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PRODUCER INCENTIVES IN LIVESTOCK DISEASE MANAGEMENT:
A SYNTHESIS OF CONCEPTUAL AND EMPIRICAL STUDIES

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Chapter 1 provides an introduction, while Chapter 2 focuses on the economic determinants of farmer decision-making related to animal diseases. Chapter 3 examines non-pecuniary influences on farmer behaviour based on behavioural literature. Chapter 4 discusses outside factors related to farmer disease management, such as collective action, the role of other food chain participants, as well as the factors related to disease in wildlife.

The consultant report by Christopher Wolf from the Michigan State University, Department of Agricultural, Food, and Resource Economics provided input to Chapter 2, Chapter 3 (Section 3.3), and Chapter 4 (Section 4.2 and Section 4.3).

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EXECUTIVE SUMMARY

Management of livestock diseases has become increasingly important given the concentration of livestock production, large volumes of cross-border trade, and international travel. Many diseases pose threats to humans and wildlife. Farmers are the primary decision-makers in livestock disease management. How can government policy align farmer incentives with public objectives related to livestock disease risks? This report examines various aspects of this broad question and provides recommendations for more effective government policy.

Farmers have clear incentives to prevent livestock disease, but as rational entrepreneurs they trade marginal benefits of efforts against the marginal costs. Farmers may also weigh long-term gains from investments in farm biosecurity against returns to investment in other areas. For their decisions on disease management, farmers need to understand the options which depend on disease biology, prevention techniques, tests for infection and their costs, treatments available, and market reactions. The role of policy then is to:

- **Enable farmers to make better informed decisions on disease management**: facilitate their access to necessary knowledge, skills and information, including the information that could be tailored to particular farm situations, as well as decision-support tools.
- **Encourage the development of technologies and services that decrease the costs to prevent and control disease**, so that private decisions on disease management result in lower disease occurrence and lower public costs.
- **Communicate the potential for economies of scope in biosecurity practices**: when farmers understand that certain practices can prevent multiple diseases, farmer incentives to undertake those practices are strengthened.

Uncertainties and risks add complexity as farmers do not have perfect information when making disease management decisions. Risk perception is an important factor: if a farmer believes there is negligible risk that a disease will be contracted on his farm, he will be unlikely to invest in its prevention. There are biases and risk perception issues that must be addressed in order for farm managers to make adequate livestock disease management decisions. Governments should therefore:

- **Ensure sufficient communication and education on animal disease risks**, so that farmers better understand the risks they are facing and their potential effects beyond the farm.
- **Increase government's own understanding of risk awareness and risk preferences of the farming community** as a necessary input into livestock policy design.

Infection on one farm may cause damage to neighbouring farms, affect the whole sector, or even threaten human health. This is the principal rationale for government involvement in animal biosecurity. However, government policies need to address potential information problems, in particular when it comes to very harmful diseases and compensation for related losses. One problem is moral hazard, where a farmer who expects to receive compensation in the event of a disease outbreak has weaker incentives to avoid risk during “peace time”. Another problem is that if a farmer reports a disease, there may be costs incurred related to that reporting, and thus a budget-constrained farmer may be inclined to wait and see without alerting authorities. Compensation schemes for epidemics can address these information problems if they:

- **Induce sufficient effort by farmers to prevent disease**: for example, by shifting part of the risk to farmers through less-than-full compensation of losses, or differentiation of payments according to individual risk profiles; by making payments conditional on farmers exercising certain
biosecurity practices, or implementing farm biosecurity plans, or participating in disease programmes.

- **Provide incentives for early reporting of disease:** for example, by denying compensation where there is a failure to report, or applying no or reduced payment for diseased animals.

Whether livestock holders run commercial production or farm for subsistence or as a hobby, changes their incentives to manage disease. Policies designed for commercial farms will likely be a poor fit for non-commercial animal operations and hobby farms. Incentives may also depend on geographical location which affects vulnerability to disease risk and farmer's ability to free-ride on the biosecurity efforts of others.

- **Allowing flexibility in policy design to account for specific characteristics of farms** may improve the alignment of incentives.

Economic motivation is essential, but only partially explains farmer behaviour. The broader values of farmers and their ability to process information and gain knowledge, their habits and social connections also influence disease management decisions. Policy needs to act along the whole spectrum of these behavioural drivers to engage different notions – psychological, social, as well as economic – to have a more broadly shared response within the farming community. Information services, education, advice and communication activate such drivers. Policy makers need to:

- **Build evidence on behavioural aspects to understand the complexity of drivers behind farmer disease management** and integrate that knowledge into policy design.

- **Encourage communication and social connectivity amongst farmers,** understand who the opinion leaders are and the farmer’s principal sources of reference in order to exploit effective communication pathways to deliver policy.

- **Use gentle nudges,** rather than coercive measures, by appealing to preferred values.

Farmers are at once individuals who make individual choices and members of communities having a common interest. Collective action can provide responses to shared concerns, by generating economies of scale and scope that reduce the private cost of management. Such actions can strengthen compliance with norms, develop and enforce industry standards, and support best practices. It can also improve the division of responsibilities between government and private actors. The role of policy should therefore be to:

- **Provide evidence of the benefits of collective action,** external facilitation, and information through existing networks.

- **Foster institutional and financial soundness of producer institutions** through legislation, and address the “free-rider” problem that constrains collective action.

- **Develop the potential for collective action** in areas such as farmer capacity building, risk insurance, surveillance, and responses to livestock epidemics.

Farmers and agri-food industries co-operate to ensure food quality and verification of production practices to consumers, and to maintain market access. These programmes may provide a framework to foster farm biosecurity practices or create positive spill-overs to prevent disease.

Finally, wildlife as a reservoir and vector of disease complicates management. Farmers might be able to manage sporadic risks through biosecurity actions, but continuous disease pressure from a disease reservoir in local wildlife is not manageable at the farm level. Government agencies charged with disease control in livestock and wildlife populations should co-ordinate and complement their efforts.
CHAPTER 1.

FARMER AND PUBLIC ROLES IN LIVESTOCK DISEASE MANAGEMENT

1. Livestock disease management is increasingly important given the concentration of livestock production, and the large volumes of cross-border trade of agricultural products, international travel, and the recognition that many diseases pose threats to humans and wildlife. The economic impact of infectious animal disease outbreaks can be enormous. The World Organisation for Animal Health (OIE, 2014) estimated that disease could reduce food output by more than 20% worldwide and create significant risks for human health and animal welfare. More than 75% of emerging diseases are classified as zoonotics – animal diseases that can be transmitted to humans, while the nature of some emerging diseases remains uncertain. Livestock epizootics may threaten the economic well-being of farmers and ranchers, safety and viability of the food production system, valuable wildlife resources including endangered species, and human health (Cleaveland et al., 2001; Daszak et al., 2000).

2. Disease is inherent to animal production and a major concern for farmers with livestock. Although significant economic losses from animal diseases would be greater if not for farm management efforts, producers are unlikely to voluntarily take into consideration all the social costs that disease can have on livestock, wildlife and humans. Disease outbreaks in livestock have repercussions up and down the supply chain. For example, trade losses are of prime importance when considering the economic impact of infectious disease. Private farm disease management behaviour may therefore lead to externalities and a rationale for government intervention (Sumner et al., 2005).

3. The OECD framework for management of risk in agriculture helps to clarify the roles of private producers and government in risk management (OECD, 2011). This framework classifies risks depending on their probability of occurrence and economic impact (Figure 1.1). Three layers are distinguished: high frequency – low damage normal risks; low frequency – high damage catastrophic risks; and marketable risks with intermediate levels of frequency and damage. A key idea is that a differentiated policy response is required across these risk layers. “Normal” risks should remain the responsibility of the farmer. “Marketable” risks can potentially be managed through market tools, such as insurance, and require institutions for risk sharing – these can be fully private or with public participation. Catastrophic risks are beyond the capacity of individual farmers to cope with. They generate significant negative externalities, and governments are expected to provide assistance.¹

4. A challenge for policy makers is to establish an optimal pattern of policy intervention by delineating the different risk layers. This delineation is particularly relevant for catastrophic risks because societies will expect government action with respect to such risks. In the area of animal disease, the frontier of catastrophic risk is relatively explicit due to the formal classification of diseases into the most

¹ This framework is an ideal representation of the public and private roles in animal disease management and does not intend to capture the complexity of real-world policy situations. Actual government policy responses may differ from the preferred pattern set out below, reflecting the multitude of influences such as the country’s political settings, policy path dependency, and institutional specificities and constraints. The case studies for Australia, Chile, and Korea illustrate such variations in actual patterns of policy responses to animal disease risks.
and least harmful at the international (the OIE) and national levels. All countries have lists of harmful organisms for animals, with the most harmful groups effectively delimiting the catastrophic risk. Such groups are commonly termed “notifiable” animal diseases. Due to the strong cross-border and externality aspects of disease risks, they are the responsibility of national authorities and are governed by international regulations and/or regional biosecurity systems (e.g. within the European Union). The international dimension of animal disease risks is an additional factor that calls for well-developed formal frameworks to prepare for catastrophic risk management. In all countries, national governments have an explicit responsibility with regard to the most harmful organisms: verification of reports about suspected disease, ensuring the response to disease outbreaks through measures such as culling of animals, depopulation, restrictions on animal movement, and vaccination, as well as providing indemnities to farmers to ensure that disease is reported.

Figure 1.1. Optimal pattern of risk management strategies and policies in livestock disease management

<table>
<thead>
<tr>
<th>Least harmful diseases</th>
<th>Most harmful diseases</th>
<th>Policy instruments and risk management strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Risks</td>
<td>Marketable Risks</td>
<td>Structural programs, emergency responses, trade assistance, indemnities.</td>
</tr>
</tbody>
</table>
| Small damage but frequent | Middle range | - Private insurance  
- Public-private insurance  
- Mutual funds |
| Catastrophic Risks     |                       | - Emergency response frameworks  
- Indemnity payment  
- Assistance for re-stocking |

Risk probability

- On-farm biosecurity practices  
- Diversification  
- Contracting

National biosecurity system infrastructure, services and regulations:  
Risk assessment, communication and information  
Research, education and training

Source: Adapted from OECD, 2011.

5. Some livestock disease risks can be shared through markets and lie within the “marketable” risk layer. Livestock disease insurance exists in EU countries (Germany, the Netherlands, Spain, Czech Republic, Estonia, Finland, Greece and Italy), Turkey, the United States, Chile, and Korea. These insurances can cover highly contagious notifiable diseases as well as others outside that group. While insurance is well developed for many types of business risks, it is more challenging when applied to livestock disease due to generally insufficient biological and epidemiological evidence, which in turn makes it difficult to estimate the scale and probability of a disease event. But governments can create the
general conditions for the development and good operation of risk sharing markets. This could include a subsidy provision where there is a market failure (e.g. public-private insurance schemes or subsidised reinsurance), or some other type of facilitation (e.g. creation of information systems to help the “production” of insurance products).

6. The “normal” risk layer as applied to an animal disease can be associated with diseases that occur frequently but are not highly harmful. Farmers should be able to manage such risks individually by using on-farm biosecurity techniques, diversification of activity, and other means available to farm households. The government’s primary role here should be to support private activity through general economic mechanisms, such as tax, credit or social safety nets. However, some diseases that present a “normal” risk may lead to government programmes, such as those for the eradication of certain endemic diseases.

7. Finally, governments have responsibilities that cross all risk layers. These are “general services” to enable national biosecurity systems to function as a whole, such as building and maintaining appropriate national veterinary systems for the prevention, control, monitoring of diseases, and supporting regulations. Publicly (co)funded research, risk assessment and communication are other cross-cutting functions of governments. Information is a key element in all risk layers, enabling the detection and evaluation of risks and is a crucial input to decisions of all parties involved in risk management, from government to farmers undertaking biosecurity, to private insurance providers and the food industry. Governments can also be expected to participate in providing training and education that support the whole continuum of animal disease management. However, the boundary between public and non-public provision of such services is intrinsically movable and depends on the nature of the activity, which is not static. Thus, there may be a rationale for collective action by industry in these areas, which can often be undertaken in partnership with governments (Chapter 4).

8. Farmers are the primary decision-makers and first-incidence parties with respect to animal disease at all layers of risk featured in this framework. This report continues previous OECD work on agricultural risk management by taking a micro-economic perspective of risk management that focuses on the incentive-compatible livestock disease management policy. The objective is to examine: a) decision-making by individual farmers with respect to livestock disease prevention and control; and b) relate farmer incentives for animal disease prevention and control to public policies.

9. This micro-perspective opens a range of issues in animal disease management policy that fall under the broad problem of the compatibility of private incentives with public objectives. Farmers have obvious incentives to prevent livestock diseases due to their negative effects on farm income, farm asset value, and even the viability of the farm enterprise itself. Farm managers take measures against the introduction of diseases and to mitigate the effects of diseases that are present. A rational profit-maximising farmer will invest in disease prevention up to the point where the marginal private benefit from prevention is equal to marginal costs. From a social optimum perspective, even a fully informed farmer may rationally underinvest in disease prevention. Moreover, farmers do not have perfect information when making their decisions: they are uncertain about the trade-off between marginal benefit (avoided loss) and marginal cost of such investment. The financial consequences associated with farm biosecurity and disease reporting are crucially important. Individual farm disease risk can have negative local externalities and may affect the whole livestock industry and food chain, consumer well-being, and human health. It is difficult to perfectly monitor the actions taken by farms to control a disease. There are risks of moral hazard where the government has a role to regulate and monitor the activities of the different actors in the food value chain (Rushton, 2009). Furthermore, decisions by farmers are in reality more complex than those described by traditional economic rationality. Other values and motivations, farmers’ ability to process information and build knowledge, their habits and social connections are also factors in their decisions. Finally, farmers are part of groups that have a common interest in many areas of livestock disease management, which creates a rationale to act collectively.
This report synthesises the economics, veterinary, and epidemiology literature that examines these aspects. The country experiences are also analysed to identify the policy implications for incentive compatible farm disease management decisions.

The review proceeds as follows. Chapter 2 considers farm decisions from a viewpoint of standard economic rationale. Various aspects related to farmer decisions and policy incentives are considered, including the trade-off between the economic costs and benefits of disease management, the presence of risk, information asymmetries, and farm size. Chapter 3 extends the perspective beyond the conventional economic rationale and introduces a behavioural economics approach to farmer decision making. It examines how broader values, perceptions, “important others”, and social norms influence their decisions. Chapter 4 considers influences and actors beyond the farm, including the role of farmer collective actions and other participants in the food value chain. It also looks at the impact that wildlife reservoirs and vectors may have on farm management decisions. Each of these chapters concludes with the implications for animal disease policy. Although each chapter takes a specific perspective on farmer behaviour, there is certain overlap and interdependency among and across these topics.
REFERENCES


CHAPTER 2.

ECONOMIC DETERMINANTS OF FARMER DECISION-MAKING RELATED TO ANIMAL DISEASE

12. This chapter reviews the major economic and financial issues of management decisions by farmers as they relate to livestock disease. Section 2.1 examines these decisions from the perspective of cost-minimising or profit-maximising with no risk, uncertainty or information issues, which is perhaps most appropriately applied to endemic diseases. Section 2.2 considers the role of risk and uncertainty, while farm incentives in the presence of information asymmetries are the topic of Section 2.3. These two sections provide insights that are the most relevant for epidemic diseases. Section 2.4 examines the role of the farm industry structure and spatial effects in disease management. Section 2.5 discusses the implications for livestock policy.

2.1. Farmer disease management decisions under certainty

- In a basic economic model, farmers prevent and control disease so that expected marginal benefits equal the marginal cost from those activities.
- Expenditures on disease prevention and control have diminishing returns, so it is often not economically optimal to prevent all expected losses from disease.
- Because of the negative externality associated with disease, farmers may under-invest in prevention and control relative to a social optimum.
- Technological improvement and (or) government action to lower prevention and control costs would shift a loss-expenditure frontier, resulting in a private cost-benefit solution with less disease.
- In making decisions on disease management, farmers must be able to understand the options they have related to disease biology and public action on the disease in question.
- One role of policy with regard to farmer profit optimisation is to equip farmers with knowledge and cost-efficient techniques to prevent and control diseases.
- Many biosecurity practices prevent from multiple diseases or vectors to develop; considering these benefits across diseases can lead to greater efforts and investment in biosecurity and surveillance.
- Dynamic relationships between producer choices and disease status may make complete disease eradication a sub-optimal strategy.

13. Farming as a business enterprise drives food production in OECD countries. The financial aspects of farming include profitability (generating returns), solvency (possessing adequate equity), and liquidity (ability to pay bills as they are due). Animal diseases may decrease profits through market and morbidity losses. Mortality losses of livestock directly affect farm wealth. Lost profitability and wealth can threaten farm financial viability.

14. Livestock producers continually face decisions with respect to diseases. These management decisions are either ex ante to the occurrence of disease, and include prevention measures in susceptible herds, or they are ex post and regard control measures when diseases occur (Chi et al., 2002). The probability of infection from a given disease depends on farm practices (prevention) as well as the prevalence rate in host populations (livestock, wildlife, and humans) in the relevant area.
15. The private benefits of livestock disease prevention and control include higher production as morbidity is reduced, lower mortality or less early culling, and avoided future control costs. With respect to prevention, farmers can allocate operating resources or investments to biosecurity programmes. These programmes often involve limiting livestock contact (e.g. via quarantines and controlling the movement of new livestock), as well as preventing other potential vectors of disease from entering the farm (e.g. wildlife or human contact). In addition, farm biosecurity may involve testing livestock and feed prior to purchase, strict sanitation regarding the possible ways that disease may be introduced on the farm, including via people and vehicles entering the farm, separating new-borns from infected dams, and protecting feed supplies from wildlife. Farmers control disease by monitoring and testing their own herd and reporting relevant infections to authorities. Treating disease is possible in some cases and may involve medicines as well as veterinary visits. In situations where recovery from the disease is impossible or treatment expenses are economically prohibitive, depopulation and culling of animals may be the only recourse. Early involuntary culling has long-term implications for livestock capital stock and significant costs related to animal replacement.

16. The motivations of farmers to control disease are to avoid livestock mortality and related replacement expenses, livestock morbidity and related production losses, increased veterinary expenses, and potential losses from business interruption when government programmes mandate the slaughter of entire herds or flocks. Farmers' motivations to shirk disease control include time, labour, management, and capital constraints.

The basic economic model of farmer decision-making related to disease management

17. McInerney et al. (1992) developed a decision model for disease management where the farmer trades off the costs to control disease and avoided losses (Figure 2.1). An output loss implies a benefit that is taken away (e.g. production loss) or an unrealised potential benefit. Losses are reductions on the output side of a process due to livestock morbidity or mortality. By contrast, some economic effects are expenditures (E). They represent resources that have to be allocated either to moderate the impact after a disease occurs or to avoid disease. The negative economic effects of a disease appear in one or other form, so that the total economic effects of a disease occurrence (C) are: \( C = L + E \). L(E) is a loss-expenditure frontier that shows the relationship between control costs and avoided losses. If no action is taken to control disease, the losses would equal (E) on the vertical axis. If expenditure of effort is incurred for control of disease (points M, K and A), this will reduce disease losses (to \( L_M, L_K \) or \( L_A \)).

18. This framework employs two key assumptions. First, there is a trade-off between output losses and control expenditures – all other things being equal, higher disease control expenditures result in lower losses. Second, control expenditures have diminishing returns – as they increase it becomes more expensive to reduce losses.\(^2\) One implication of diminishing returns is that economic cost of disease management (C) has optimal level, i.e. the point beyond which adding an additional unit of expenditure would reduce loss by less than a unit.\(^3\) The implication is that it will not generally be economically rational

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\(^2\) The trade-off between losses and expenditures is shown by \( L_A < L_M \) with \( E_A > E_M \) and *vice versa*. Curve L(E) slopes downward at a diminishing rate, i.e. bringing losses down from \( L_M \) to \( L_K \) would require smaller additional expenditures than reducing them by the same amount from \( L_K \) to \( L_A \), i.e. \( E_K - E_M < E_A - E_M \). This is the standard economic assumption of diminishing returns. Concerning this assumption, McInerney et al. (1992) state that it has a powerful logical basis in economics and that the nature abounds in processes which display diminishing returns, so there is no reason to suppose this is different in the case of animal disease.

\(^3\) This optimum loss-expenditure combination is reached at the point when an additional unit of control cost is equated to the additional unit of reduced loss. This is the “marginal cost” criterion in economics.
to avoid all expected losses from disease (Dijkhuizen, et al., 1995). As drawn, the frontier, beyond point A runs parallel to the horizontal axis indicating in this example that some positive level of disease loss ($L$) is unavoidable. This assumption is justified when diseases are unavoidably present in reservoirs or adjacent to the livestock operations. A new technology that lowers the control cost, public management programmes that reduce the density of disease, or government programmes offsetting the losses with indemnity payments would shift the frontier down and result in a situation with less disease.

**Figure 2.1. Farm trade-off between disease loss and control expenditures**

![Graph showing the trade-off between disease loss and control expenditures.](image)

*Source: Adapted from McInerney et al., 1992.*

19. Chi et al. (2002) built on ideas of McInerney et al. (1992) and put them into a more formal economic framework of damage control inputs. The authors state that the optimal level of disease control, and the consequent disease level, cannot be determined using the same framework as for conventional inputs that tend to increase output levels with higher use. Instead, following Lichtenstein and Zilberman (1986), they consider disease control to be a damage control input because it acts to prevent output from falling, rather than to further enhance production. The farm decision is thus posited as maximising profits by choosing preventive and control measures as inputs in addition to standard production enhancing inputs. They found the standard marginal benefit equals marginal cost for standard inputs, prevention inputs and control inputs.

20. Producers are concerned about the direct cost of the disease. They will minimise the costs of prevention and curative activities insofar as they pay those costs (i.e. costs are not off-set by government indemnity or disaster payments). These considerations are irrelevant if the producer choice is limited because government programmes mandate a response. This is true in the case of several livestock-borne diseases that pose a direct human health threat or cause large economic damages to the livestock sector or related industries.

Graphically, the economically optimal cost of disease management ($C$) corresponds to the point M on Figure 2.1 where the 45° line is tangent to the $L(E)$ frontier.
21. The cost-benefit approach also leads to a distinction between the private and social costs of disease management and the existence of disease externalities. Beyond private impacts, animal disease has economic impacts across the wider economic system. This concerns food safety, human health, sanitary reputation to maintain access to export market, and broad spill-overs of disease on business sectors along the food chain. The private cost (C) for farmers does not reflect the full social cost of disease management, implying that private producers do not have inherent incentives to invest in disease management up to the “socially optimal” level which takes into account all externalities of animal disease. The frontier of the social economic cost of disease managements is thus always above the private frontier L(E). The existence of animal disease externalities is the principal economic justification for public investment in animal biosecurity. Furthermore, individual producers may have many objectives when they make investment decisions. Kristensen and Enevoldsen (2008), for example, found that the level of investment in herd health management on Danish dairy farms would never be at the socially optimal level because returns to investment were often better in other areas, and short-term gains were valued more than possible larger long-term gains, i.e. the time value of money and certain pay-off.

22. To make decisions regarding disease management producers must understand the options they have relative to the disease in question. These options depend on disease biology, prevention techniques, tests for infection and their costs, treatments available, market reactions, as well as industry and government programmes and policies. Disease biology includes transmission modes and rates, disease evolution (e.g. length of time to infectious period), production losses associated with the disease, and mortality rate (where applicable). Preventing the spread of disease often involves movement restrictions and quarantines. Treatment may include medicines and services to assist recovery. Market reaction involves the change in price for infected livestock and livestock products (which may result in a price of zero). Industry and government programmes may include indemnity payments, quarantines, test and cull programmes, or required depopulation and resulting business interruption losses.

Biosecurity economies of scope and preventive spill-overs

23. It is common practice in the veterinary literature to consider on-farm management on a disease-by-disease basis, in large part because observational or case-control studies are designed to identify management “risk factors” for infection. If each disease is considered as an independent event (i.e. by making biosecurity and health management decisions on a disease-by-disease basis), the full scope of disease management actions are ignored. A preventive spill-over exists whenever a health management or biosecurity practice yields preventive returns for more than one disease, such as control measures that reduce the probability of disease transmission to a facility. For example, improving sanitation practices of poultry production may help prevent both new castle disease and avian influenza.

24. From an economic standpoint, estimations of disease control functions should take into account the potential for disease management practices to affect the prevalence of multiple diseases, so that resources can be allocated efficiently. Preventive spill-overs may be thought of as either multi-product outputs of individual management practices or as input externalities, which may be either positive or negative. If management practices are viewed as livestock production inputs, then the notion of preventive spill-overs suggests that biosecurity practices are non-allocable factors in the sense that shares of the input cannot be allocated to the prevention of a specific disease or set of diseases and not to others.

Dynamic feedbacks in disease management

25. The economic analysis also emphasises the interactions between human decisions and epidemiologic state, that is, the feedback between disease management decisions and the evolution of the epidemic. Horan et al. (2010) describe multiple connections of epidemiology with human behaviour: culling rates are determined by a chosen combination of testing and removal efforts, the sub-populations
under quarantine are also the result of human choice, domestic animal movements depend on economic activities, such as trade, while densities of wild populations as vectors of disease can also be influenced by wildlife programmes. All these choices appear in epidemiological models as parameters. A further idea is that human choices change as the disease situation evolves. Thus, as herd densities decrease through a density-reducing strategy, producers have fewer private incentives to invest in tests and slaughter of infected animals because of diminishing returns to these investments.

26. A consideration of dynamic feedbacks in the biosecurity system changes the perspective on optimal disease management strategies. Epidemiological strategies that abstract from these feedbacks generally assume that: (a) the objective is disease eradication, with management metrics based on the disease-free equilibrium, and (b) human behaviours are an external force on the disease dynamics. Alternatively, the bioeconomics approach joins human behaviours and disease biology in one system where human behaviours are endogenous to the analysis. The bioeconomic approach does not impose complete disease eradication as an explicit objective – it uses economic criteria in conjunction with epidemiological modeling to determine the economically optimal level of disease control (Horan et al., 2010). With this approach eradication is only optimal if its marginal benefit outweighs the cost. Fenichel et al. (2010) find that the bioeconomic approach may or may not optimally result in eradication but that in all cases it yields a larger net present value than does the conventional disease ecology approach.

2.2. Risk, uncertainty, and farm decisions

- Farmer decisions depend on their identification of risk; if farmers incorrectly identify risk, they may not act.
- A policy implication is to facilitate risk identification by farmers; better information on the presence, spread and consequences of disease can facilitate farmer decisions.
- Risk-averse farmers are likely to make greater efforts to reduce the probability of disease, leading to lower disease occurrence.
- Disease outbreak changes risk perception, with farmer responses during an outbreak likely being different from their responses during peacetime.
- Insurance can shift the composition of investments towards riskier production activities.

27. The discussion so far has left aside risk or uncertainty as part of producer livestock disease decisions. This section considers decision-making under risk and uncertainty which most appropriately applies to epidemic diseases. Animal diseases, and in particular epidemics which require a government response, are major sources of risk for farmers. Meuwissen et al. (2001) found that epidemic disease which is viewed as the second largest source of risk is essentially linked to price risk. In that study, non-epidemics ranked 17 out of 22 sources of risk. Baltussen et al. (2006) show that epidemic disease risks are perceived as highly important concerns amongst Dutch dairy, pig and poultry farmers, both in terms of their probability and possible effects. Non-epidemic diseases were typically perceived as less important.

Risks identification and farm risk management strategies

28. The types of risk faced by an enterprise are important in considering farmer perceptions and decisions. Mikes et al. (2015) define the types of risk as preventable, strategy execution, or external risks. Preventable risks are those that arise from routine operations. Preventable risks should be a focus of routine management and should not be tolerated; one might consider, for example, diseases that can be prevented by vaccination or common animal husbandry practices. Strategy execution risks are those that firms take in order to achieve higher returns; in farming, this might include the risk of infection from bringing in outside livestock during herd expansion. Firm managers can identify and influence the likelihood and impact of strategy execution risks, but some residual risk will remain. External risks arise from events the farm
manager cannot influence. An example might be a local outbreak of foot-and-mouth disease due to border protection failure. Farm managers should consider responses and resiliency to external risks. Delineating risks in this way is useful with respect to farm animal disease management decisions because these decisions are primarily concerned with preventable risks. However, this framework suggests that farm managers should consider the potential for disease derived from strategy execution activities. If farmers incorrectly assume a particular disease is external, they will ignore it. Thus, one important job governments can facilitate is risk identification.

29. As a risk management exercise, animal disease management requires assessing the likelihood of disease. For locally endemic diseases, this is part of standard herd health management. For exotic infectious disease, this assessment will be quite difficult. According to Hardaker et al. (1997), there are many potential psychological pitfalls in making probability judgements. Other pitfalls include avoiding uncertainty instead of managing the situation and incorrectly relating events and likelihoods to past experiences and irrelevant events perceived to be similar. To overcome these pitfalls in assessing probabilities for risky decisions, Hardaker et al. (1997) advocated facilitating subjective probabilities for decision-making by using experts, experiments, past experience, and simulation. All these sources can be used to derive subjective probabilities of exotic disease occurrence on farms. This information could serve as the foundation for farm disease risk information programmes.

30. At the farm level, risk management strategies can be categorised as collecting information, avoiding risk, selecting less risky practices, diversification, flexibility, and insurance. All these strategies may have relevance to farm animal disease management and information plays a key role as it can help reduce the dispersion of the subjective probability distribution. Information can shift the location of the distribution. Thus, better information on the presence, spread and consequences of disease can facilitate better decisions. Avoiding or reducing exposure to risks includes such potential actions as postponing a decision until more information is available, implementing safety standards until more is known, or taking a decision that is close to the status quo. With respect to farm disease, this might include taking preventive measures prior to confirmation of outbreaks in the area. Selecting less risky practices, such as maintaining a closed herd, would minimise risks of some diseases. Diversification might have less direct relevance to farm animal disease, but one might imagine that diversified farms might be better equipped to deal with consequential losses. Finally, flexibility refers to maintaining options that allow for more responses to risky situations.

Risk aversion and uncertainty

31. All producers are likely to make certain investments in disease prevention, but their management decisions under risk depend on risk aversion. Rat-Aspert and Fourichon (2010), using a decision-epidemiologic model, found that more risk-averse producers make greater efforts to prevent disease to reduce the probability of such an event, which in turn would lead to lower disease occurrence. Niemi and Heikkila (2011) concluded that a risk-averse producer may be willing to pay advance premiums to reduce unpredictability of disease losses, whereas a risk-neutral producer does not pay attention to the volatility of losses. Risk-neutral producers prefer a financing scheme which collects funds only after an outbreak has occurred, whereas risk-averse producers prefer a scheme which collects premiums both before and after an outbreak.

32. While it is common to use the concepts of risk and uncertainty interchangeably, economics differentiates between the two. Risk refers to situations where potential states or outcomes are known, along with the probability of their occurring. Uncertainty may be defined as not knowing or having no reasonable approximation of either the outcomes or the probabilities of the event occurring (Hardaker et al, 1997; Mahul and Gohin, 1999). Uncertainty leads to option value and information value literature. Bernanke (1980) notes that uncertainty retards investment. Greiner et al. (2009) analysed the adoption of
best conservation practices by farmers and found that option values for unknown events prevented strongly financially motivated farmers from adopting new practices in the absence of external incentives. In the context of livestock disease management where farmers decide whether to invest in biosecurity, the cost of deferred biosecurity is lost output, while the gain is additional information. Bloom (2014) found that uncertainty increases in times of economic downturns. Does risk perception increase during disease outbreak? It seems likely. It is therefore worth considering farmer responses during an outbreak as being different than in “peacetime” with respect to a specific disease.

33. Elbakidze and McCarl (2006) compared pre-event preparedness versus post-event response and asked when it would be economical to protect from infection. Specifically, they highlighted the trade-off between certain pre-event (ex ante) expenses for probabilistic events and expenses after (ex post) an infectious disease event. For these diseases the probabilities are generally unknown and subject to lack of information and context. They found that the optimal level of investment in pre-event preparedness would increase as an event probability and severity becomes larger and post-event response strategy is less effective and more costly. For potentially low probability of infection, marginal benefits of ex ante biosecurity might be quite small. Also, if there are neighbouring farm operations which are not investing in biosecurity or there are wildlife reservoirs nearby, the farmer may believe (justifiably) that their efforts are unlikely to have a significant impact. Thus, one expects farmers to under-invest in prevention of these diseases.

34. For insurance related to livestock disease – either explicit insurance such as business interruption or implicit insurance such as ad hoc compensation schemes—an important issue is the extent to which it can influence farm behaviour. A particular concern is that the presence of insurance may encourage riskier behaviour from farm managers relative to disease management. A risk-averse farmer will reduce the expected financial impact of a loss by reducing the severity of any loss that occurs (self-insurance) and by reducing the probability of loss occurrence (self-protection). Ehrlich and Becker (1972) showed that self-insurance is always a substitute for market insurance, whereas self-protection and market insurance might be complements. OECD (2011) indicates that crop insurance produces a crowding-out effect on production diversification as an on-farm risk management strategy and that farm income has greater variability with a higher share of insured land.

2.3. Farm incentives and information asymmetries

- Information asymmetries exist with respect to farmer actions and risk types.
- Higher indemnities can strengthen the incentive to report, but weaken the incentive to prevent disease.
- There is a lack of empirical studies to verify the predictions from analytical models in this area, but some empirical evidence finds that disease reporting is “price-elastic” in relation to the indemnity received.
- To align incentives with policy goals, any indemnity plan should shift part of the risk to farmers.
- Insurance for interruptions in farm business may increase incentives to report, but is difficult to put into place.

Animal disease management as a principal-agent contract with hidden information

35. There is a relationship between governments and farmers or livestock industries in preventing and controlling livestock disease. Governments control borders, negotiate trade agreements, and establish eradication and surveillance programmes. Farmers are responsible for their own herd health management and must disclose reportable diseases. For many contagious diseases, particularly those with human health or trade implications, the government will purchase condemned animals as a form of indemnity. Such compensation can also involve further assistance to clean and disinfect farms, or even payments for consequential losses (e.g. business interruption).
36. These relationships between farmers and government might be thought of in terms of a contract (Gramig et al., 2009; Hennessy and Wolf, 2015). Theoretically, this contract foresees that the farmer will make an adequate effort to prevent disease or – failing that – report the presence of disease, while the government will make efforts to prevent the introduction of the disease, provide surveillance at and within country borders, and organise responses should a disease occur.

37. A principal-agent framework applied to government-paid indemnities to farmers for diseased livestock can be set up as a government principal wishing to minimise expected disease costs, subject to getting farmers to invest appropriate efforts into disease prevention and control. There are many instances where farmers might have relevant information about disease in his herd, as well as information about their efforts to prevent disease (the likelihood of disease) that are unknown to the government. This can create two types of information problems: moral hazard and adverse selection.

38. Moral hazard refers to a situation where the agent(s) can undertake actions that affect the value of the transaction with the principal but that the principal cannot monitor or enforce perfectly. If the agent can put in less effort without detection – and less effort decreases the likelihood of a desirable outcome – then one would expect shirking on the part of the agent. That is, if others are willing to pay for mistakes you make, then you are less likely to consider the negative repercussions of your behaviour. The solution might be to make the potential farm loss under disease – that part which is not covered by indemnities – significant enough so that the farmer has an incentive to put time and effort into an effective biosecurity action.

39. Adverse selection applies to situations where the agent has information pertaining to a relevant transaction but which is unknown to the principal. With respect to insurance, this may lead to customers who are at a relatively high risk vis-à-vis others to be relatively well insured (Baltussen et al., 2006). Adverse selection leads to the crowding out of low-risk customers by those who are at high risk, leading to a potential failure of the insurance market. The solution to adverse selection in insurance has been to structure the set of contracts available so that the customers’ choice of contract terms signals their risk profile (i.e. high or low risk).

40. Adverse selection may also occur with respect to reporting disease and epidemic indemnification. If the farmer reports a disease, he will incur costs related to that reporting. If the farmer perceives, perhaps incorrectly, that the expected costs are smaller when disease is not reported, one can expect that behaviour to occur. Although most informed farmers would report the disease, in the case of highly contagious diseases, significant economic damage can occur with only a few bad outcomes, even just one (Hennessy and Wolf, 2015). For example, Enright and Kao (2015) using a game-theoretic simulation, suggest that even a small number of non-cooperating farms could make a difference in the prevalence of disease, with this contribution becoming greater if the disease is easily transmissible.

**Private costs and economic incentives for disease reporting**

41. The farmer is expected to maximise net profits (or utility as a function of expected profits) by choosing appropriate disease prevention and control practices. A standard optimisation results in a first order condition that equates the decline in marginal expected loss from disease to the marginal cost of control measures (McInerney, 1996; Chi et al., 2002). The decline in expected losses is a benefit from farmers’ efforts to manage disease. It may include a lower probability of many diseases on the farm which may also spill-over to benefit neighbours by reducing the incidence of disease on their farms; it may also reduce the possibility of wildlife disease and risks to human health. The desired behaviour is that the farmer should report the disease quickly to limit its spread.

42. The consequences for an individual farmer of reporting disease, however, provide many disincentives to report. If the animal has a disease for which there is mandatory control or eradication...
programmes, the herd or flock will be depopulated. This results in lost genetics, potentially lost capital value (depending on indemnity payments relative to actual market value), and losses from business interruption as fixed costs must be covered. In addition, depending on the disease, other herds in the region or even the entire country might be subject to quarantine or movement restrictions. These restrictions result in losses for other herds and perhaps even an entire industry. The slightest suspicion of a diseased animal can shut down international trade for some diseases, e.g. bovine spongiform encephalopathy. The potential for consumers to associate—perhaps incorrectly—human health risks with the presence of disease can result in reduced demand. For diseases with mandatory control and eradication programmes, government and media scrutiny is also unpleasant and potentially costly. Thus, the farmer may be inclined to respond by waiting to see if recovery is possible, quickly marketing the suspect animal, or destroying the animal without alerting the authorities.

43. The amount required to incentivise reporting is a function of current market conditions and a number of potentially farm-specific factors, but several considerations can frame the problem. In order to align incentives, farmers must be compensated for reporting at least as well as they would be in the next best alternative. For example, if the farmer believes the alternative is to quickly market the animal and avoid business interruption, then the indemnity must be at least at the level that can be achieved on the market. Should depopulation be needed and the farmer to abstain from livestock production for a quarantine period, then business interruption is a relevant consideration for the farmer. Losses from business interruptions include foregone revenues net of avoided costs. To understand business interruption losses, a distinction between variable and fixed costs is useful. When a cattle enterprise is removed, many—and perhaps most—variable costs of production are not incurred. For example, there is no need to purchase feed for cattle. Fixed costs, in contrast, cannot be avoided or varied when production ceases (over the time period considered). The standard list of fixed costs includes interest on investment, depreciation, property taxes, and insurance. Because the depopulated farms are expected to resume operation, the fixed costs must be covered during the interim period.

44. Finally, the study by Sheriff and Osgood (2010) is interesting in that it adds a temporal perspective, suggesting that incentive compatibility constraint is more restrictive in the multi-period model than in a single period model. By revealing disease exposure today, sellers of livestock signal a higher chance of future exposure. If they believe the buyer will use this information against them, sellers with unhealthy animals must be compensated for future income loss in order to be willing to truthfully reveal disease today.

Compensation effects on disease prevention and reporting

45. Barnes et al. (2015) undertook a comprehensive review of the literature related to the effect of animal health compensation on farmer disease prevention and reporting. They note that economic insights into this issue are largely based on theoretical or simulation modelling that use stylised situations and simplifying assumptions rather than empirical data (e.g. Jin and McCarl, 2006; Beach et al., 2007a; Hennessy, 2007a; Gramig et al., 2009; Boni et al., 2013; and Hennessy and Wang, 2013). They also conclude that there is a general lack of comparative evaluations based on actual rather than modelled outcomes under different policies.

46. The basic premise of economic analysis is that all else being constant, the higher the indemnity the greater the likelihood of disease reporting. While compensation encourages reporting, it can also reduce the privately optimal preventive investment (Beach et al., 2007b). Hennessy (2007a) and Hennessy and Wang (2013) find that indemnity payments are likely to reduce producer incentives to protect herds, as do Bicknell et al. (1999). Beach et al. (2007a) found that there was a bigger deviation between private and social optima in regions with greater disease externalities and smaller farms, especially when high compensation was independent of preventive actions.
47. The study by Kuchler and Hamm (2000) is notable in that it examined 41 years of experience with indemnities as a natural experiment on the incentives created by prices. They studied US farmers reporting of sheep infected with scrapie, a prion disease for which the US government had an indemnity-based eradication programme from 1952 through 1992. It was then replaced by a voluntary flock certification programme. The authors recognised the potential for moral hazard as farmers could essentially manufacture diseased animals if it was profitable to do so. While the market price for sheep moved in response to supply and demand, the indemnity payment was fixed. Relative prices are important in this case and when the fixed indemnity was higher than the market price for sheep, farmers “produced” or found more diseased animals. Similarly, when the indemnity was lower relative to market price, fewer animals were turned in for indemnity. The authors found that not only was the supply of diseased animals upward sloping, but that it was price elastic, i.e. a 1% increase in indemnity payments relative to the market price for lambs yielded a greater than 1% increase in the number of confirmed scrapie cases.

48. The further logic is that compensation can provide adequate incentives to producers to prevent and report disease if it is designed to account for moral hazard and adverse selection problems. Within this logic, design characteristics of compensation, such as eligibility criteria, payment rates and schedules become essential. The basic principle is that farmers should share risks (and costs) of disease epidemics. Full compensation will not encourage preventive behaviour; indeed, “why bother if all costs are covered?” (Gramig et al., 2009; OECD, 2012; Barnes et al., 2015).

49. Gramig et al. (2009) suggest an indemnity scenario to deal with both moral hazard and adverse selection problems. A farmer’s investment in biosecurity is modelled as an ex ante moral hazard problem and farm reporting as ex post adverse selection. The authors argue that a one-size-fits-all indemnity payment cannot deal with both information problems. Two distinct mechanisms are needed for each: an indemnity to address moral hazard and help achieve the desired levels of biosecurity, and fines to induce early disclosure of disease status and address adverse selection problem. By combining two distinct policy instruments, each designed to deal with a single information problem, it is possible to create incentives for farmers to behave consistently with government objectives. Comparing this to a simple indemnity reveals an important difference: while standard indemnities increase with disease prevalence in a herd (i.e. pay the farmer for each diseased animal), the solution here is that the indemnity decreases over a range of disease prevalence which reflects how long the disease was present on the farm before it was reported. This scenario represents a differential indemnity schedule based on reporting the disease and employing the deductible principle in order to shift some of the risk to farmers.4

50. Hennessy and Wolf (2015) further develop that if the costs of reporting depend on market, industry, and farm specific factors, behaviour will depend to some degree on those factors. For example, if reporting results in an indemnity payment that is set at an average market price, one might expect farms with inferior quality livestock to be more amenable to reporting than those farms with superior quality livestock. Similarly, if reporting results in mandatory depopulation and business interruption, one might expect that those farms with relatively higher fixed costs (which must be borne during business interruption) to be more reticent to report than those with lower fixed costs (Wolf, 2005).

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4. Gramig et al. (2009) also consider actual indemnification mechanisms in some countries that use the principle of risk-sharing. For example, Belgium and the Netherlands no longer compensate producers for dead animals in the case of epidemic livestock diseases and only partially compensate them for diseased stock. The authors note that while such a mechanism sets no explicit fine for non-reporting, there is a penalty for waiting to report since dead animals fetch no payment. This feature can help achieve incentive compatibility with reduced or no monitoring costs. Partial compensation for animals that are already infected will shift some of the risk to farmers. The authors suggest that an indemnity plan that does not shift risk in this fashion may actually create incentives to allow infections to spread.
51. Making indemnities contingent upon farmer reporting assumes that a reasonable manager would and could notice the disease, so this condition makes more sense for diseases with readily identifiable symptoms. Livestock disease control systems are often based on ways of detection which expand vulnerability. First, detection often uses visual observation of clinical signs; thus disease can be present and spreading before detection. Second, the clinical signs of some important (dangerous) diseases are indistinguishable from signs of other diseases and could be misidentified (Bates et al., 2003; Elbakidze, 2008). Studies reveal that farmers, and sometimes even veterinarians, experience difficulty in identifying reportable diseases (Box 2.1).

52. Farmer incentives for disease prevention could be increased if indemnities are made conditional on farmers exercising certain biosecurity practices, implementing farm biosecurity plans, or participating in disease programmes. This, however, imposes high monitoring efforts on governments, but country experiences show that this effort could be shared with or performed by industry groups (see Australia case study in TAD/CA/APM/WP(2016)24/FINAL). Another way to address incentives for prevention is to differentiate indemnities according to farmer risk profiles, for example, the disease outbreak history of the farm (see Korea case study in TAD/CA/APM/WP(2016)25/FINAL). Meuwissen et al. (2006) also considered that classifying farms based on their epidemic disease risk and use of deductibles was important in order to align incentives with policy goals. This approach is also demanding in terms of administration: beyond the challenge of defining the risk status and differentiating farms accordingly, it requires the establishment of the relevant information systems.

53. Consequential losses are typically outside the scope of compensation schemes for epidemics and regarded as entrepreneurial risk. Some of these losses are a consequence of compulsory measures to control the epidemics, such as protective vaccination and livestock movement restrictions. Consequential losses influence the farmers’ incentives to disclose a disease as they have strong implications for the longer term viability of farms.

54. Livestock insurance may be one solution to market risks related to livestock epidemics (Meuwissen et al., 2000; Meuwissen et al., 2006; Meuwissen and Asseldonk, 2013). However, such insurance is in practice limited because of the significant difficulty to estimate the scale and probability of livestock epidemics risk, classify and price it accordingly, and because this risk tends to be systemic. As a result, the actual supply of livestock insurance is limited, while its uptake from producers is low due to high premium costs. This may indicate a market failure in provision of livestock disease insurance and can be an argument for a policy action (e.g. creation of information systems to facilitate the ‘production’ of insurance products) to make such insurance more operational. Other market instruments to manage livestock price risks are forward-, futures- and options contracts, but the degree to which these can deal with prolonged market effects is unclear, while only limited groups of livestock producers use futures and options contracts. There exist industry risk pooling arrangements, such as industry funds, but they are rare and typically created to deal with direct epidemic losses. Thus, the approach to consequential market losses from disease epidemics remains a largely open policy issue.

55. Financial considerations are not the only drivers of farmer reporting behaviour. Farmers may experience difficulty in identifying a reportable disease, dissatisfaction with, limited awareness, or uncertainty about reporting procedures, farmers may also feel guilt and shame about reporting a disease. These aspects are the focus of Chapter 3 which draws on the behavioural literature. It is nevertheless important to stress here the complexity of farmer reporting behaviour (Box 2.1).

5. Under protective vaccination, animals may not be destroyed. However, when marketed, such animals command reduced price as their processing involves higher costs.
56. In this respect, Barnes et al. (2015) observe that the economic literature concentrates on financial incentives, while the behavioural literature is mostly concerned with non-financial drivers. These two research streams are weakly integrated and there remains scope for investigating the extent to which the performance of compensation arrangements might depend on behavioural influences. The suggestion by Elbers et al. (2010b) well exemplifies the problem – they point out that increasing compensation may be ineffective as a means of encouraging reporting if a disease is not perceived by farmers as a serious problem. Here they notice the interaction between a financial incentive and behavioural driver such as farmer’s risk perception. Thus, a range of financial, regulatory and nudging policies are required to match farm response with socially desired outcomes, although empirical and theoretical evidence to discern the optimal mix of interventions is limited.

**Box 2.1. Non-financial determinants of farmer-reporting behaviour**

Producers’ level of knowledge about diseases and their likely consequences informs their risk assessment and responses. The inability to identify clinical signs of disease quickly, or to identify the signs which need to be reported and at what threshold, hampers reporting (Wright et al., 2016; Delgado et al., 2014; Elbers et al., 2010a). The situation may be further complicated if there have been no disease occurrences in a long time, so both producers and veterinarians may not be prepared to quickly identify disease (Elbers et al., 2010b). This could be coupled with the fact that some farmers (and veterinarians) feel that raising a false alarm would be worse than missing a possible emergency (Elbers et al., 2010a; Elbers et al., 2010b). Producers’ beliefs about the extent to which they can efficiently control the event may also determine behaviour. Those who feel they can themselves control the outbreak do not tend to report it immediately (Wright et al., 2016).

Risk perceptions are a factor in farmers' reporting behaviour (Wright et al., 2016; Elbers et al., 2010; Delgado et al., 2014). For example, Bronner et al. (2014) studied the brucellosis surveillance system in France based on mandatory notification of bovine abortions. They note that despite the epidemiological rationale to detect a brucellosis outbreak early, most farmers viewed it as an externally-imposed tool concerning an externally-imposed issue that created few worries for them.

The behavioural literature reveals that community opinions influence farmer reporting behaviour. Some sources refer to guilt and shame and “farmer stigma” related to disclosures of disease. Farmers may feel that if they report, in particular if they are the first to do so, they will be negatively viewed by their social network (Elbers et al., 2010b; Delgado et al., 2014). A cross-country study by Vergne et al. (2016) showed that farmers and hunters who did not immediately report suspected cases of disease were more likely to believe their reputation in the local community would be adversely affected if they were to report. However, social influence can also be propulsive to reporting if this constitutes an existing social norm, i.e. if farmers believe that the persons whose opinion matters for them expect them to report and that others would also report if disease occurs on their farms. Delgado et al.,(2014) find, for example, that cattle producers indicated they would experience social pressure from all the external groups included in the survey (e.g. family, veterinarians, business partners, neighbours, professional organisations) to report cattle with clinical signs consistent with FMD.

The transactions costs of disease reporting appear to be a significant factor. Dissatisfaction with procedures – “long and tedious”, not transparent, or leaving uncertainty about the outcomes of reporting – are found to be among the deterring factors (Elbers et al., 2010b). Delgado et al. (2014) observed that any uncertainty associated with compensation was likely to influence producers’ willingness both to report disease and comply with response measures. Some surveillance actions based on disease notification can be seen by farmers as time-consuming, impractical or compensating for bureaucrats who are not doing their part (Gunn et al., 2008). Consideration of costs and benefits of investigating clinical signs of disease is also identified as a factor of producers’ reporting decision-making: if an animal is worth less than the cost of veterinary service, it makes more economic sense to kill it than pay for a veterinarian visit. The service infrastructure, e.g. proximity of a veterinarian, has been identified as a factor in the reporting disease by Australian farmers (Wright et al., 2016).

The general acceptance of reporting frameworks, a sense of ownership of the rules, and overall trust in government play a role in the reporting behaviour of farmers. Although farmers expect to cede some of their autonomy for improved biosecurity, they can feel frustrated at the prospect of losing control of their business if a disease is identified on their property (Wright et al., 2016). Farmers may view control measures as inappropriate and be unwilling to comply with them (Elbers et al., 2010b; Bronner et al., 2014). Trust-building, involvement in decision-making regarding surveillance and reporting frameworks, a two-way and clear communication about future actions would help increase collaborative behaviour with producers (Wright et al., 2016).
2.4. Farm size, industry structure and spatial issues

- Industrialised production can be associated with increased disease prevention and control efforts, but also with large impacts of disease if it breaks out.
- Hobby/lifestyle residential farms are likely to be more motivated by factors other than financial.
- Hobby producers are likely to underinvest in biosecurity because they do not consider effects of disease on professional producers.
- Policies designed with consideration of commercial farms only are likely to be a poor fit for non-commercial operations.
- Biosecurity efforts of neighbours affect producer incentives to prevent and control disease.

57. While the proportion of livestock, dairy and poultry products from large, commercial operations has increased over time, smaller operations exist in the form of part-time, hobby, life-style farms, and, in some countries, as subsistence farming segments. There are many ways to divide or segment farms by type based on the motivation of their operator. Primary motivations include business, such as profit and equity, but also family values, lifestyle, and hobbies. While specific categories depend on the context and method of analysis, it is clear that those who make decisions within farm enterprises vary in their mix of values and motivations that drive their decisions, including those related to disease control and prevention. It should also be noted that in addition to farm livestock, pets and other backyard animals can affect disease occurrence and spread. This section considers the implications for disease management from this diverse set of farming structures. It concludes with the discussion of spatial issues of disease management.

Industrialised agriculture

58. With changes in technology, reform of long-time agricultural support policies, and the subsequent integration into world markets, livestock agriculture has undergone significant structural change. Commercial farms are becoming larger and more specialised. The prototypical example is contracting in the US poultry and pork industries where large corporations own the livestock which are raised by contracted farmers. This leads to important disease management and liability questions. Disease prevention and control is expected to depend on farm size, available resources and production technology, all of which are jointly determined (Hennessy et al., 2005; Hennessy, 2005).

59. As livestock operations increase in size, production technology usually dictates a movement towards confinement operations. Animals spend less energy on foraging, defence against predators, and temperature regulation (Wang and Hennessy, 2014). Confining animals also involves physical protection...
against infection and other diseases. Therefore, the animals’ environment is under greater control. At the same time, control technologies are also required as animal and or farm density can be a factor in increased disease risk.

60. How do incentives to guard against infectious disease risk interact with the scale of production? There should be scale economies in biosecurity, at least in investment in facilities and enclosures. Siekkinen et al. (2012) studied the cost of biosecurity on Finnish poultry farms. They found economies of scale, i.e. costs decreased as size (number of birds) increased. This effect was largely driven by decreasing labour costs. However, Wang and Hennessy (2014) found that because biosecurity is a technical complement to scale, a unit cost decline in biosecurity can reduce optimal scale.

61. Larger commercial operations (poultry or pigmeat) are less likely to become infected because of their larger resources and more stringent biosecurity measures; see for example Beach et al. (2007b) who analyse highly pathogenic avian influenza. However, to the extent that infections do occur in these sectors, the impact is likely to be very large, with many animals killed by disease and depopulated. Mintiens et al. (2003) considered risk of classical swine fever (CSF) spread in Belgium and concluded that densely populated livestock areas incorporate an increased risk for epidemic disease spread when outbreaks occur. Rushton (2009) noted that large, industrial livestock operations might capture most of the benefits of livestock disease control and eradication. In general, one would expect increased biosecurity and therefore less potential for disease outbreaks on very large operations because of the level of investment and specialisation of these operations.

Part-time, hobby or lifestyle residential operations and backyard flocks

62. The risk factors associated with small (backyard) production include reduced hygiene and biosecurity measures, a mixed confinement which increases the probability of disease transmission across species, and free range allowing the interface with wild life (e.g. Whitehead and Roberts, 2014; Conan et al., 2012; Hamilton-West et al., 2012). Other authors highlight the features of small-scale production which may reduce disease risks, such as extensive free-range systems, which in this argumentation is a factor preventing rapid disease spread, spatial dispersion of small producers, and the fact that animals in small establishments may have more mobilised immune system due to exposure to diverse environmental stress (Behnke et al., 2011).

63. As far as developing countries are concerned, smallholders are generally viewed as the major weak point in national biosecurity (Grace et al., 2008). As for developed economies, the evidence about the role of smallholdings in the occurrence and transmission of disease is fragmented. This issue has attracted increased attention in recent years in the context of the outbreaks of highly pathogenic avian influenza. Bavinck et al. (2009) found that from an epidemiological point of view, backyard flocks played only a marginal role in the outbreak of the highly pathogenic avian influenza in the Netherlands in 2003. Smith and Dunipace (2011) estimated that the contribution of backyard poultry flocks to the transmission dynamics of highly pathogenic avian influenza epidemics in commercial flocks was “modest at best”. However, they also warned against ignoring the contribution of backyard flocks in estimating the efforts to control the disease. Beach et al. (2007b) observe that minimal biosecurity present in nonindustrial production is frequently identified by animal health agencies as a risk to commercial sectors, even in countries where these activities account for a negligible share of output and sales. Conan et al. (2012) present the view that neither system is more to blame for infectious disease spread and that biosecurity levels have to be increased in both commercial and backyard poultry systems.

64. Understanding the incentives of small holders to protect their livestock is important for the development of policy approaches towards these constituencies. Part-time, hobby or life-style farmers do
not depend significantly on agricultural enterprises for their income. Thus, the financial implications of disease may not motivate them to invest in biosecurity measures (Defra 2008).

65. Kobayashi and Melkonyan (2011) found that biosecurity actions with own benefits or lasting impact in home communities exhibited a positive relationship with the behaviour of producers from geographically close areas. The number of biosecurity actions taken were positively associated with the number of animals, and varied among commercial and hobby producers and across species and types of commercial production.

66. Professional farmers have incentives to carefully monitor and manage biosecurity, while hobby farmers derive utility from the value of the farming activity itself (Blank 2005; Defra 2008). Ceddar et al. (2008) considered biosecurity in application to invasive species by comparing profit-seeking professional producers to utility-seeking hobby producers. Hobby producers are likely to underinvest in biosecurity because they do not take into account the effects of disease on professional producers. Since disease control generates positive external benefits, hobby producers will under-invest in it. While the gains from a socially optimal policy are sizeable, the transactions costs of a corrective policy may be prohibitively high. A pest control subsidy for hobby producers can lead to an increase in hobby production with associated negative impacts. This subsidy also would not recognise that the mere existence of the hobby farms is an important component of the problem. An alternative is a penalty for hobby farms based on the deviation of their pest control from the socially optimal level. However, this would be hardly realistic as it requires monitoring and large transactions costs. Finally, professional and hobby farmers could get together to have a joint surveillance and control programme. The policy implications of this work are that designing policies with commercial farms in mind is likely to be a poor fit for the non-commercial animal operations. These groups seem to be logical candidates for voluntary assurance and co-operative programmes.

Spatial aspects

67. The spatial analysis provides insights into how externalities affect farmer’s incentives for disease management. Locational characteristics lead to heterogeneity of producer incentives to prevent and control disease, they affect the degree to which producers are both vulnerable to risk and can free-ride on the biosecurity efforts of others (Horan et al., 2010).

68. Hennessy (2007b) studied spatial externalities of disease across multiple operations in close proximity. He used an illustrative model of agricultural biosecurity where only farm location and production scale were articulated. The author concludes that the nature of spatial interactions matters as it determines the extent of incentives to free-ride on neighbours' actions. For instance, "edge" farmers (with neighbours only on one side) face lower risks than "middle" farmers located in-between two neighbours. The middle farmers thus would invest more in biosecurity, whereas edge farmers may free-ride on these efforts. Another observation is that intensive production, by strengthening private incentives to protect, can reduce the proportion of potential production lost to disease in a region. However, subsidies targeted to smaller production lots may encourage larger farms to invest less in biosecurity, thus reducing the overall economic surplus.

69. Rat-Aspert and Krebs (2012) examined the collective action to control endemic diseases for which management decisions are left to individual initiative. In their model a farmer decides whether to protect his herd against a particular disease by vaccinating or by adopting biosecurity measures which create a positive spill-over. By lowering the risk of disease occurrence, this would provide benefit to other farmers. Conversely, farmers could be encouraged to behave as a free-rider seeking to benefit from the efforts of neighbours without bearing the costs. This behaviour would generate a negative externality since this behaviour would lead to maintaining the disease within the geographic area considered. This results in strong interrelationships of individual decisions to control animal disease at the area level. For
communicable diseases, effectiveness of control measures will often depend on the ability to act in a coordinated manner across a group of operations (horizontal coordination).

70. Rich et al. (2005a, b) analysed the decisions to control foot-and-mouth Disease (FMD) as a spatial model in which behaviour of neighbours influences the payoffs to each individual from control efforts. Producers could choose between high and low effort to control FMD. Low effort results in contracting disease with certainty. Because of disease spill-overs, the effectiveness of high effort depends on the actions of neighbours. In locations with high prevalence of disease, the rationale to increase control of disease is relatively low, while spatial spill-overs only exacerbate the problem with the result that disease is likely to be endemic. In locations with lower disease prevalence, producers may be more or less inclined to engage in increased disease control depending on neighbours’ choices. The authors suggest that for disease control regulation to be effective, private incentives across space need to be aligned and argue for a spatially nuanced policy depending on risk factors and pay offs to biosecurity. Beyond that, policies that promote market development and increase the herd value may be the most effective as they increase private incentives to prevent and control disease.

2.5. Implications for animal disease policy

71. This chapter framed the farm management decision by focusing on economic and financial aspects of disease management. It can be expected that individual farmers will under-invest in prevention and control as the market does not reflect all costs or all benefits for farm-level disease management. Farmers may also see returns to investment to be better in other areas and value short-term gains more than possible larger long-term gains from investments in farm biosecurity. In this situation farm managers may not be incentivised to behave as policy makers would prefer them to do when making animal disease management decisions. Thus, policy makers must consider actions to more closely align the public and private costs and benefits of such practices. Several areas of public action for reducing the divergence between private and socially optimal outcomes might be justified, especially in view that some diseases have large social economic costs.

72. A rational economic decision process assumes that a profit-maximising farmer will invest in prevention up to the point where the marginal private benefit from prevention is equal to marginal costs. Farmers’ biosecurity effort thus derives from weighing the costs against benefits of such effort. The trade-offs depend on the nature of disease, available techniques, the costs involved, market conditions, and other factors. Producer must understand these trade-offs, so knowledge and information is an essential input into individual’s biosecurity decisions. The less aware farmer is likely to make inadequate investment decision to prevent disease and this will determine the overall risk of disease entry. The policy role in this regard is to assist farmers in gaining the relevant knowledge, including by tailoring the information to farmers’ particular needs and circumstances and providing them with decision-support tools. Development of technologies and services that lower prevention and control costs is an additional area for public action, for example, expenditures to reduce cost and efficacy of disease tests and veterinary services might be in order. Within the basic economic framework, these investments would shift a private loss-expenditure frontier so that private cost-benefit solution would result in less disease.

73. Economies of scope in biosecurity practices are generally ignored which undervalues these practices. When disease management is considered at the farm level on a disease-by-disease basis, the cost-benefit can be misleading. Often management practices that prevent or eliminate one disease assist in preventing or eliminating many others. Thus, disease prevention and management may exhibit economies

6. In fact, this study looked at the coordination problems of FMD control across countries in South America. However, their model is neutral to whether a country or an individual producer is considered – the authors use these notions interchangeably.
of scope. The consideration of potential preventive spill-overs in disease education and information programmes can encourage farmers to take these effects into account in allocating effort and investment to disease prevention and control. Farm level decision tools and aids should account for these benefits. The potential for realising these gains should be actively communicated to farm managers as part of disease risk communication and advice for farm biosecurity practices. Understanding that practices prevent many diseases will strengthen farm incentives to undertake those practices.

74. Uncertainties and risks are associated with virtually every aspect of disease management, making farmers’ risk perceptions important drivers of their decisions. If a farmer wrongly perceives the risk to contract disease on his farm to be negligible, he is unlikely to invest in its prevention. Furthermore, farmers need to understand the probability of disease to optimise investment in disease prevention. There are biases and risk perception issues that must be overcome for farm managers to make appropriate livestock disease management decisions. Thus, governments should facilitate animal disease risk communication, information, and education so that farmers build understanding about their own risks and the links between individual preventive efforts and outcomes for the sector as whole. On the other hand, to design effective policy governments need to understand the risk awareness and risk preferences of farming constituency. For example, the effectiveness of disease reporting frameworks may depend on farmer's perception of associated risk. Despite the fact that the issue of farming risk is increasingly featured in the governments' policy agendas, there is a continued lack of evidence on farmer individual risk perceptions and preferences.

75. Public policy intervention in livestock disease management can directly impact producer decisions. Diseases where human health is at risk or which have large potential economic effects associated with them are in the domain of public control. Public policies here range from bounties/indemnities for infected livestock to required herd depopulation and farm decontamination.

76. Farmer actions and relevant information about the farmer and farm operation are not perfectly observable. The presence of information asymmetries related to monitoring behaviour in preventing and reacting to disease outbreaks created an additional challenge for aligning incentives for disease prevention and reporting.

77. Higher indemnity payments can encourage farmers to monitor and report diseased animals by compensating for the losses in animal value taken for disease eradication. This is particularly, appropriate for diseases where timely detection is crucial to minimise damages to the industry, economy or human health. Paying fair disease-free market value is necessarily greater than the true market value of diseased animals culled by the government. This action is often justified as intending to create incentives to report. However, one must be mindful not to provide incentives for farmers to produce diseased livestock. Several natural experiments have confirmed that misalignments in reactions to financial policy incentives occur. Higher indemnity payments can discourage farmers from biosecurity measures to limit the possibility of disease occurrence and spread. If someone else is paying for losses there is less incentive to avoid risky behaviour. A critical aspect of livestock disease policy is to avoid the perverse incentive to produce infected animals.

78. Animal health authorities have typically relied on a single mechanism – indemnities – to facilitate both *ex ante* biosecurity effort and *ex post* reporting. By using a single mechanism to promote biosecurity and to report simultaneously, the incentives for individual private action are not clear.

79. Unless farmers face some uncompensated losses as a result of outbreak it cannot be expected that they undertake sufficient prevention and timely report disease. Some countries have implemented policies which move towards risk-sharing in interesting and appropriate ways. For example, if there is no indemnity for dead animals there may be a penalty for waiting to report disease. This policy can help to achieve incentive compatibility with reduced or eliminated monitoring costs. Some of the risk would shift to farmers if the indemnity rate decreases over some range of disease prevalence, or if partial compensation
for already-infected animals is provided. An indemnity plan that does not shift risk in this way may actually create incentives for infection.

80. Furthermore, farmers react to private incentives and the best course of action for an individual farmer will depend on the farm type and size as well as individual financial considerations. For example, one might expect farmers to react differently to the same indemnity rate depending on the individual costs they incur: e.g. farms with superior quality livestock and higher fixed costs would be more reticent to report disease than those with lower quality animals and lower fixed costs. Economic modelling may be instrumental to evaluate how different farmer groups, regions, and market segments respond to the size of incentives.

81. In deciding whether to report disease farmers react not only to financial incentives. The ability to identify reportable disease, transactions costs and uncertainties associated with reporting, psychological barriers, social pressure, acceptance of reporting regulations and overall trust in government, also influence the disease disclosure. The degree to which financial and non-financial drivers interact and impact farmer decisions is little researched. Building a holistic view of barriers to disease reporting is a necessary step towards more effective and cost-efficient disease control frameworks. Some countries have progressed in this direction (see Australia case study in TAD/CA/APM/WP(2016)24/FINAL).

82. Diverging farm size and specialisation has implications for farm management and policy. Farm size and type are correlated with incentives and behaviour related to livestock disease management. Large, industrialised farms have significant investments in livestock and are more likely than smaller operations to have accompanying disease management systems. The production technology that complements biosecurity practices is more likely to be present on full-time operations. They are also more likely to have full time veterinary services. However, the magnitude of a disease outbreak is also much larger should prevention or containment fail. Part-time and hobby farms may be less aware of disease issues and practices. Keepers of backyard flocks are even less likely to be concerned with disease prevention. Smaller operations may also be less responsive to financial incentives than larger commercial operations. The existence of part-time or hobby farms alongside commercial livestock operations is important because they are less likely to be motivated by consequences to profit or assets from disease outbreaks. To incentivise these groups for increased disease prevention and reporting, a local action is likely required. This may include voluntary surveillance initiatives, awareness campaigns, information and knowledge dissemination adapted to non-professionals, social rewards, and any other action relevant in the local contexts. The relevant experience can be drawn from local environmental initiatives. Policy could potentially play a role in promoting and facilitating such local initiatives.

83. Spatial analysis demonstrates that locational characteristics lead to differentiation of farms by the degree to which they are vulnerable to risk given the biosecurity effort of neighbours. Farmers’ decisions about additional investments in disease prevention are influenced by negative externalities and positive spill-overs from the actions of their neighbours and farmers may free-ride on the biosecurity efforts of others.

84. Appropriate disease policies, information and education programmes thus must consider the entire spectrum of livestock operations, including size, intensity and geography. To align incentives policy makers need to classify farms based on motivation, resources and constraints. Segmenting policies by farm size and type and location may also assist in aligning incentives.
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CHAPTER 3.
INSIGHTS FROM BEHAVIOURAL ECONOMICS INTO FARMER LIVESTOCK DISEASE MANAGEMENT

85. The domain of behavioural economics combines psychology, sociology, and economics to examine the behaviour of economic actors and provides valuable insights for public policy. Section 3.1 introduces the theoretical framework of behavioural studies and the mapping of behavioural drivers onto different policy areas. Sections 3.2 to 3.5 discuss the key findings of behavioural research with its application to livestock farming, and Section 3.6 summarises the policy implications.

3.1. Theoretical framework for behavioural economics

86. The intention of behavioural economics is to infuse psychological realism into theories of economic behaviour as opposed to the standard economic model where actors are fully "rational", with perfect control, and consistently act in their own self-interests (Roberto and Kwachi, 2016). Applied to agriculture, the behavioural economics literature emphasises the importance of social and psychological influences in farmer decision-making and suggests that farmers seek to balance economic, social and lifestyle goals (see overview by Howley, 2015). The behavioural approach has been instrumental in examining the issues related to a voluntary change of farmer behaviour, such as sustainable farming, and mitigation and adaptation to climate change (reviewed in OECD, 2012). The rise of animal disease and animal welfare concerns in the 2000s and the recognition that the individual producer plays a key role in addressing these concerns led to a growing behavioural research in livestock farming.

87. Behavioural economics attempts to find patterns on how people act in ways that classic economic theories may characterise as "irrational". It seeks to build models that can account for behaviour in a psychological and social context (Amir and Lobel, 2008). If behaviour deviates in predictable ways, policy makers can design policies that take into account a range of drivers of human behaviour, including non-economic ones. While there is no unified underlying theory for behavioural economics, there are models that may be used to understand farmer livestock disease decision-making.

88. A theoretical framework applied in many behavioural studies in agriculture originates in the Theory of Planned Behaviour (TPB) (Ajzen, 1991). It states that behaviour is the product of an intention to perform the behaviour and distinguishes the following determinants of intention (Figure 3.1): the attitude towards behaviour, the subjective norm to engage or not in behaviour, and the perceived behavioural control. These constructs have further determinants. The attitude towards behaviour results from the beliefs about possible effects of performing the behaviour (outcome belief) and the value that is attributed to this effect (outcome evaluation). The subjective norm is determined by how one sees if the “important others” expect him or not to perform a particular behaviour (social normative belief) and one’s motivation to comply with these perceived expectations. The perceived behavioural control is determined by one’s belief that he (she) has necessary resources to perform the behaviour (control belief strength) and

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the importance of these resources (control belief power). That is, of two individuals with equally strong intentions, the one who has the confidence to master this activity is more likely to act.

89. Ajzen (1991: 199) acknowledged that the TPB was open to additional predictors and more developed versions of TPB consider additional factors that explain why intentions do not always translate into behaviours, such as skills, knowledge, and environmental constraints (e.g. Fishbein and Yzer, 2003). Other studies also introduced additional independent variables that could contribute to the intention-behaviour relationship (Figure 3.1). These, for example, include inertia or habit, moral obligation, self-identity, personal normative beliefs, past behaviour, and cognitive skills (Burton, 2004; De Lauwere et al., 2012). Behavioural research related to livestock disease management employs also other theoretical models and methods which use relatively similar behavioural constructs. The TPB is presented here to facilitate further review as the behavioural studies on livestock disease refer extensively to this model.

Figure 3.1. Theory of Planned Behaviour framework

![Theory of Planned Behaviour framework](image)

Source: Adapted from Burton (2004); Garforth (2010); and De Lauwere et al. (2012).

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8. De Lauwere et al. (2012: 152), for example, present the views of several authors on the weaknesses and strengths of the TPB model.

9. For example, Valeeva et al. (2011) applied a Health Belief Model to study risk management behaviour of Dutch pig farmers. Palmer et al. (2009) draw on the Social Cognitive Model to research the effect of trust on responses of Australian farmers to infectious diseases. Both of these frameworks originate from behavioural health research. Other authors (e.g., Toma et al., 2013; Sok et al., 2016) employ statistical methods, such as Structural Equation Modelling (SEM) to test and estimate the causality between the a priori determinants of farmer biosecurity behaviour. This method is also used in combination with behavioural modelling to test model parameters. Other works use a "grounded theory approach" which begins with the collection of qualitative data. These data are then reviewed and codified, and grouped into concepts and categories to constitute a framework of analysis (Elbers et al., 2010 a, b).
90. The TPB presents (farmer) behaviour as a complex interaction of influences where the explanatory power of these influences regarding behaviour depends on specific contexts. In the context of agriculture, this implies that the impacts of individual factors on intention and the transformation of this intention into specific behaviour depends on a farming issue in question, farming type, individual characteristics of a farmer and other contextual parameters. Using the TPB constructs, Garforth (2015: 34) well describes this multifactorial and context-specific nature of farmer behaviour: “… farmers’ behaviour in respect of animal disease risk management would be influenced by their knowledge of specific practices; their attitudes to specific practices and to disease risk management in general; their view on the efficacy of specific practices in reducing disease risk (…‘outcome beliefs’ and hence attitudes) and of disease risk management in general; their previous experience of specific practices and the experience they have heard from others; their perception of their ability to put specific practices into effect and of factors that constrain them (…’Perceived Behavioural Control’…) which may include current habitual behaviour; their perception of what other farmers in similar situations are doing with respect to disease risk management; and their perception of what other people important to them would think about their implementing or not implementing specific measures (…‘subjective norms’…).”

91. Because of the contextual specificity, any generalisations about the relative importance of behavioural drivers, i.e. the degree to which each of them – farmer attitudes, subjective norms, perceived behavioural control, or any additional predictors – lead to certain behaviour, can be only suggestive. Also, the results coming from various studies depend on specific methods of analysis and how the surveys are structured. However, the value of behavioural research, such as TPB and other models, is that it helps to typify the drivers of behaviour. A further step is to establish connections of these behavioural drivers with specific policy actions. The framework developed by Prendergrast et al. (2008) from the Social Market Foundation in London is an example of such a mapping exercise.

**Figure 3.2. A framework for policy makers: Behavioural drivers and policy options and tools**

Source: Adapted from Prendergrast et al. (2008).
This framework groups the drivers of individual’s behaviour into external, internal, and social ones and links them with specific policy domains and policy instruments (Figure 3.2). External factors include monetary and effort costs and are influenced by traditional market-based policy interventions, such as taxes, subsidies and regulations. Internal factors concern individual characteristics of decision-makers related to how they cognise reality and the role of habit in their behaviour. Social factors encompass norms and other aspects of social capital.

This framework illustrates that traditional market-based interventions work through only a part of behavioural drivers. They may be necessary but most likely are insufficient and that policy interventions influencing individual and social drivers need to be also engaged to induce preferred behaviour amongst farmers (Prendergrast et al., 2008; OECD, 2012).

The following sections are structured along the three axes of the policy framework above: external (economic), internal and social factors of farmer behaviour. The findings from the behavioural economics literature with implications for livestock disease management and policy are discussed. The discussion also draws on general behavioural literature and the studies related to other agricultural issues which are considered of relevance to the disease management. Although the body of behavioural studies in agriculture is increasing, more research is required. In particular, the work focussed on livestock disease and other issues of livestock farming has been less extensive than in the application to environmental and climate change issues. Yet, the available research allows drawing insights that can help livestock disease policies to become more effective.

### 3.2. Economic considerations: Impact on key determinants of farmer decision making

- Cost-benefit considerations affect all elements of farmer decision-making process.
- Policy can influence farmer beliefs about economic outcomes of their actions and thus facilitate socially desirable private decisions.

Behavioural analysis of livestock farmers demonstrates that economic considerations affect all key determinants of their disease management decisions. Alarcon et al. (2014) studied the decision-making process of pig farmers using the TPB model which includes farmer attitudes, subjective norms, and behavioural control. They found that financial reasons were the most frequent drivers for disease control. In a related qualitative analysis the farmers reported that the observation of ill pigs, reduced production performance, and (or) mortality levels were the most frequent drivers for disease control, the majority of respondents linking these factors with the risk of entering an economically unsustainable situation. Looking further into the subjective norms that affect disease control decisions, the study found that farmers’ motivation to comply with external advice depended on their belief that they obtain positive returns. Farmers valued the advice of a veterinarian high because they believed he was able to consider the economics of disease and of possible interventions. The same study also points out that perceived behavioural control as a driver of farmer decisions also had strong economics aspects. Thus, a measurable outcome of a disease measure was shown to be a factor of farmers’ control belief, while farmers’ perceived inability to employ additional labour or investment to implement a disease measure as a factor of their power to control.

These findings imply that the cost-benefit perspective permeates all elements of farmers’ complex decision-making process. There is a role for policy which is to influence farmer perceptions and beliefs about the economic outcomes of their actions. This involves enhancing farmer knowledge and information necessary to assess the cost and benefits of disease management decisions. This also requires providing sufficient evidence on the cost-effectiveness of desired farm practices which can facilitate
farmers’ decisions to adopt them. The policy objective is to encourage farmers for socially desirable decisions that reduce the overall risks and impacts of diseases. Behavioural approach reveals that economic choices can be influenced by psychological and cognitive factors which policy makers should possibly take into account in formulating and communicating policy.

3.3. Internal factors in farmer decision making: Cognition and bias

- The cognitive process is at the core of farmer decision-making.
- Farmers’ overconfidence with respect to biosecurity practices may lead to a lack of action.
- Cognitive biases and habits are defaults that can mislead farm decisions.
- Overcoming these is a role of livestock policy from the behavioural perspective.

97. Behavioural models regard decision-making mechanism as a cognition process: the process of acquiring knowledge and building understanding by individuals. Thus, farmer decisions depend on whether they are willing to use information, the extent to which they are capable to process it and learn, whether they generally have adequate knowledge, and how they are able to transform it into a decision. Referring to the TPB model, Garforth et al. (2006) state that a significant positive correlation between the attitude, subjective norm, perceived behavioural control, and intention indicates a cognitive driver, while a significant negative correlation indicates a cognitive barrier. In order to induce a desired change in farmer behaviour, policy should reinforce cognitive drivers and address cognitive barriers (Garforth, 2015).

98. Behavioural research provides insights into perceptions of livestock farmers about their own expertise in disease management and the adequacy of their effort to control disease risks. Based on several collective studies of UK livestock farmers, Garforth (2010) concludes that farmers generally seem to trust their own judgement. Kaler and Green (2013) provide similar observation from their survey of UK sheep farmers who generally consider themselves the experts to manage their complex business. Another study of UK farmers’ attitudes to recommended livestock disease practices showed that “farmers felt they were currently doing all they reasonably could do, within the constraints of their farm, to minimise risks and their decisions were appropriate to the level of risk they saw at a time.” Farmers typically judged they were making rational decisions and had high level of confidence in their own knowledge and expertise (Garforth, 2015).

99. The analysis also suggests that although farmers seem to generally feel confident about their expertise and the adequacy of their biosecurity effort, they are susceptible to cognitive biases and failure. Brujinis et al. (2013), for example, analysed farmer ideas about the cost-effectiveness of various practices related to animal welfare and found that farmer evaluations diverged from the results obtained from models, and in some cases, quite significantly. The authors note that this might be particularly the case of new practices whose cost-effectiveness may be more difficult for farmers to evaluate compared to the well-known techniques. Meuwissen et al. (2001) concluded that farmers were conceptually interested buying insurance for consequential losses of epidemics, but because these epidemics are low-probability/high-consequence events farmers have trouble assessing the probability and potential magnitude of such risks. Due to this cognitive failure, farmer willingness to pay for epidemic insurance is generally less than the actual premium required (Skees and Barnett, 1999).

100. Biases are defined as systematic error in (farmers’) judgments that affects their decisions and behaviour. Some of the relevant biases include the planning fallacy wherein people overestimate the ability to perform future tasks. In application to disease management, such bias could consist of farmers being over-confident in their ability to manage a disease incident without recourse to external expertise, such as testing and consultation by a veterinarian. Optimistic biases may be where people assume they are at below the median risk. For example, although producers may acknowledge disease outbreaks as a high threat at
the national level, they may perceive their personal risks as low (Palmer et al., 2016). Present-biased preferences and intertemporal choice where one disproportionately weighs present over future concerns, i.e. farmers may prioritise investments in areas other than increased farm biosecurity because they perceive other business concerns as more obvious concerns (Wright et al., 2016). Finally, the status quo bias results in people sticking to current default options because this involves less effort than switching. Status quo bias routinise behaviour or leads to habits. Even where a new behaviour brings substantial benefits to the individual concerned, breaking habits requires a distinct cognitive effort on the part of the individual (Prendergrast et al., 2008 with reference to Jackson, 2005). Education, training, and awareness campaigns can help establish new behaviour, which should then be reinforced through repetition, awards and continued awareness. Understanding default livestock disease practices and pushing or resetting them is one role for policy. For example, the status quo bias can be overcome by making a programme opt-out rather than an opt-in, which can have a large impact on participation. Habits may have specific aspects in application to livestock disease. Lupo et al. (2014) studied oyster farmers reporting behaviour and observed that “habituation” impeded disease reporting despite the incentive to do so provided by compensation. They described habituation as a consequence of lacking continued alertness and awareness, and the continued involvement by authorities that led to an exotic disease becoming endemic. Barnes et al. (2015) develop this idea by noting more broadly that producers may become accustomed to a situation that was previously stressed as being significant. They highlight the need for persuasion and regular baseline communication between government and producers.

101. A role of livestock policy from the behavioural perspective is to overcome farmers’ cognitive bias and failures. The way in which the policy and disease consequences are presented can factor into overcoming bias (Box 3.1).

**Box 3.1. Psychological and cognitive bias affecting economic choices**

Problem framing concerns the ways of communicating about the reality. The way a problem is defined determines one's understanding of and approach to that problem. Redefining or reframing a problem can help broaden the range of alternatives and solutions examined. Kahneman and Tversky (1979) developed these ideas in application to economic choices. They pioneered the concept of "loss aversion" which says people care more about losses than gains. Thus, if a problem is framed in terms of potential expenses and costs it will often elicit a different response than the same situation framed in terms of potential gains. Considering loss aversion would suggest that referring to potential losses is likely to be more effective than to gains in encouraging behaviour such as reporting diseases or implementing biosecurity. Bocqueho et al. (2013) confirmed that farmers responded more to penalties than bonuses because of "loss aversion".

The endowment effect occurs when ownership tends to make people overvalue resources because of attachment. The result of the endowment effect is that people’s willingness to pay (WTP) is not equal to their willingness to accept (WTA). WTP value is the maximum amount a person would be willing to offer for a good, while WTA value is the minimum amount required for an individual to forgo a good, or to bear some harm. The empirical studies show that the values obtained by WTA are consistently higher than those expressed by WTP, when valuing the same good. The implication of the endowment effect is that policy makers should use willingness to accept values if possible (Shogren et al., 1994). This effect shows up in the willingness of farmers to part with diseased livestock and could affect their intention to report disease in response to the amount of indemnities offered.

The next effect is the reference effect where people tend to judge potential outcomes and actions relative to a previous experience or what they have witnessed even when the current situation has little or no reference. If the farmer has no experience with epidemic diseases, he may fail to understand the potential consequences for their operation.

Another effect can originate with sunk costs which, despite the assertions of economists that these should not influence decisions, often do so. People become psychologically invested when they already have expended money and effort into a project, regardless of the current costs and benefits. Thus, if recommended disease prevention requires a new investment or a move away from current practices, farmers may resist. In this case, demonstration of benefits of alternative practices and setting examples becomes particularly important.
3.4. Social influences in farmer decision making

- Psychological and social factors influence farmer behaviour.
- Opinions of “important others” are factored into farmers’ decisions, particularly through subjective norms.
- Veterinarians are the largest outside influence on farm behaviour.
- Social capital is essential to activate norms and collective action.
- Individuals see different values in farming, necessitating a more nuanced rationalising of policy.

102. The agricultural behavioural literature abundantly demonstrates the importance of the psychological, moral and social aspects of farmer decisions (e.g. Howley, 2015; McGregor et al., 1996; O’Donoghue and Howley, 2012). In a more specific context of livestock disease management, Alarcon et al. (2014, pp. 227-228) report that animal welfare, the image and reputation of the farm, and the pride of being a good manager also acted as motivators of disease control, although these were stated less frequently than the financial ones. Delgado et al. (2012) and Delgado et al. (2014) using the TPB framework examined factors related to Texas cattle producer’s intent to participate in FMD detection and control and disease reporting. Moral norms, trust in other producers and social pressure, were among the factors that influenced producer behaviour.

103. Social influences have been shown to have great effect on decisions. People have a tendency to base actions and beliefs on what others are doing or believing. The probability of an individual adopting certain behaviour increases with the increase in proportion of those who have already done so (Colen et al., 2015). This section discusses social factors of livestock farmer decision-making: social norms, farmers’ referents and social capital are in the focus.

Veterinarian, other farmers and government influence on decisions

104. While farmers generally appear to prioritise their own expertise, the views and opinions of others have been shown to have an effect on farmer decisions. Using the constructs of the TPB model, external opinions influence farmers’ outcome beliefs and outcome evaluations and thus, their attitudes towards performing specific behaviour. Opinions of others also affect farmers’ behavioural control beliefs. “Important others”, or social referents, are at the core of subjective norms as another key construct of farmer behaviour. As a socio-psychological concept, norms represent individuals’ basic knowledge of what others do and think they should do. Individuals do not like to feel their actions are out of sync with norms and are motivated to do “the right thing”.

105. A great deal of behavioural research has found that, not surprisingly, veterinarians are the most important source of information and the primary opinion sought by farmers. Garforth (2015: 36), with reference to research in the United Kingdom, notes that veterinarians in private practice are widely seen as credible sources of advice and information by livestock farmers. One reason is that farmers consider veterinarians capable of interpreting and adapting the information according to their farm circumstances. Alarcon et al. (2014) find that the majority of surveyed pig farmers considered their veterinarian’s opinion and advice the most valued, while trust in the veterinarian and or the acknowledgement of his professional competence was in many cases an important factor to comply with external advice. Garforth et al. (2006: 162) studied the decisions of dairy farmers in South West England to adopt techniques for heat detection in cows. Their respondents indicated the veterinarians as the most important external referents. Elliot et al. (2011) and Taylor et al., (2016), and Delgado et al. (2014), and Sok et al. (2015) report a similar finding. However, research also contains caveats on the role of veterinarians as farmers’ referents. Alarcon et al. (2014: 239) report respondent’s negative view that veterinarians “have fashions” and farmers have to be sometimes cautious to take up their advice, importantly also, two respondents in this study saw
a conflict of interest of veterinarians as they also sell drugs. Derks et al. (2013) examined veterinarian awareness of farmer goals and attitudes to herd management in the Netherlands and diagnosed veterinarian misperceptions in that area. Hall and Wapenaar (2012) found that the value that farmers place on discussion with their veterinarians was not matched by a readiness of the veterinarians to initiate discussion.

106. Research also identifies “other farmers” as key referents of farmer disease management, although the evidence is mixed due to specific contexts. Garforth et al. (2006) found other farmers to be the second important referent after the veterinarians in motivating farmers to act in a specific way. They also measured a considerable gap between the impact of these two referents on farmers’ motivation to comply with their views and the impacts of other referents (artificial insemination service, farming press, private consultancy, agricultural universities and internet). Alarcon et al. (2014: 231) similarly report that other farmers’ experiences guided some of the respondents’ decisions on how to control a disease problem, particularly when the cost issue was of concern to the respondents. In contrast, Bruijnis et al. (2013: 109) studying farmer decisions related to the adoption of dairy foot health techniques found that fellow farmers were not seen as important referents compared to feed advisors, foot trimmers and veterinarians. These authors also found a low “motivational power” on farmers of the animal health service and press.10

107. Farmers’ perceptions of government can be drawn from Garforth et al. (2013), who report that the majority of UK pig and dairy farmers in their study judged one or more of Defra’s11 recommended practices for livestock disease management to be either ineffective or inappropriate. In another study of farmers’ attitudes towards buying consequential loss insurance, the respondents showed a strong disinclination to comply with the views of Defra on this matter (Garforth, 2015: 34). More generally, Garforth (2015: 36) concluded that a “recurring theme from recent research in the United Kingdom is the view that government departments and agencies are ill-informed about the realities farmers face and are principally interested in regulating and restricting what they can do rather than supporting their farming enterprises.” Palmer et al., (2009) also report for Australia a lack of trust in government sources, e.g. scientific institutions linked to the government. This evidence may be partial and reflect a specific country situation at a particular juncture (e.g. an aftermath of a serious disease outbreak), but it suggests that farmers’ (dis)beliefs about government may act as barriers to voluntary uptake of policy recommendations.

108. Overall, these findings underscore the importance for policy makers to understand who the farmers’ referents are in order to exploit the most effective “entry points” to communicate and deliver policy. Sok et al. (2016: 118) suggest that social pressure might act as a “catalyst” for policy instruments and leverage the (cost) effectiveness and efficiency of interventions. Veterinarians appear to be the main influence group; in other circumstances, fellow farmers may be also important. Thus, “farmer-to-farmer” or “veterinarian-to-farmer” communication may be more effective in influencing farmer decisions than that of “government-to-farmer”. Local and personal contacts have more influence on livestock farmers’ intentions than more distant and impersonal sources (Garforth, 2010). Farmer forums should be exploited or promoted where farmers could learn directly from others’ views and experiences (Garforth, 2015 with reference to Kilelu et al., 2014).

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10. Interestingly, spouses can also be very influential in farmers' decision making. Kuhfuss et al. (2015), for example, report this finding with respect to the adoption by farmers of agri-environmental schemes.

Social capital and collectivity

109. Farmers can be viewed not just as individuals making separate choices, but as members of communities which have a tangible interest in common (Defra, 2008). Livestock farmers have an obvious interest in common in discouraging behaviour which causes negative externalities of animal disease. This common interest also serves to address broader societal concerns, such as food safety, various aspects of human health and also food security in less developed countries in particular. Society members identify and pursue common interest through trust, reciprocity, obligations, networks, norms, relationships, values, and informal sanctions. All of these form social capital and determine the quantity and co-operative quality of a society’s social interactions. Ahn and Ostrom (2008) distinguish three categories of social capital: trustworthiness, networks, and institutional arrangements. Mutual trust is essential for establishing social relationships. Networks can be described as a set of relationships characterised by familiarity with the others involved through past dealings and repeated interactions with them. Institutions represent more explicit relationships with formalised rules and procedures which often have statutory form, and also tacit rules, but which are sometimes forged over a long history (OECD, 2013). Social capital is important for livestock disease management from several perspectives.

110. First, social capital helps to promote values and norms that discourage behaviours which cause negative externalities. Because actions outside of social norms are often viewed with disapproval, peer pressure and the need for approval provide incentive to conform. Thus, if social norms include responsible farmer disease prevention and control, the effects are more likely to be lasting than when influenced by authority and less monitoring and enforcement of these practices may be required. If it is normally considered shameful, it might be counter-productive to introduce fines, while if it is normally considered the right thing to do, it might be counter-productive to introduce financial benefits (Dawnay and Shah, 2005).

111. Second, social capital fosters virtue by encouraging community orientation and co-operation (Defra, 2008). Although farmers are generally in competition with one another, they may in certain situations see collective action as a rational approach to limit or halt disease and to deal with the consequences. Behavioural economics has been applied to examine when and under which conditions collective action occurs. These conditions are largely rooted in social capital, such as responsibility, trust, reciprocity, and information flows through social networks. According to Ostrom (2009), co-operation is more likely to occur in settings where: 1) many of those affected agree on the need for behavioural change and feel joint responsibility for future outcomes; 2) the reliability and frequency of information about the phenomena of concern are relatively high; 3) participants know who else has agreed to change behaviour and that their conformance is being monitored; and, 4) communication occurs among at least a subset of participants. Heffernan et al. (2008: 369), observing UK cattle and sheep farmers, concluded that a lack of trust, or more broadly, a lack of “social connectivity” within the farming community explained a lack of collective action for biosecurity. The primary message is that farmers are much more likely to choose cooperative behaviour if they have social bonds and are aware that others are choosing cooperation as well. Thus, information about costs and consequences from reliable and relevant sources and facilitating communication among farmers may encourage cooperative solutions. Educational and information programmes could utilise well known examples of preferred behaviour relative to livestock disease prevention and control. These programmes could also utilise veterinarians and industry sources to convey costs and consequences of disease and potential benefits from co-operation across and among farm operations.

112. Third, social capital is likely to activate interactions between farmers and government. Participation through the existing social networks in discussing issues helps farmers learn about the policy context and act in ways beneficial to the community. Farmers with high linking social capital seem to be
inclined to increase interaction with government on specific issues as opposed to farmers with low linking capital (Defra, 2008).

### 3.5. Farmer values and motivations attached to farming

3.5.1. Rural sociologists have studied farmers’ values and their motivations to be engaged in farming. These studies brought into light a concept of farming styles, strongly synergetic with other behavioural analysis. Gasson (1973: 527) distinguished four broad value orientations of those undertaking farming: 

- **Instrumental**: farming is a means of obtaining income and security (e.g. making maximum or satisfactory income and security, safeguarding future income, expanding business);
- **Social**: farming is for gaining prestige as a farmer (e.g. belonging to farming community, maintaining family tradition);
- **Expressive**: farming is a self-expression or personal fulfilment (e.g. exercising special abilities, exercising self-respect for doing a worthwhile job, chance to be creative), and
- **Intrinsic**: farming is an activity in its own right (e.g. enjoyment of work tasks, healthy outdoor life, value in hard work, independence).

3.5.2. These insights led to further research into patterns of farmers’ behavioural motivation and the related farm typologies. For example, Rehman et al. (2008) identified several farming styles in England and this work fed into Defra’s further development of its Farmer Segmentation Model. Based on a multivariate analysis of responses to a set of 51 statements about farming values and objectives, five farming types were identified: “custodians”, “lifestyle choice”, “pragmatists”, “modern family business” and “challenged enterprise” (Figure 3.3).

**Figure 3.3. Defra’s Farmer Segmentation Model**

- **Custodians (25%)**: Farming is a way of life. Pride in farming heritage and environment.
- **Lifestyle choice (6%)**: Farming is not the main source of income. Tradition and a pleasure.
- **Pragmatists (22%)**: Balanced approach. Emotional connection with farming, but recognises need to focus on business.
- **Modern family business (42%)**: Family success and income. Financial planning important.
- **Challenged enterprise (7%)**: Farming is a burden and a struggle. Isolated and pessimistic for future.

**How to engage?**

- Respect
- Partnership working towards mutual benefits
- Protecting the future

More emotive, sensitive to needs, not directive but an inclusive approach.

**How to engage?**

- Business-focused
- Productivity
- Input costs


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12. A recent pilot study by Wilson et al. (2011) embedded Defra’s segmentation framework within Farm Business Survey for England. 750 Farm Business Survey respondents were interviewed for this study, which established the following distribution of farmers according to segments: custodians (14%), lifestyle choice (7%), pragmatists (53%), modern family business (21%), and challenged enterprise (4%).
Notably, this analysis revealed that segments were similar when profiled by “external” descriptors, such as farm size, region and farm specialisation, and it was only when attitudes were included that major differences emerged. Thus, farms can be characterised differently if “internal” characteristics of farm operators are taken into account. A key policy inference is that different farm groups may be less or more reactive to the reasoning based on purely economic rationality (and to economic policy tools). A broader rationale should be employed in incentivising a desired behaviour amongst farmers and different communication and language need to be exercised to influence different farm groups (Defra, 2008). As Defra’s Farm Segmentation Model suggests, for some farm groups, a less directive and emotive outreach may be more effective, and which also suggests collective solutions and appeals to public good aspects of farming – these could be benefits of good livestock practices for the local community, animal welfare, human health, or societal welfare more broadly. For other groups, a more pragmatic messaging is required, with reference to cost management, financial consequences of bad or good livestock diseases management, and its impacts on farm productivity.

Certainly, because culture and values differ across societies, the farm segments can have different psychological and social profiles and weights across countries compared to those drawn in the model above. However a general implication is that differentiating farms also by these features as opposed to conventional criteria of farm size, specialisation, or region, may make policy more effective. Policy communication should engage different notions – psychological, social, as well as economic – to have broader response in farming community. Synergies can be found here with the concept of “nudging” which suggests that policy makers can design policies that improve well-being through gentle nudges rather than through coercive measures by appealing to individuals’ more profound values (Box 3.2).

Thaler and Sunstein (2008) developed the concept of “nudging” as “any aspect of choice architecture that alters people’s behaviour in a predictable way without forbidding any options or changing economic incentives”. Nudge is the idea that formal regulations are not required because a small push can get people to change behaviour. In contrast, regulation is “budging” by reducing choice sets (Barnes et al., 2013). Thaler and Sunstein argue that if behavioural economics teaches us that we do not always act in our best interest, then policymakers must rethink the tools of regulatory command to change behaviour and better align our immediate choices and our deeper, truer preferences.

Applied to livestock disease policy, nudging means steering farmers towards better decisions by presenting choices in different ways. For example, it may be the case that presenting biosecurity practices as a form of “production insurance” may encourage adoption more than simply presenting them as livestock health protection. Another example from the research is that that telling someone of their electricity consumption compared to their neighbours prompted them to use less. Perhaps the same applies to livestock or poultry disease prevention and control. These types of questions about what language is most appropriate for nudging behaviour could form the core of a rigorous research programme. Economic experiments could be instrumental in this regard (Colen et al., 2015). They allow the identification of relevant behavioural parameters and testing the policy performance against farmer preferences.

### Box 3.2. Nudging approach in policy

3.6. **Implications for animal disease policy**

Behavioural theory suggests that identification of farmer behaviour is a starting point for policy that aims to influence that behaviour. This theory regards farmers’ decisions as an outcome of complex influences which go beyond purely economic and financial factors. Farmers’ broad values and motivations, their ability to process information and build knowledge, and their social connectedness also drive farmer decisions.
118. One implication is that if policy makers desire to see a positive change in farmer behaviour they need to build evidence about it and invest in behavioural research. Beyond monetary cost, this requires joint work between the government and researchers. An important task for the government would be to formulate the policy problem and the objectives sought to be achieved because contexts are essential in any behavioural work. Another implication is that for policy to become more effective, it should act along the whole spectrum of behavioural drivers to constrain those that prevent the desired behavioural change and build upon those that work towards it. Behavioural analysis shows that such interventions lie primarily in the domains of information, education, advice, and policy communication. There is a substantial body of expertise that combines behavioural and communication science which could be applied to livestock disease management (Fishbein and Yzer, 2003).

119. Livestock farmers generally feel confident about their expertise, but this may reflect overconfidence, cognitive biases and cognitive failure. The role of livestock policy is to understand and offset these through improved risk communication, credible early warning information, and targeted information and advice (Garforth, 2015).

120. Behavioural economics suggests that information about the disease including its likelihood and consequences, should be framed so as to alleviate or overcome cognitive biases. Establishing a culture of habits and preferred behaviour may strongly influence farmers. The government may wish to use surveys, focus groups and other means of communicating with stakeholders to assess the relevant biases, habits and norms. These actions may have both short- and long-term implications for farmer behaviour.

121. Perceptions of farmers about trustworthiness of information and advice are highly important. Information from government may be mistrusted and ignored, whereas veterinarians and fellow-farmers may be perceived as reliable referents. Policy makers need to understand who the farmers’ referents are to exploit the most effective pathways to communicate and deliver policy. Some evidence suggests that livestock farmers are not particularly proactive in seeking new information (Garforth, 2015). Their willingness to operationalise the information also depends on whether it can be easily adapted to their particular circumstances. Thus, any modes and tools that help farmers to customise general information and evaluate the proposed measures in application to their own business will increase the absorption of information.

122. Economic considerations permeate farmers’ decision mechanism for livestock disease management. Enhancing farmers’ knowledge, information, and ability to assess the economic costs and benefits of these decisions should be a permanent policy focus. Providing sufficient evidence on the cost-effectiveness of desired farm practices is integral to that task. To encourage desired behaviour it may be more effective to highlight potential losses than gains, as people tend to focus on losses much more.

123. While economic motivation is important, farmers differ in how they balance it against other values which are not necessarily connected with farming as business. Farmers may be less or more responsive to the reasoning based on purely economic rationality and, thus, to economic policy tools. Policy should engage different notions – psychological, social, as well as economic – to have broader response in farming community. By appealing to preferred values, policy makers can use gentle nudges, rather than applying coercive measures. Through the use of displaying and communication choices and context, policy-makers can nudge behaviours such as biosecurity practices and reporting of suspect animals.

124. Social capital – social norms, local networks, professional groups – assists in appropriate decisions by individuals and enables collective action where they see common interest. If policy can change social norms to align with preferred behaviour, the effect is likely to be long-lasting and require less enforcement. Engaging communication and social connectivity amongst farmers should be factored into livestock policy. Building trust between livestock farming and broader society is also important.
Raising the general public’s awareness on existing biosecurity standards and systems for disease prevention, industry quality assurance, voluntary certification which makes safe products easily recognisable, are ways to reinforce social norms for high biosecurity in livestock farming.

In sum, to integrate a behavioural approach into policy for improved animal disease management decisions the first step is to understand which behaviour is occurring (and by whom). This may result in determining that the behaviour is in line with goals or out of bounds, and identify segments or subpopulations that can be targeted. The second step is to understand why undesirable behaviours are occurring. This information can be utilised in the third step which is to design and implement potential actions to nudge, anchor, or otherwise positively reinforce preferred actions. The policy actions may include information and education programmes, framing desired actions in terms of avoided losses, providing professional or expert information on risks and frequencies of occurrence, or resetting default actions.
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CHAPTER 4.

ISSUES OF LIVESTOCK DISEASE MANAGEMENT BEYOND THE FARM:
COLLECTIVE ACTION, THE ROLE OF FOOD CHAINS, AND WILDLIFE

126. The focus of the previous chapters has been on the individual farmer aspects of disease management and decision making. This chapter considers outside factors that play a role in farmer disease management and should be accounted for in policy design and implementation. Section 4.1 looks at livestock farmers operating as a group; specifically, it examines producer collective action in livestock disease management, often involving partnerships with government. Section 4.2 considers the role of the actors in the rest of the value chain in co-operating with farmers and influencing farm animal disease management. Responses to food safety and quality, animal welfare and other consumer concerns related to livestock production methods may drive changes in farm practices by aligning incentives with policy objectives. Section 4.3 assesses what the presence of wildlife populations as disease reservoirs and vectors means to disease management and farm decisions. Section 4.4 summarises the implications of these aspects for livestock policy.

4.1. Producer collective action in livestock disease management

- Livestock disease management functions within a continuum between pure public and pure private goods, which leaves much scope for collective action.
- To act collectively, farmers should perceive an animal health problem as a shared concern.
- The “free-rider” problem is a typical barrier to collective action.
- Many farmers view epidemic disease as a government problem and endemic disease as an individual farm programme which discourages collective action.
- Farmers should see benefits from collective action as greater than costs.

127. Collective action is defined as “the action taken by a group (either directly or on its behalf through an organisation) in pursuit of members’ perceived shared interests” (Marshall, 1998). Collective action in agriculture has been shown to play an important role in supplying farms with inputs, services and marketing agricultural products, risk management (OECD, 2011), and agri-environmental activity (OECD, 2013a; OECD, 2012a).

128. The premise for collective action in livestock disease management is that the variability and different attributes of related functions place these functions within a continuum between pure public and pure private goods (Box 4.1). The boundary between public and private provision is intrinsically movable and depends on the nature of activity, which in itself is not static and may change, for example as new technology becomes available or new regulation is introduced. In addition, even if the characteristics of activity suggest predominantly a public good nature, this does not necessarily mean that public sector must provide it directly. The government may contract out the service to producer groups and manage it through financing, regulation, taxes, levies, or subsidies. Even if a service is a direct public function, there is

13. For example, the development of drugs and “pour-on” insecticides has changed the control of trypanosomosis in endemic areas from a public good to a private good as the benefits of control can now be limited to those who purchase the drugs or insecticides (Holden, 1999: 428).
rationale for participation of private stakeholders to make the service more effective and efficient, for example, when it concerns risk assessment, building of information systems, design of contingency plans, or implementation of specific disease programmes.

Collective action also depends on the degree to which the societal attitudes of state paternalism versus self-reliance are established towards the farming community. It will more likely develop more in the policy environment which creates little expectation amongst farmers that the costs of their business risks will be systematically shared by society. Collective action also depends on farmers’ perceptions of particular livestock problems as an individual or collective matter. Heffernan et al. (2008, p. 358), in their study of bio-security collective action among UK cattle and sheep farmers conclude that they largely considered epidemic diseases as an issue external to individual producer and a matter of border control agencies, national biosecurity policy, and regulations. At the same time, they viewed endemic disease as a problem of “bad” farmers and not of those who manage their stock well. The authors conclude that when a problem is viewed as an individual problem, there is little utility in acting collectively.

Box 4.1. Theory of public and private goods in application to livestock health

The rationale for public and private roles in the context of animal health is strongly associated with the notion of externalities and public goods. The distinction between public and private goods is based on the criteria of excludability and rivalry. Excludability considers whether the provider or consumer of a service can prevent (or exclude) others from simultaneously benefiting from the service. Rivalry (or subtractability) concerns the extent to which the use or consumption of a good or service by one individual reduces the availability of this good or service to others. High rivalry enables individual consumption, whereas low rivalry permits joint consumption. Holden (1999) applied these criteria to specific veterinary activities and concluded that few of them are purely public, or private goods and most contain elements of each.

<table>
<thead>
<tr>
<th>Excludability</th>
<th>Public goods</th>
<th>Toll goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Epidemic or zoonotic disease control (including surveillance, movement control, quarantine services)</td>
<td>Vaccine production</td>
</tr>
<tr>
<td>Low</td>
<td>Some extension</td>
<td>Diagnostic services</td>
</tr>
<tr>
<td>Low</td>
<td>Some research</td>
<td>Veterinary clinics</td>
</tr>
<tr>
<td>Low</td>
<td>Control of foodborne diseases</td>
<td>Dips</td>
</tr>
<tr>
<td>High</td>
<td>Drug quality control</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low excludability</th>
<th>Common pool goods</th>
<th>Private goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Tsetse control on pre-communal land using traps, targets or aerial spraying</td>
<td>Endemic disease</td>
</tr>
<tr>
<td>High</td>
<td>Drug quality control</td>
<td>Sales of drugs and spraying vaccines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some extension</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some research</td>
</tr>
</tbody>
</table>

Thus, beyond activities with predominantly public and private good properties, some can be qualified as “toll goods”, i.e. excludable, but with low rivalry, so that non-paying users can be denied access to the service, but several people may use the service at any one time. An example of a toll good is a cinema - several people can watch the film at the same time, but non-paying users can be denied access to the cinema. Other examples of toll goods are buses, trains and airplanes. Because of the high excludability characteristics, toll goods can usually be financed by the consumer. However, some services with low rivalry may require large initial investment. The investment required might exceed the funds that can be raised by the private sector. The construction costs of a railway line for example may be so great as to deter private sector investment. In certain circumstances, public finance may be justified in order to establish the facilities and resources to produce the service, although the private sector may then finance the operation of these services.

There are also “common pool goods”, which on the other hand, have high rivalry characteristics (increased consumption diminishes supply for others) but are non-excludable (i.e. non-paying users cannot be prevented from using the service). An example of a common pool good might be a village water supply: no one can be prevented from using the water, but increased consumption of water by one individual would reduce availability to others. Because non-paying users cannot be denied access to the resource, no incentive exists for the consumer to pay for the service (in this example, to drill more boreholes). Common pool goods, thus, usually require some form of public financing.

130. The insights from the environmental analysis about the benefits and the barriers to collective action can be projected onto livestock disease management (OECD, 2013a). Collective action can generate economies of scale and scope and reduce the cost of management through sharing and mobilising resources. It can promote norms, industry-specific rules, and best practices. It can enable knowledge sharing among members and increase their technical capacity. Collective action can provide the flexibility to tackle local issues better than in a centralised way. Because disease occurrence and spread has spatial dimensions, disease prevention and control across neighbouring farms can be complements (Hennessy, 2005). In these cases, collective action may allow individual farmers to manage their stock and coordinate farm practices at an appropriate geographical scale beyond administrative borders.

131. While yielding potential benefits, collective action also has barriers. A key barrier is the “free-rider” problem. If people cannot be excluded from using a good, they have little motivation to voluntarily contribute to its provision. The issue is then how to limit free riding. Another barrier to collective action is that it requires additional transactions costs compared to individual activity. These include search costs, bargaining costs, and monitoring and enforcement costs. Third, sceptical attitudes to collective undertakings may be a barrier as farmers are used to individual management. As noted in Chapter 3, collective action requires sufficient social capital to create trust and social connectedness that enable potential participants to formulate and pursue shared interest. Fourth, uncertain policy environment including funding, objectives and management can inhibit participation by increasing uncertainty about the future and benefits of the programme (OECD, 2013a). This uncertainty may be about, for example, potential market effects from trade and movement restrictions or whether ad hoc payments for consequential losses will be provided to affected farms.

132. A distinction of collective action by who leads it is useful for further examination (OECD, 2013a). Collective action may be bottom-up driven and take the form of farmer-to-farmer cooperation. In this case it typically can emerge to deal with issues specific to particular locality or region. Another type is a top-down collective action led by producer groups when there is a concern for the whole sector. In both cases, collective action may occur without government involvement or may integrate government at different administrative levels and receive government support in various forms. Some countries provide evidence of unique partnerships between farm industries and government in livestock disease management. In Australia, for example, the principle of public-private partnership is at the core of the national on-shore biosecurity system.

**Farmer-to-farmer co-operation**

- Not much is known about farmer-to-farmer co-operation in livestock disease management.
- Interrelationships of individual decisions to control animal disease can be strong at the area level.
- Farmers are likely to co-operate if there is a shared resource or novel techniques for uptake.
- Mistrust of others’ actions and motivations discourages collective action.
- Efforts to support group formation must recognise and address perceptions of social connectedness amongst the communities involved.

133. OECD (2012a) and OECD (2013) highlight many examples of farmer-to-farmer collective action related to agri-environmental and climate change activities, typically also engaging other rural community stakeholders and local governments. An initial search for such practices in livestock disease management seems to show that they are not well documented and attract less attention of researchers.

134. Although more investigation is required into the incidence and the scope of farmer-to-farmer cooperation in livestock disease management, some insights can be drawn from a study by Hall and
Burnett (2014) who examined whether farmers in England and Scotland would consider collective action for crop disease control. Cooperation was more likely when using new or unknown disease treatments. Farmers were more likely to consider cooperation when there was a shared resource (e.g. a weather station), a third party to facilitate, penalties for free-riders, evidence of benefits from cooperative action, information explaining why cooperation was useful, and financial support to cover cooperative action costs. Factors of mistrust of other farmers that discouraged cooperation were: doubting others would stick to the plan, not wanting to share plans with competitors, likelihood of disagreements, and belief that it was “not in their nature to help each other.” One approach to encourage collective action is to utilise existing networks where social capital in the form of mutual trust and reciprocity exists. Farmers were more likely to consider novel cooperative approaches. The authors suggest that policy-makers to encourage collective action should clarify its benefits, provide support including financial support, external facilitation, some form of shared resource, information and evidence of benefit.

**Collective action by livestock industry groups**

- Industry action is more likely to occur in producer groups that are institutionally and financially sound.
- Country experiences show that the livestock industry can lead in many fields of livestock health.
- Farmer capacity building is a typical area where industry leadership can be exploited.
- Industry co-operation in disease insurance can have advantages over private provision.
- The livestock industry can lead in specific disease programmes, supported by government.

Experiences across countries suggest that the scope for industry led collective action in livestock disease management can be broad. Such initiatives are most likely to develop if there are strong producer groups, characterised by institutional and financial soundness and the organisation procedures that ensure good connectivity with and among individual members. In some countries producer associations function on the basis of systems where levies are made compulsory by national law for all producers in the industry, and its collection is administered via the national tax systems (Box 4.2).

**Box 4.2. Levy systems for producer associations**

New Zealand’s Commodity Levy Act (1990) empowers producers to self-impose levies through a vote in order to finance the “industry good” activities. Once voted, the levy becomes obligatory for all commercial producers of a commodity and is charged on each unit marketed as a type of sales tax. Levies are collected by downstream operators and transferred to industry good bodies. The obligatory character of the levy is grounded by the necessity to avoid a “free-rider problem”: everyone is obliged to pay as it is difficult to exclude non-payers from benefiting from “industry goods” just because they have the characteristics of public goods. However, this compulsory levy is introduced through voting and is therefore self-imposed. There is also a requirement to vote (every six years) the continuation of a levy; it is therefore possible that the levy can be repealed by farmers, which acts as a strong means of farmer control over the association (for example, in 2009 wool producers voted against continuation of a wool levy which happened in the context of substantial economic difficulties that the sector experienced at the time). The activities to be undertaken by the industry good body must be approved by the levy payers.

In Australia, a levy system is operated and administered by the Australian Government at the request of industry. A levy is payable on transactions involving livestock (defined to include sheep, lambs and goats) and/or cattle (defined as bovine animals other than buffalo – there are separate levies on buffalo, deer and pigs). The levy is paid by the trader or the slaughterhouses purchasing the animals. Components of the levy are used to fund: research, development and marketing activities by Meat and Livestock Australia (MLA), programmes conducted by Animal Health Australia (AHA), plus contributions to the National Residue Survey. The Levies Revenue Service (LRS) receives the funds and forwards them to the relevant organisations, in addition to distributing the Australian government’s matching research and development (R&D) contributions. Activities funded by levies include R&D, marketing and promotion, plant and animal health programmes, and residue testing.

*Source: OECD, (2011); OECD (2012b)*.
136. The examination of country practices distinguishes several broad areas of collective action by the livestock industry including: (i) farmer capacity building; (ii) implementation of specific disease programmes; (iii) disease risk insurance; (iv) disease surveillance; and (v) responses to disease outbreaks. In all these areas there is a rationale and examples of partnerships between industry and government.

137. Capacity building is a typical activity of industry groups, consisting of the provision of general information, training, and education for livestock farmers. This is the case where the benefit of collective action occurs through economies of scale and scope. Funded research on control measures, causes and consequences of disease, as well as co-operative extension and other educational resources are often administered and performed co-operatively between government, university, industry, and private farm organisations. Concrete examples are provided in the country case studies as part of this review.

138. Industry led collective action also concerns programmes to control and eradicate specific disease. These are often implemented in cooperation with government: the industries can fully fund the programmes or share the funding with governments and other stakeholders, while government (through its affiliated agencies) can ensure the overall co-ordination and implementation of these programmes (Box 4.3).

Box 4.3. Industry participation in disease control and eradication programmes in Australia

Australia has a long history of industry involvement in livestock disease eradication. At present, livestock industries fund the projects to manage Johne’s disease in sheep, cattle and alpaca. These industry-funded projects are co-ordinated by the Animal Health Australia.1 Technical advice is provided by the National Technical Adviser and, from time to time, Technical Working Groups may be convened at the request of the industries with representatives provided by Animal Health Committee. In addition, to these programmes, Johne’s disease Market Assurance Programmes (MAPs) are being carried out for the same types of animals (sheep, goats, cattle and alpaca). They are based on collaboration between the states and the industries concerned. These are voluntary programmes for producers to identify and promote their negative Johne’s disease status to clients. Herds and flocks participating in the MAPs are not accredited as free of Johne’s disease, but they have a lower risk of being infected compared to non-assessed herds and flocks. Producers can minimise the spread of Johne’s disease by sourcing replacement animals from herds or flocks in the MAP assessed. Participating herds or flocks are tested to determine their disease status and managed to reduce the risk of infection (Animal Health Australia, 2016a).

Australia carried out a long-standing bovine brucellosis and tuberculosis eradication programme and in 1997 it achieved the status of ‘TB Free Area’. Monitoring for tuberculosis has continued under the five-year Tuberculosis Freedom Assurance Program and measures to further reduce the risk of new cases have been implemented. Radunz (2006) credited the success of this programme to strong industry and government support. Industry supported negative incentives for non-cooperating producers. Industry funding provided financial incentives to accelerate progress such as subsidies for mustering and holding, compensation for exposed stock sent to slaughter or destroyed, low interest loans for cattle yards, fencing, restocking freight rebate and interest subsidies. Funding was provided by the cattle industry (50%), state governments (30%), and the federal Australian government (20%). Funding initially contributed to operational costs and compensation payments for test reactors. Later it was extended to provide compensation for cattle and buffalo exposed to infected animals. Financial assistance was also extended to provide subsidies for low interest loans and other incentives.

1. Animal Health Australia is a not-for-profit public company uniting 32 members and representing Commonwealth, state and territory governments; industry organisations; service delivery and non-programme participants and associate members (feed producers and research institutions). It currently manages more than 50 national programmes related to animal and associated human health, biosecurity, market access, livestock welfare, productivity, and food safety and quality.

139. Industry led collective action in the form of mutual funds can also develop in disease insurance. The advantage of mutual funds is that they can provide coverage targeted to specific risks of producer groups which larger and more diversified insurers do not provide. These companies can also better deal with problems of asymmetric information and moral hazard as they tend to have a stronger sense of
ownership and trust amongst their stakeholders compared to conventional public stock companies. Mutual funds may also adopt flexible regimes of premium collection, which are better tailored to cash flows of their clients. Governments can provide the initial incentives to create such funds by way of start-up capital and attracting private expertise for product development. However, mutual companies may suffer a lack of financial robustness due to their relatively small size and the small scope for diversification in their risk portfolio, requiring sometimes re-insurance support from the government. Their business decisions may also be more susceptible to stakeholder pressure (Box 4.4).

**Box 4.4. Dutch mutual insurance funds for livestock disease**

Mutual insurance companies were created for several agricultural industries in the Netherlands, among which two that are specialised in disease risk insurance for poultry and pigs.

Avipol Mutual covers rearing and breeding broiler production farms in the poultry sector against the risk of specified poultry diseases. The point of departure for this insurance was that public assistance was no longer available. Only farmers with an Integral Chain Control and Salmonella Control (ICcsc) certificate can participate in this mutual. Certified flocks are considered to have a lower risk of microbial infections, including the insured salmonella types. In order to obtain a certificate, poultry farmers must take strict measures with respect to: 1) construction, lay-out and cleanliness of the enterprise; 2) manner of keeping poultry; 3) supply of animals, (hatching) eggs and feed; and 4) third party visits. If contamination is detected, strict control measures are applied for treatment or destruction of animals and (hatching) eggs, and removal of the contaminated material and manure.

The Porcopol insurance scheme was created in 2002. It covers consequential losses from swine epidemics (FMD, classical swine fever and Aujeszky disease) on sow farms. Members of the mutual receive a fixed compensation per sow in the case where (i) sows are infected with Aujeszky disease and need to be vaccinated; (ii) sows are infected with FMD or classical swine fever and need to be culled; or (iii) sows need to be pre-emptively culled because of an outbreak within a sphere of 1 km. Preventive vaccination does not trigger a payment.

The experience of the Dutch mutuals is instructive in that it shows that specialised insurance funds can fill the market niches that otherwise would not be filled by larger and more diversified insurers. Perils covered by these relatively small-scale companies are generally not covered by large insurers because of expected problems of moral hazard and adverse selection. Small mutual funds can cope with these problems better because they can better address information asymmetries. There is typically good knowledge of the members and their business, involvement of members in mutual control (e.g. as board members of a mutual), and there is direct access to clients. Dutch mutuals also apply specific rules concerning the premium payments, which may provide certain advantages from the perspective of producers. For example, Avipol and Porcopol divide premium payments into advance and adjustment payments, enabling producers to spread premium payments over time. This also creates incentives for risk prevention and to expand the retention level in order to minimise the eventual cost of insurance. If no risk has occurred by the end of the year, the unused premium is allocated to all farmers insured. However, the experience of specialised Dutch mutual also show a lack of financial robustness and that they tend to be dependent on government support (e.g. for re-insurance).

*Source: Melyukhina (2011).*

140. Another area where farm industry collective action can play an essential role is the management of disease outbreaks. While the approach in many countries is for the government to operate without direct industry involvement, successful cooperation can occur between government and industry groups. The latter can be instrumental in the assessment of risk and the establishment of the required response measures; they can also play a critical role in ensuring local outreach and feedback. Industry funds to participate – along government – in the cost of livestock epidemics is a potentially important activity, discussed in the following section.

**Public-private partnerships in management of livestock epidemics**

- Alternative financing to fund disease losses can provide a framework for co-operation and have implications for incentives.
- Some countries have successful long-term cost-sharing arrangements for epidemic diseases.
141. Public-private partnerships can be created to share the responsibilities and the costs of control of livestock epidemics between government and livestock industries (Box 4.5). Alleweldt (2013) notes that such partnerships are found only in a small number of countries, but where they exist, they have high level of stakeholder acceptance. In the context of this review, it is appropriate to discuss cost-sharing schemes from the perspective of how they help to better align public and private incentives.

142. Cost-sharing schemes are by definition *ex ante* frameworks and as such, they substantially reduce the uncertainty that individual producers face in the event of disease outbreak. This is achieved through protocols that spell out potential control measures and the procedures to define the sets of measures to be applied in response to a particular epidemic. These schemes can also set in advance the compensation principles, including the scope of compensation (direct losses versus consequential, or types of disease), the formulae to establish compensation amounts, and timeframes for its execution.

143. A cost-sharing approach also inherently incorporates mechanisms to address moral hazard. Because the beneficiaries (farmers through their groups) pay a share of the outbreak response cost, they see an incentive to limit that cost by avoiding disease risk through sufficient preventive effort. An additional lever for prevention can be an inclusion of a requirement for the beneficiaries to be prepared for an outbreak and take recovery measures in order to receive compensation. In the Australian EADRA, for example, there is the requirement for producers to have individual bio-security plans. These plans contain measures to mitigate the risks of disease entry or spread and can be developed with direct contributions of industries. Thus, grazing industries in Australia have published the National Farm Biosecurity Reference Manual—Grazing Livestock Production as the basis for a farm biosecurity plan. Moral hazard is also addressed through peer pressure: individual producers become eligible for compensation as part of producer groups that can monitor the adequacy of members’ practices; this monitoring can also increase pressure for early reporting of disease by individual farmers.

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**Box 4.5. Experiences of cost-sharing arrangements in livestock epidemics**

*Dutch Animal Health Fund (AHF)*

In the Netherlands, producer contributions to direct costs of livestock epidemics are operated through the Animal Health Fund (AHF). The current procedures were developed following the devastating epidemic of Classical Swine Fever in 1997/98 when the control measures generated significant expenses for the government. The AHF effectively sets the maximum amount of producer contributions to cover the direct control costs in the case of a disease outbreak. Any spending required beyond this limit is equally shared by the Dutch government and the European Union (the latter through contributions from the EU Veterinary Fund). The AHF covers all primary livestock types: pigs, cattle, poultry, and sheep and goats. The accumulation and use of the Fund is managed by Commodity Boards for Livestock, Meat, and Eggs. Producer contributions occur through levies per slaughtered/exported animal, or per unit of milk sold. The size of the fund and the levy amounts are based on a scientific risk assessment and the evaluation of the financial cost of the control measures. However, the size of contributions is also subject to negotiations between the government and industry. In deciding the size of the fund, only the risks of major diseases are considered (mainly, CSW, FMD and AI). In the event of other large epidemics, additional assessments are made and additional levies imposed. The combination of measures applied to control epidemics (scope of culling, recourse to preventive vaccination) constitutes part of the budget assumptions. For example, the different control strategies applied in specific epidemic events explain the differences in the amounts of funds for each of the five-year periods since 2000.

*German Animal Disease Funds*

The main financial arrangement for epidemic diseases compensation in Germany is the animal disease funds (Tierseuchenkassen). In contrast to the Dutch Animal Health Fund it is a more regionally diversified system. The legal foundation for Tierseuchenkassen is the Animal Disease Act which constitutes an overall federal legal framework, but laws in each federal state are also applicable. Fifteen of Germany’s sixteen federal states have their own Tierseuchenkasse controlled by a Governing Board whose members are chosen by state agricultural ministries, county veterinary authorities and agricultural organisations. The Tierseuchenkassen compensate livestock owners who suffer financial losses due to epidemic disease outbreaks. Compensation is provided for direct losses due to officially ordered culling, losses from animals that die after destruction was ordered, and when a disease is detected after the death of
the animal. Compensation includes the actual value of the animals, and culling and disposing costs.

Beyond epidemics compensation, Tierseuchenkassen have a role in prevention and eradication of disease. Prevention measures include surveillance and monitoring for diseases including classical swine fever, bluetongue disease, avian influenza and various cattle diseases, as well as vaccination programmes. Tierseuchenkassen establish and finance actions to eradicate non-epidemic diseases, such as Infectious Bovine Rhinotracheitis (IBR) in cattle. Generally, state governments consult with the Tierseuchenkassen to co-ordinate their respective expertise, experience and financial resources regarding livestock epidemics. Some Tierseuchenkassen voluntarily engage in monitoring and other prevention measures for non-epidemic diseases. Under some state laws, Tierseuchenkassen also implement the mandatory tasks of compensation for rendering and disposing of animal by-products.

These publicly administered funds are supported by mandatory levies paid by livestock operators, as well as by funding from state governments and co-financing from the European Union. Livestock holders’ levies are based on the particular species, the number of animals, and possibly other criteria, such as the weight and age of animals, herd size, the commercial use of animals, the risk of disease, and the absence of infectious diseases. They also depend on the expected costs for the general operation of each Tierseuchenkasse for each species. These costs can include prevention measures, the building of reserves or repaying debts stemming from previous reimbursements. Each farmer must annually report data on his/her livestock to the Tierseuchenkasse. Each Tierseuchenkasse’s Governing Board determines the levies which are authorised by the state government.

**Australian Emergency Animal Disease Response Agreement (EADRA)**

The Emergency Animal Disease Response Agreement (EADRA) in Australia is a contractual arrangement between the Australian state and territory governments and livestock industries to collectively ensure preparedness for and response to emergency animal disease. The EADRA covers 61 categorised animal diseases and 23 signatories (national and state and territory governments and 14 industry bodies).

EADRA is a broad framework that embraces the whole spectrum of activities for prevention, preparedness for, and response to disease incursions. The cost-sharing in the emergency response to disease epidemics is the central component of this agreement. It establishes the formulae for the distribution of burden: (i) between the governments and industry; (ii) the burdens of specific governments within the government part; (iii) and the burdens of specific industries within the industry part. An overall principle to determine the government-industry cost shares derives from the potential externality effects of disease on the overall society: the higher these effects, the higher government’s and lower industry’s share is, and vice versa. For that purpose, EADRA stipulates four categories of animal diseases. The diseases that seriously affect human health and/or the environment but which may only have minimal direct consequences to the livestock industry are defined as Category 1 diseases (e.g. rabies). The biosecurity measures for diseases in this category are fully funded by governments. Category 2 diseases may have “slightly lower” national socio-economic consequences, but have significant public health or environmental consequences that result in “very severe” production losses (e.g. BSE, AI, or FMD). The government funds 80% of the cost of measures for Category 2 diseases, while the rest is industry funded. Government and industry share the cost equally of Category 3 diseases, which have “generally moderate” national socio-economic consequences, with minimal or no-effect on human health or the environment, but “severe” production losses (e.g. CSF, Bluetongue, Newcastle disease). Diseases that are not expected to significantly affect the society and for which their main effect is limited to the livestock industry are categorised as Category 4 diseases for which industry pays 80% of the cost (e.g. Aujesky’s disease, bovine tuberculosis). Finally, if a disease cannot be characterised under any of the above categories, all costs are borne by the government.

In addition to the proportion of the cost shared between the governments and industry, EADRA sets the specific formula on how the cost is shared between governments of different levels and between different industries. The national and state/territory governments equally share the cost of an emergency disease response. However, the cost that each state shares depends on the disease under consideration. Within the industry, the cost is shared according to the benefit that each industry receives from the emergency disease response. If the disease affects only one species, then the industry related to that species bears the entire cost that falls to that industry. If the disease affects more than one species, the share of the cost attributed to each industry is determined by both the gross value of production and the importance of the specific disease for that industry.

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1. See case study on Australia for further detail on EADRA.

because there is a problem of asymmetric information: government has limited information on the true
costs of complying with reporting requirement for the farmers. Cost-sharing schemes can reduce
information asymmetries because they involve farmer stakeholders which benefit from and contribute to
costs of compensation. These schemes therefore have incentives to generate the information which would
lead to an “appropriate and equitable” compensation. Consultations that are part of the cost-sharing
agreement enable information sharing, while negotiation procedures between stakeholders provide the
flexibility to fine-tune compensation levels and cost-sharing.

145. Beyond considering the incentives that cost-sharing schemes create for an individual farmer it is
also instructive to analyse the factors that make these schemes successful. Based on a comprehensive
review of the existing disease compensation schemes (OECD, 2012b), Alleveted (2013) indicates several
principles for a “pragmatic and manageable” system. One is that such schemes should be mandatory, with
those who contribute directly to the overall risk of the disease paying into the schemes. Inclusion of
downstream industries does not seem rational as this would add complexity, in particular in the
determination of which industries should contribute. Another principle suggested is that all those who pay
should receive the benefits if they are directly affected. Cost-sharing schemes should generally cover direct
losses related to outbreaks without covering consequential losses. However, it might be warranted to cover
business interruption losses in movement restriction zones because if culling is implemented, farmers in
such zones may be worse off than those whose herds were culled (this, however, requires further
investigation). An additional principle is that schemes should adjust the levies paid according to risks at the
individual level; for example, based on the level of biosecurity measures implemented. However, this is
hard to apply in practice. Finally, epidemic cost-sharing schemes could incorporate prevention measures,
such as financing specific vaccinations.

4.2. The role of other agri-food chain participants

- Other firms in the food value chain are mostly concerned with foodborne illnesses.
- There is increasing public concern with verification and traceability of production practices in food value chains
  which may encourage other participant to become involved with farm biosecurity and herd health programmes.
- Voluntary insurance programmes are enabled by industry-government co-operation.

146. Changing public attitudes about livestock and poultry production have made processors and
retailers more cognisant about links to farm practices. Specifically, the public in many countries is
increasingly aware and concerned about food safety and animal welfare (Waller, 2006). These concerns
manifest themselves in food preferences and depend critically on labelling. Agri-food chain firms,
including restaurants, food retailers, and processors, are increasing the use of hazard and quality control
programmes, traceability, certification, and production contracts. Each of these may play a role in
facilitating and encouraging animal disease control either directly, if it affects safety or quality, or
indirectly, if the practices spill-over to prevent or control disease (Box 4.6).

147. Foodborne diseases are a major concern of retailers and processors because of the market effects.
Food safety is an over-whelming concern of food marketers. To the extent that disease present at the farm
level bears food safety risks, processors and marketers, including retailers, restaurants, grocers, are quite
concerned. Government agencies directly deal with most foodborne illnesses from bacterial issues. Many
of the practices and monitoring that is performed to prevent and control foodborne illnesses may have
spill-over effects to assisting in preventing animal disease. Further, the frameworks that are utilised to
monitor and certify practices related to foodborne diseases could be adapted to monitor and certify
biosecurity and other measures related to animal disease. An example is the Hazard Analysis of Critical
Control Points (HACCP) that identify risk in food chains. HACCP can point out the risks involved by
contacts at markets, the mingling of livestock or poultry, transportation, slaughter, and at preparation points. HACCP can assist in disease control and prevention by providing recommended preventive measures (Edmunds et al., 2013). Edmunds et al. (2013) concluded that adopting the HACCP system could work effectively as a rapid response system to tackle emerging outbreaks of infectious diseases.

Box 4.6. Livestock traceability systems in Australia

The National Livestock Identification System (NLIS) is the permanent identification and lifetime traceability system in Australia for cattle, sheep and goats. NLIS (Pork) has been also established and NLIS (South American Camelids) is in the process of development for alpaca. All three systems operate as industry–government partnerships.

The NLIS combines three elements to enable the lifetime traceability of animals:

- an animal identifier (a visual or electronic ear tag known as a device)
- identification of a physical location by means of a Property Identification Code (PIC)
- a web-accessible database to store and correlate movement data and associated details

As animals are bought, sold and moved along the supply chain, they must be tagged with an NLIS-accredited tag or device. All animals leaving a property (PIC) must be identified with a NLIS-accredited device before moving off the property, unless a permit is obtained from the state or territory. Each movement they make to a location with a different PIC is recorded centrally on the NLIS Database.

The NLIS is able to provide a life history of animal's residency, and to discern contacts with other animals.

Any device or property statuses that indicate that any animals may pose a biosecurity or health risk are reported to processors to ensure that the affected animals are tested at slaughter. This maintains the safety, quality and integrity standards of Australian red meat and livestock and reduces the impact of a potential livestock disease epidemic or residue incident.

Source: Meat and Livestock Australia (2016); Animal Health Australia (2016b).

148. Increased vertical integration in many countries and livestock sectors involves increased contracting that explicitly defines management practices and deals with monitoring issues. Contracting and third party verification can certainly involve biosecurity, sanitation, and other practices related to prevention and control of disease. To the extent that these pressures are growing, one might expect the agribusinesses, processors and retailers further down the food chain to increasingly influence farm management decisions. This, in many ways, is captured in the contracting process in the poultry and pork sectors. Market access is also linked to achieving and verifying the practices and standards described in the contracts.

149. Farm animal welfare is another area of increasing concern related to animal agriculture. Many consumers link farm animal welfare, farm size, and food safety. Pressure to allow traceability and assure the production processes of livestock, dairy and poultry products has led to scrutiny of farm practices. Traceability and certification of origin and practices of food supply is an area of growing importance in food chains (Meuwissen et al., 2003). Specifically, traceability and certification in meat supply chains requires transparency, due diligence and control of livestock epidemics (Meuwissen et al., 2003). In order to encourage and enable these changes, it is important to understand the break-even costs of traceability, liability and recall insurance, and regulatory incentives to motivate adoption by free-riders.

150. Private agri-food firms as the gatekeepers to market access play a greater role in specifying and verifying farm production practices. In many cases, these firms are concerned with the social license to sell food and, in particular, food safety. Partnerships with government and farm groups may utilise these changes to align farm incentives and encourage practices to prevent and control disease. Thus, the
prevention of foodborne illness and the contracts and mechanisms that accompany them could complement animal disease control.

4.3. Wildlife relationship to farm animal disease

- Wildlife are increasingly relevant as reservoirs and vectors of disease.
- Farmers consider wildlife as an exogenous force concerning the likelihood of farm infection.
- Biosecurity practices to prevent infection from and to wildlife may be different from standard practices for other disease sources.
- The presence of a wildlife reservoir changes relevant practices and tools for disease control as well as farmer attitudes towards disease management.
- Wildlife diseases are often managed by government institutions different from those dealing with livestock disease, which makes inter-agency co-ordination critical.

151. The economic risks of wildlife diseases to livestock agriculture are significant. The spread of infectious diseases among and between wild and domestic animals is a major global problem (Daszak et al., 2000; The Economist, 2005). Wildlife can be a disease reservoir as well as a vector of disease transmission. If wildlife are infected, they may become a disease reservoir and the disease can remain present even if it is eradicated in domesticated livestock. The continued presence of many livestock and poultry diseases are caused and facilitated by wildlife such as deer, possums, badgers, ferrets, and elk. Migratory birds may help spread strains of highly pathogenic avian influenza (HPAI) among domestic poultry. Wildlife are also carriers of chronic wasting disease and other pathogens that put livestock and humans at risk of infection (Horan et al., 2010). Another consideration is that the majority of human diseases are zoonotic (Cleaveland et al., 2001), and domesticated livestock and poultry may transmit diseases from wildlife to humans (Pearce-Duvet, 2006).

152. From the perspective of farm disease management, wildlife are a potentially important source of disease infection that are viewed as exogenous to farm decisions. Thus, when agricultural and environmental agencies are considering the farmer response, they should also explicitly consider the potential for disease pressures from wildlife populations. The presence of wildlife disease reservoirs complicates disease control and eradication both politically and logistically.

153. Farm biosecurity practices can be divided into those that prevent disease from entering (bioexclusion) and those that prevent disease from leaving (biocontainment) the farm, herd or flock. Farmers often view biosecurity strictly from controlling disease from entering their herd (Liebler et al., 2009). Farmers tend to focus on the bioexclusion aspects of biosecurity rather than biocontainment as they are more concerned about protecting their assets than outside animal populations whether they are livestock or wildlife. The potential for contact—whether direct or indirect—between domesticated livestock and poultry and wildlife that may spread disease means that farmers should be educated and incentivised to consider disease spread from their farm in biosecurity practices.

154. Livestock population management or biosecurity choices may influence economic damages by affecting disease transmission between wildlife and livestock. Bicknell et al. (1999) modelled multiple populations in a bioeconomic model of bovine tuberculosis (bTB) transmission between brush-tailed possums and dairy cattle in New Zealand. In addition to the standard testing and culling of infected cows, Bicknell et al. suggested managing the possums (i.e. hunting them) to reduce the disease reservoir and potential contacts with cattle. But this was not a true multi-host-pathogen model because possum disease dynamics were not modelled.
Horan et al. (2005) and Horan et al. (2008) analysed the livestock-wildlife problem as a dual-host pathogen where the disease was endogenously determined in both the cattle and deer herds and could move between them. In addition to wildlife management (i.e. feeding and culling deer), biosecurity on cattle farms was a disease management tool. They found that biosecurity in the cattle sector put less pressure to reduce deer stock. If cattle were more profitable, it might become optimal to eradicate deer as a means to eliminate bTB. However, the model demonstrated that it is not always optimal to eradicate the disease particularly if biosecurity can sufficiently separate the two populations. Results indicate there may be benefits to jointly managing the livestock and wildlife populations, but in reality different agencies (or ministries) are often charged with livestock and wildlife disease control. When multiple agencies are involved in managing disease in multiple wild-life and livestock populations, the demands of clients and agendas can lead to conflicts and sub-optimal decisions.

The policy implication of wildlife disease reservoirs and vectors affecting livestock populations are that government agencies charged with disease control in livestock and wildlife populations should coordinate and complement efforts. From the farmer perspective, biosecurity practices should account for the potential for disease to enter and exit the farm via wildlife. Additional management and policy questions should be examined in future research efforts.

4.4. Implications for animal disease policy

The economic theory suggests that the variability and different attributes of specific functions in livestock disease management place them within a continuum between pure public and pure private goods. The boundary between public and private provision is intrinsically movable and leaves much scope for collective action by producers.

Producer collective action in livestock disease management should be given sufficient consideration by policy makers. Collective action can provide more efficient responses to shared concerns by generating economies of scale and scope and reducing private cost of management. It can strengthen compliance with norms, develop and enforce industry standards, promote and support the adoption of best practices. It can improve the division of responsibilities between government and private business in disease risk management and help a better alignment of private incentives with public concerns.

For collective action to occur, farmers should see benefits from it as greater than the costs. Collective action also depends on farmers’ perceptions of particular livestock problems as an individual or collective matter. Policy makers should work to build farmers’ consciousness about the link between their individual risk management effort and its short-term and long-term effects on livestock markets and the whole food chain, food consumer behaviour, and human health. Livestock policy should integrate as a necessary component the communication and research focussed on the broad spill-overs of farm disease management. Collective action also requires sufficient social capital to generate trust and social connectedness to enable potential co-operators to formulate and pursue shared interest. An initial examination shows that there seems to be little inclination amongst farmers to act collectively at the local level. However, the issue of how strong rationale for such local initiatives may be in disease management requires more research. If there is rationale, policy role would then be to provide evidence of benefit, external facilitation, and information through existing networks.

Industry-led collective action in disease management, in contrast, has sufficient evidence to support its potential as a contributor to disease prevention and control. Collective action in these fields is more likely to develop if strong producer groups exist and are institutionalised around a broad spectrum of shared industry interests. Policy may foster institutional and financial soundness of producer institutions through legislation. In particular, governments can help to address the “free-rider” problem that constrains collective action by making the contribution of all potential beneficiaries obligatory by law. This, however,
should be balanced by the flexibility provided to farmers in deciding about the rationale for forming common institutions, their funding priorities, and accountability towards individual members.

161. Country experiences demonstrate that the scope for industry-led collective action can be broad, spanning from farmer capacity building through disease surveillance, specific control and eradication programmes, risk insurance, to partaking in response to disease emergencies. Through these initiatives, producers obtain a sense of ownership over animal health. In all these areas there is also a rationale for and examples of long-standing partnerships between industry and government.

162. Public-private cost-sharing in livestock epidemics is an important example and a tool to improve compatibility of public and private incentives in several ways. Cost-sharing between governments and industry, typically involving ex ante protocols, can substantially reduce uncertainty for both individual producers and government. It can limit moral hazard and information asymmetries, and thus facilitate early disclosure of disease. Although governments are likely to face strong producer resistance to sharing the financial burden of livestock epidemics, there are examples of long-standing schemes with a high level of stakeholder acceptance. Some experiences show that a strong budget deficit can trigger the introduction of a new system. For cost-sharing schemes to be successful, the responsibilities of parties and where the benefits fall should be clearly determined before establishing the cost-sharing arrangements. Although the advantage of cost-sharing schemes is that they can substantially reduce uncertainties surrounding emergency situations, it is important that they are sufficiently flexible so as to be adaptable to specific circumstances. These schemes need to provide sufficient space for consultation and prior negotiation among the stakeholders.

163. Industry and farmers co-operate to supply food quality and production practice verification to consumers and maintain market access. These programmes may provide a framework to ensure biosecurity practices or create positive spill-overs to prevent disease.

164. Wildlife as a reservoir and vector of disease complicate management. Farmers might be able to manage sporadic risks through biosecurity, but a continuous disease pressure from a local reservoir is not manageable at the farm level. It is often the case that different agencies/ministries are tasked with managing wildlife and livestock policies, but lack of co-ordination can exacerbate disease control. Government agencies charged with disease control in livestock and wildlife populations should co-ordinate and complement efforts.
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