased productivity was assigned a moderate priority and all other factors low priority. Two factors were considered irrelevant and assigned a score and weight of zero, effectively excluding them from the analysis. The score for each factor was multiplied by the weighting and the final assessment made by adding up all of the weighted scores.

In this analysis, the figure of 69% of the potential maximum for direct benefits suggested that an economic analysis based on these alone might have shown the proposed disease control strategy to be viable. The indirect factors, including the highly weighted livelihoods contribution scored only 44% of their potential and brought the overall weighted score down to 56%. To complete the analysis, the cost side would be analysed using an equivalent weighting and scoring process. Comparison of benefit and cost percentages would then indicate the merit of the proposal. A high percentage for benefits combined with a low one for costs would suggest the most favourable outcome and a low percentage for benefits combined with a high percentage for costs, the least favourable.

This proposed model is open to a number of criticisms, and when developing a weighting and scoring system it is important to be aware of its limitations. The number of factors chosen influences the impact of each factor because the final score is derived by addition. In this example, there was potential for overlapping of factor 5, contribution to livelihoods, with factors 6, contribution to the wider economy and 1, increased productivity, which might lend unintended weight to these elements of the analysis. A crude weighting system such as the one used here might not provide enough subtlety in distinguishing between the importance of different factors. Because scores for different factors may be drawn from a widely different sources, the assignment of values needs to be carefully thought through. Nevertheless, this example serves to demonstrate that simply assigning values to all elements of an analysis, and discussing their underlying assumptions, has the power to draw out factors that may previously have been hidden or under-valued. While an analytical process of this kind cannot replace the existing methods of economic evaluation, it may be a valuable accompaniment to them, giving greater emphasis to factors that are not easily assessed in cost-benefit analysis.

As yet, there are no firm conclusions on the utility of the different methods mentioned in this section, but it would be a worthwhile piece of research to evaluate them on a disease control case study.

Data limitations

Ex ante appraisal uses existing data on productivity, disease incidence and impact and livestock markets, combined with expectations about disease control effects derived from expert opinion, experiments and information from similar livestock production systems in which disease eradication programmes have already been applied. Results are ideally presented as a range of possible scenarios, taking into account uncertainty and natural

variation in the parameters used. Lack of reliable input data, often a problem in developing countries, may reduce confidence in the predictions or create a very wide range of possible outcomes which are of limited utility for policymakers.

Ex post evaluation, while using similar analytical tools, should ideally use retrospective data on productivity, disease and markets, collected before and during the disease control programme, and should therefore produce accurate estimates on which to base future policy. However, since the necessary data are often unavailable or unreliable, analysis may rely on retrospective data gathered by rapid appraisal after the programme and this, combined with the problem of assessing the contribution of disease control compared with other planned or unplanned influences on livestock systems, can make it very difficult to arrive at an accurate assessment of the benefits and costs of a programme.

The greater the complexity and comprehensiveness of the analytical process, the greater the data demands, and inevitably there is a trade off between the quality and comprehensiveness of data that would be preferred for an analysis and the cost of data collection.

At farm level, reliable data from research and consultancy reports and country databases are available for quite a number of production systems. Inevitably there is a bias towards certain systems, notably cattle and the more commercialised production systems. Lack or unreliability of disease incidence data may be a constraint and may not easily be augmented by cross sectional studies if incidence is low or variable. Estimates of the potential impact of increased trade on prices and offtake volumes may also be an area of uncertainty for a production system and country which does not already have established export markets.

At the sector, national and international levels, in addition to the data needed at farm level there is a need for livestock population statistics, which may be based on very infrequent censuses. Additionally, to estimate economic prices, there is a need to value non-traded goods which in some systems may not be easily done.

Analyses that attempt to include social weightings or to estimate knock on effects have all of the above data demands as well as additional ones specific to the analysis. Data on social preferences, required for social CBA, are not normally available from routine sources and require expert consultation. This need not be a lengthy process but needs to be planned with care to minimise subjectivity. Economic surplus models require data on price elasticities of all traded output commodities analysed. Whole-economy models, such as the SAM, require far more extensive data on the livestock and other sectors, and are only practical to use if such data are already available from official sources.

9 Conclusions and recommendations for research areas

General conclusions on disease freedom and export

This paper has shown that disease freedom can have important and positive impacts on growth of the livestock sector, with corresponding costs depending on a variety of factors related to the current status of disease, the control policy chosen and the available executive capacity. Regional disease control initiatives for control of epidemic disease have been and will continue to be important. A successful disease eradication policy is likely to share planning and financing between private and public stakeholders, and to take advantage of available capacity in the private and paraprofessional sectors for delivery of vaccination and surveillance

It has also shown that the benefits of export trade, once established, are many. However, establishment of an export market is a complex and costly process. As tariff barriers to trade decrease, non-tariff barriers are becoming more demanding, and more difficult and costly for developing countries to overcome. The countries which have been successful to date have been mainly middle income countries. If the establishment of the WTO is truly to create a level playing field in livestock trade, technical and financial assistance will be needed for those developing countries least experienced in trading with the developed world.

Availability of data and published literature

Published literature on the economics of epidemic diseases and their control is surprisingly scarce. FMD appears to have the most comprehensive body of published literature. Rinderpest has recently been examined in ten African countries in a single study. Economic analysis for the other List A diseases appears to be limited to a few publications. Moreover, while attempts are being made to improve the quality and availability of macro-level livestock population data, productivity and incidence data on which to make assessments are limited in many countries, particularly, it seems, for small ruminants and poultry.

Issues for further study

The current review has identified analytical and data gaps and areas of potential interest to policymakers in developing countries. In order to broaden the current knowledge base, the authors believe that the following would be of value. In each case, the study results could be made available both as published material and on a web-site managed, for example, by FAO.

a) Development of information and an analytical framework for the assistance of policymakers

The studies carried out to date have been effective for the assessment of direct benefits and costs of disease freedom, but less so in establishing values for indirect impacts, including those in the wider economy and impacts on disadvantaged sectors of the population. This means that incomplete information is available to livestock policy makers, who require it for prioritising their countries' livestock development efforts and in order to access poverty-focussed development assistance. A wider reference base is needed. At the same time, a methodological review is needed to develop and thoroughly test a multi-criteria framework for socio-economic impact assessment of policies for livestock disease freedom.

The review should be based around a small number of strong and carefully focussed case studies chosen to illustrate key differences in economic and trade development, veterinary services capacity and livestock production system characteristics. Suitable candidates might include a wider socio-economic assessment of PARC, to build on the existing economic assessments, and the socio-economic appraisal of a disease control or eradication programme for small livestock. The framework developed to serve these examples should evaluate practicality, cost and speed of different analytical methods as well as quality and detail of outcome.

b) A review of different institutional approaches to delivery of vaccination and surveillance

Delivery of vaccination and surveillance by a combination of public, private and paraprofessional actors appears to be a valuable approach and has now been attempted in different ways in a number of countries. A strong institutional assessment as well as comparative assessment of the effectiveness and cost-efficiency of existing strategies under different land/animal densities would be valuable to inform livestock policy makers of the lessons learnt.

Case studies should be used to examine the sustainability of existing efforts and identify transferable components of successful systems, and might include, for example:

♦ FMD control in countries of Latin America which have a long history of commercialisation and private sector delivery, and where stakeholders have been involved in the planning and implementation of disease control, by means such as joint committees for implementation and funding of vaccination and surveillance. These could provide valuable lessons for establishing disease control through the private sector.

♦ PARC could be used to provide lessons in the development, cost-effectiveness and sustainability of a large regional initiatives, the factors influencing cost recovery in low income countries, and in the effectiveness and cost-efficiency of paraprofessionals. The socio-economic data available from a more complete analysis of PARC would then be valuable as a basis for assessing the more difficult problem of CBPP control.

♦ A comparison of attempts at ASF and CSF eradication in Chile or Brazil with those in Africa may provide valuable lessons in future design of eradication programmes.

c) Livestock export development advice for low-income countries

The costs and difficulties of developing a livestock sector (either for domestic consumption or export purposes) which can "add value" to its products and is adaptable to potentially rapid market needs will be greatest for low income countries. Areas for further work include:

♦ Institutional and technical analysis of critical points in livestock production, marketing and trade. This would use case studies of key production and marketing systems to identify the most effective means to assist producers and those involved in livestock trade and marketing to cope better with changing markets under conditions of structural adjustment and depreciation.

♦ A review of means to secure existing markets in the face of disease outbreaks

♦ Increased training material on key elements of an assessment of an export market. This should be provided as manuals describing the steps of analysis and information needed, illustrated by case studies.

♦ Development of a centralised information base providing access to a wide range of information on trade and other impacts of disease eradication

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