Chapter 4

Issues of livestock disease management beyond the farm: Collective action, the role of food chains, and influences from wildlife

This chapter considers outside factors that play a role in farmer disease management. It covers how livestock farmers working collectively to manage livestock disease in areas such as risk insurance, surveillance, and in response to livestock epidemics. This collective action often involves partnerships with the government. What influence do actors in the rest of the value chain have on farmer livestock 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. This is followed by a discussion of what the presence of wildlife populations as disease reservoirs and vectors means to disease management and farm decisions. The final section summarises the implications for livestock policy across these issues.

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.

Collective action is defined as "the action taken by a group or an organisation in pursuit of members' perceived shared interests" (Scott, 2014). 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).

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.[1] 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 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), 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.

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.

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.

Rivalry (or subtractability)	Excludability: Low	Excludability: High
Low	**Public goods** • Epidemic or zoonotic disease control (including surveillance, movement control, quarantine services) • Some extension • Some research • Control of foodborne diseases • Drug quality control	**Toll goods** • Vaccine production • Diagnostic services • Veterinary clinics • Dips
High	**Common pool goods** • Tsetse control on pre-communal land using traps, targets or aerial spraying	**Private goods** • Endemic disease • Sales of drugs and spraying vaccines • Some extension • Some research

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.

Source: Holden (1999).

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.

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 can typically emerge to deal with issues specific to a 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.

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.

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).

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.

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 (Chapters 5, 6 and 7).

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).

Box 4.3. Industry participation in disease control and eradication programmes in Australia *(cont.)*

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 unifying 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.

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's disease) on sow farms. Members of the mutual receive a fixed compensation per sow in the case where (i) sows are infected with Aujeszky's 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).

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.

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.

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.

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 (CSF) 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, CSF, 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.

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

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)[1]

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 has 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 socioeconomic 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 contributed by each industry is determined by both the gross value of production and the importance of the specific disease for that industry.

1. See case study on Australia for further discussion of EADRA.

Source: Animal Health Australia (2016); OECD (2012b); Kimura and Antón (2011); Melyukhina (2011).

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 biosecurity 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.

A more fundamental aspect to early reporting is an appropriate level of compensation. While the low level does not incentivise farmer enough to report the disease detection, high level of compensation is likely to reduce farmer's incentive to take an appropriate risk reducing strategy. This is challenging 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.

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, 2012), Allewedt (2013) suggests 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.

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).

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 identifies 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.

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.

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.

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.

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).

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.

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).

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.

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.

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.

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.

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.

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.

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.

Note

1. 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).

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