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Economic Issues in Biosecurity

Economics and Policy
Research Branch

June 2005

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Summary

Biosecurity is a risk management function

Pests and diseases add to the risks faced by primary producers by:

- Lowering the productivity of existing production systems if allowed to spread
- Disrupting access to markets or the premiums available from these markets.

These two categories of risk define the scope of biosecurity systems as *incursion management* and *quality assurance*.

Although most of the benefits of biosecurity investment accrue to primary producers government will be involved.

The reasons for government involvement include:

- The existence of economies of scope (it does not make sense to duplicate the technical capabilities needed for a biosecurity system for different industries),
- To achieve human health, biodiversity and animal welfare standards
- Because legislation will be needed to convey powers to manage disease threats, and
- Because of international and national obligations.

It is not possible for the biosecurity agency to take unilateral decisions. Four problems preclude this solution:

Legislation, by itself will not lead to efficient and effective biosecurity solutions. Legislation does not resolve the underlying problems that pervade biosecurity management:

- *conflicting objectives*
- *hidden information*

- *Conflicting objectives* – there are many different actors involved in biosecurity, including farmers, government workers, importers and exporters etc. each with their own interests.
- *Hidden information* – some of the information needed to make good biosecurity decisions is hidden from decision-makers. It is not in the interest of individuals to reveal this information.

- *hidden actions*

- *Hidden action* – the actions taken by individuals are not always observable by the administrators of a biosecurity system. Administrators can not monitor all actions taken on-farm.

- *government commitment*

- *Government commitment* — any strategy needs to be implemented fully by government. A tangible effect of government commitment is that enforcement of penalties changes behaviour so that behaviour is aligned with the objectives of biosecurity policy.

Clever approaches will be needed to deal with these problems before good biosecurity decisions can be made.

New approaches are available to address these problems. Designing incentive compatible mechanisms will be important in all areas of the biosecurity system.

Incursion management:

Economists have developed solutions to problems with similar characteristics.

- *Pre-border incursion management* - The design of inter-state/country agreements to promote information disclosure and cooperation will improve pre-border incursion management.

- *Border control* - Designing incentive compatible mechanisms including a combination of rewards for revelation and threats of loss of import certificates/licences for declaring false or misleading information could improve efficiency and effectiveness of border controls.

Government needs to invest in the core skills needed:

- *Epidemiology*

- *Benefit-cost analysis*

- *Statistical design of information systems*

- *Post-border control* - Analysis of alternative incursion management strategies is an important role for a biosecurity agency. Benefit-cost analysis is the appropriate framework for this analysis, but specific information is needed to facilitate meaningful analysis. Epidemiology and economic skills are essential elements of this capability.

  Passive and active surveillance procedures underpin the ability of epidemiologists to make predictions about the rate and location of potential disease threats.

  - Statistical design will improve the ability to infer from these data sets.

- *Mechanism design - incentive compatibility*

  - Incentive design could also add to the scope and quality of data sets. An incentive compatible information revelation mechanism could be designed by combining penalties, compensation and other incentives. A systematic approach needs to be adopted to ensure voluntary, truthful information revelation is in the best interest of the information holder.

New approaches can be considered for managing endemic disease threats. Auctioning control contracts is one idea that has been developed for other policy problems but has resonance with the endemic disease control problem.

Principles for sharing the costs of a biosecurity system will promote efficiency.

It makes sense to spread the human and physical infrastructure needed for biosecurity systems across many different industries. Developing sound and robust cost sharing principles will therefore be a key element of an efficient biosecurity system. It is important to design cost sharing procedures to achieve administrative and allocative efficiency. Careful design of cost sharing protocols will give industry the responsibility of adjusting funding contributions in light of the benefits they receive.

Quality assurance can be improved by:

Quality assurance – Information about product attributes can create value. It is in the interest of producers to generate this information to take advantage of market premiums and market access. Some information can only be inferred from the population from which products are drawn. This information will be generated from the biosecurity system.

- *Statistical design of information systems*

  - Statistical design of information systems will strengthen the scope for statistical inference from population to product. This will reduce the cost of providing this information and improve credibility with consumers.

- *Implementation of cost-sharing principles.*

  - Cost sharing principles will be important to allow industry to determine the level and type of investment needed in product attribute information provision.

Designing the framework on which the biosecurity organisation is built is very important. These processes:

- *Define the skills needed*
- *Define the information needed to make decisions*
- *Ensure that relevant perspectives are considered.*

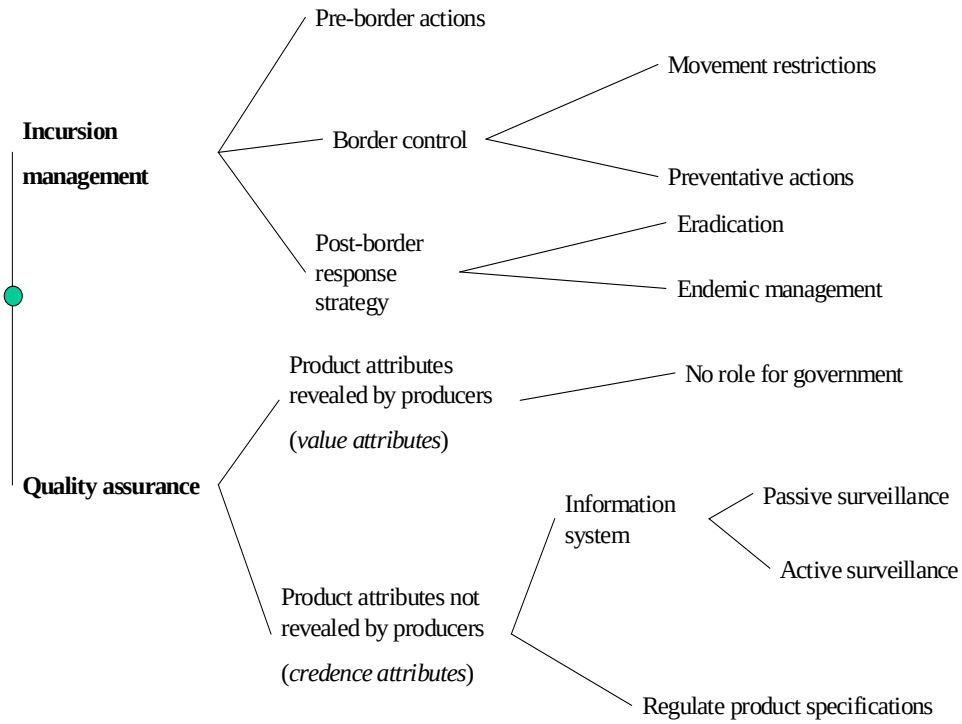
Within the biosecurity system, there seems scope to institutionalise processes that will:

- Ensure relevant information (epidemiology) and analysis (benefit-cost) is bought to light before important incursion management and quality assurance decisions are made.
- Reward relevant skills and capabilities valued for efficient and effective biosecurity management
- Reveal information needed by managers to allocate resources between competing intervention activities (eg. pre-border, border, post-border and quality assurance).
- Create incentives for innovation leading to improvements in efficiency.
- Efficiently share costs with industry.

1. Background

There are many production and price risks associated with primary production. Normally, individuals and firms can take actions to mitigate risk including commercial insurance, sharing risk with government, enterprise diversification, self-insurance etc. Each of these actions has a cost although the distribution of costs will be different for the different methods of risk mitigation. Diseases add to these risks in two ways - they lower the productivity of existing production systems if allowed to spread and they can disrupt access to markets or the premiums available from these markets. These two categories of risk precipitate a range of actions that can be categorised in two broad groups as illustrated in Figure 1: *incursion management* and *quality assurance*.

Figure 1: Key functions of Biosecurity



Management of disease incursion – There are a range of actions that can be taken to manage the risk of disease incursions including pre-border risk reduction, border control, post-border strategies, etc. By intercepting or interrupting the transmission of disease threats, it is possible to reduce the risk of diseases spreading and the associated productivity costs. Identifying where in the disease cycle to intervene and how to intervene is a complex problem that requires a detailed understanding of where disease threats originate, how they are spread, what preventative actions will be effective as well as an understanding of the benefits and costs of such actions. As shown in Figure 1, pressure can be bought to bear in many different points (eg. pre-border, border control and post-border control) and in many different ways (eg. testing, eradication, treating, screening etc.).

Quality assurance - The second set of functions is often called *quality assurance* and relates to actions that provide consumers with information about the attributes of primary products. Markets are the institution through which this information is normally transmitted. Through markets, producers are able to inform consumers about the features of their products that consumers prefer and are willing to pay premiums. In commodity markets, premiums emerge for particular attributes of goods such as protein, moisture content, fat content, etc. and languages or metrics are developed to efficiently differentiate goods according to their attributes. Governments generally do not intervene in these markets because there are clear incentives for producers to provide information on which price premiums are determined. As illustrated in Figure 1, this information is called *"value attributes"*. Governments only intervene in these markets when there are health or other reasons to insist that additional information is needed eg. to reveal salt or fat content truthfully.

However, some attributes of goods are not readily observable or are expensive to measure. It may not be worthwhile or possible to generate this information for each transaction. In Figure 1 this information is called *"credence attributes"*. Credence attributes may not be discernible even following consumption of the good. For example, organically grown vegetables may look and taste the same as to those produced using conventional farming techniques but some consumers are still willing to pay a premium for vegetables grown organically. The key point here is that there is a difference between organically and conventionally grown vegetables (one uses no artificial chemicals and the other does); it is just that it is difficult and costly for the consumer to observe the difference once the product has left the farm. Consumers could visit the farm to verify the production technique but this would be expensive. Reputation and certification is often used to provide consumers with confidence about the credence attributes of goods. Similarly, the disease status of plant and animal products is often difficult and costly to discern and quality assurance schemes have evolved to communicate certain product attributes to consumers. One of the important differences between value attributes and credence attributes is that the former are easily observed while credence attributes are difficult to observe. For many primary products, it is costly and difficult to observe disease status and consumers rely on other means, such as a quality assurance system, to convey information about the product or the population from which the product is drawn.

Just as value attributes attract premiums so do credence attributes, the key difference is the way in which this information is generated and conveyed. This information may be based on statistical inference from samples, rather than census as is the case with value attributes, and may require specialised equipment or skills to discover credence information. Nevertheless, where consumers are prepared to pay for such attributes, there are strong incentives for individuals and industries to generate this information and to ensure that QA systems are cost-effective and meet the needs of consumers.

2. Improving efficiency and effectiveness of a biosecurity system

There are a number of issues that complicate the way biosecurity systems are managed. Biosecurity systems rely on input from highly trained people with specialised equipment; and require coordination across different types of skills, such as epidemiology, pathology, economics, management etc. They involve government input and coordination on behalf of industries and require landholders to take actions that generate collective goods even though these actions may not be in the interest of the individual. The Victorian Government's 2002-03 review of biosecurity[1] clearly showed that government will be involved in the provision (not necessarily the funding) of biosecurity services. Taking this as given, there are three questions that need to be resolved if the biosecurity system is to be efficient and effective.

a) How to allocate a fixed budget between the various activities that compete for these resources.

b) What type of intervention mechanisms should government employ

c) How to share the costs of the biosecurity system between Commonwealth, State, industry and individuals.

These questions are difficult to address but are made more complex because of four factors:

- *Conflicting objectives* – there are many different actors involved in biosecurity, including farmers, government workers, importers and exporters etc. each with their own interests. A biosecurity system will need to find ways of aligning these interests to achieve a common goal.
- *Hidden information* – some of the information needed to make a good biosecurity decisions is hidden from decision-makers. Furthermore, it may not be in the interest of individuals to reveal this information because it could place them at a disadvantage. Different mechanisms to those currently employed will be needed to reveal this information.
- *Hidden action* – the actions taken by individuals are not always observable by the administrators of a biosecurity system. This occurs because individuals on farms, for example, take actions that have implications for biosecurity, that are not able to be feasibly monitored by administrators.
- *Government commitment* — any strategy needs to be implemented fully by the government so that the full benefits from the strategy is generated; this requires government to be credible when implementing policy.

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[1] See DPI (2005a, 2005b)

These observations mean that legislative and command and control approaches alone are unlikely to be very cost-effective. It is not possible, for example, to address the hidden information and hidden action problems that seem to pervade the biosecurity sector using legislation alone. Legislation will certainly be an important part of the solution but other mechanisms will need to be designed to specifically resolve the information and incentive problems that exist with biosecurity.

Fortunately, these problems are common in other sectors of the economy and economists have developed approaches that can overcome these difficulties. For example, many of the information and incentive problems observed with biosecurity also exist in the insurance industry and innovative ways of dealing with these problems have been developed. These alternative mechanisms will need to be designed to recognise the objectives of different individuals, reveal hidden information needed to make good decisions and influence the actions of individuals even though these actions are often completed away from the gaze of administrators. At first glance, these economic concepts and ideas resonate with the biosecurity problem but do not seem to have been applied to biosecurity systems in Australia or overseas.

This issues paper has identified four aspects of biosecurity management where new approaches need to be considered. These are: mechanism design, cost sharing, information systems and institutional design.

3. Designing intervention mechanisms

The Victorian Government's 2002-03 review of biosecurity (2005a, 2005b) noted that government is invariably involved in biosecurity actions. The reasons for this include:

- the existence of economies of scope (it makes no sense to duplicate the technical capabilities needed for a biosecurity system for different industries),
- to achieve human health, biodiversity and animal welfare standards
- because legislation will be needed to convey powers to manage disease threats, and
- because of international and national obligations.

It is important to carefully design the mechanisms that governments employ to achieve these goals. The following sections apply economic principles to the two broad functions of a biosecurity system noted in figure 1 (ie. incursion management and quality assurance).

3.1 Incursion management

As noted earlier, one of the key objectives of a biosecurity system is to keep threats at bay and to manage those threats that are unintentionally introduced. To achieve this, government needs to know how to gain access to information on the potential and actual disease incursion, to evaluate alternative courses of action and to implement optimal incursion management strategies. The key impediment that holds-back objective assessment of these options is that at least some of the information needed to make good decisions is hidden from government - it is *private* to the producer, wholesaler, shipper, packer, etc. For example, a landholder may choose not to reveal information about the incidence of disease if this precipitates some onerous reaction from the biosecurity administration authority[2]. In taking this course of action, the biosecurity authority loses access to valuable information that may be used to avoid the spread of the disease agent sometimes imposing significant costs of others. Individuals are therefore 'information holders' and the non-disclosure problem is assumed to pervade the plant and animal based industries. The basic idea that economists bring to problems of this nature is that there are ways of reducing the cost of gaining access to private information. For example, it may be possible to design incentive structures and procedures that promote information revelation.

[2] However, firm action may be needed in some cases. For example, neglected farms may become breeding grounds for pests and diseases. DPI Plant Standards Branch is active in monitoring neglected and abandoned orchards and enforcing appropriate clean up and management.

It was noted earlier that biosecurity threats are but one of many risks faced by individuals. These risks can be managed in many different ways. Individual information holders could carry these risks themselves by building-up savings or taking other farm management strategies that mitigate these risks. Each of these strategies in not costless and there may be costs imposed on others but not seen by the individual that change the optimal risk management strategy. Insurance products, in principle, could enable information holders to reduce the cost of the risk. Insurance is of interest because large, diversified insurance companies can wear risk more cheaply than small, specialised farms. However, insurance products designed especially to mitigate biosecurity risks are not generally available due to their systemic nature. Systemic risk means that the chance of one primary producer being affected is not independent of the chance of another being affected. This type of risk means that insurance premiums would be excessively high discouraging demand for insurance — and so it is generally not a profitable product for private insurance companies to sell.

In the absence of insurance, systemic risk discourages primary producers and others from managing incursion risk because cooperation between information holders is needed to manage incursion risk. However, cooperation is costly to secure in the absence of external intervention whether by government or an industry body.

In theory, government could manage pest and disease incursion by monitoring individuals' risk management efforts and enforcing penalties against those that do not implement risk management strategies. However, in reality this is impossible because the cost of collecting all of the information needed is prohibitive. Economists refer to this problem as "asymmetric or hidden information" because government cannot reliably monitor information holders' incursion risk-management.

Government can use a variety of instruments to provide incentives to reveal private information. For example, in current plant health legislation, it is an offence to not reveal knowledge of disease incursions. While this is the law, it is virtually impossible to enforce because the costs of discovering every landholders' status, with respect to disease incursions, and monitoring their subsequent actions, is too high. The relevant question is whether another approach offers a more cost-effective way of achieving the stated goal. For example, would it be more cost-effective to use legislation to provide incentives for information revelation? Recognising this problem, economists often attempt to get around the information revelation problem by designing *incentive compatible* instruments. In this sense, current plant health legislation is not incentive compatible because it creates incentives for individuals to hide, rather than disclose, relevant information about disease incidence. It is not in the interest for information holders to voluntarily reveal the presence of an incursion on their property since this may prompt the government to destroy parts of the property with little or no compensation.

The following sections examine intervention actions that can be taken by biosecurity administrators in the three broad categories of incursion management as defined in Figure 1 (pre-border, border and post-border control) from an incentive design and information revelation perspective.

Pre-border intervention actions - Pre-border intervention refers to situations where a disease incursion originates outside of Victoria's borders but has not spread into Victoria. Receiving information on such an incursion can potentially be more cost-effective than implementing border and post-border strategies especially if the damage from the incursion is very high. Examples of pre-border strategies are inter-State government and industry cooperation on biosecurity, trade restrictions and labelling. Pre-border strategies can be preventative (eg, inter-State government cooperation) or reactive (eg, trade restrictions). Information that will allow the implementation of pre-border strategies include the extent of spread of potential incursion threats, the prevention protocols of other jurisdictions and other States'/countries' knowledge of incursions.

At the moment, there is an informal memorandum of understanding (MOU) between the Australian States and Territories that requires information disclosure if an incursion is detected. However, there is no comparative agreement to ensure that each jurisdiction invests enough regulatory effort to reduce the potential cost of an outbreak. There may be no incentives for each State to invest in preparatory actions because the costs of credibly enforcing such an agreement may be too costly (ie, preparing for future incursions is not verifiable). This contrasts with the inter-State MOU that requires information disclosure — there are incentives to comply with this agreement because the negative publicity of a jurisdiction attempting to hide a disease outbreak can harm the reputation of officials and a government's political credibility and re-election prospects. So while there are no formal mechanisms to punish a non-compliant jurisdiction with the information disclosure MOU, sanctions are imposed by news organisations who have a strong incentive to publicise evidence of poor public administration.

An inter-State agreement to coordinate each jurisdictions' investment in preparatory actions may be possible. It would require the establishment of an impartial 'umpire' to monitor and enforce the agreement. There may be some scope to use non-government organisations to assist in monitoring and enforcement (eg, to publicise each jurisdictions' investment levels). Incentives could then be designed into an agreement to promote desirable investments. Consideration should also be given to defining what are 'desirable' investments because it is the *effectiveness* of the preparation rather than the level that is important. Animal Health Australia (AHA) is coordinating an attempt at this for animal health and welfare. Performance standards for outcomes have been established. Each jurisdiction as well as industry is expected to report against these standards.

An alternative or complement to an inter-jurisdiction agreement is adding a legislative requirement to ensure that imported produce came from an 'area of freedom' as defined in the SPSS agreement. This would require truthful information disclosure from the exporting jurisdiction which may or may not be attainable. For example, some jurisdictions may not conduct surveys to discover if an area is free of pests and diseases, choosing to rely on absence of detection rather than known absence of pest or disease.

Key message:
The design of inter-state/country agreements to promote coordinated investments in incursion management will improve pre-border incursion management.

Border controls - Border controls relate to incidents that originate outside of Victoria but which threatens to spread into Victoria. The challenge is to design a surveillance and response strategy that accurately identifies the incursion threat and provides options for appropriate and cost-effective response. Such a strategy would require information from individuals who may be potential vectors (eg, importers). Likewise, information holders (ie, potential vectors) have an incentive to not reveal information if the product originates from a risky source. Disclosure of this information could result in penalties or fines and disruption of sales or commercial relationships with their suppliers. Another problem is the cost of the detection and response strategy and their associated costs such as on-going sampling and laboratory costs. There are also problems with verifying that an information holder did indeed know about the disease — how penalties are applied needs to be aware of punishing verifiable actions rather than accidents. Finally, government has an obvious role to enforce border controls because industry has no incentive to enforce such rules.

An incentive-compatible approach to border control could involve designing mechanisms that reward potential vectors for revealing their knowledge of the threat risk of importing products. This is difficult to achieve because the way incentives are constructed will influence behaviour. For example, the reward for potential vectors would need to be sufficient to exceed the private benefit from hiding this information but not be too generous to encourage deliberate fabrication of information in order to gain a reward. Combinations of positive and negative incentives can offer solutions to this problem. For example, a combination of rewards for revelation and threats of loss of import certificates/licences for declaring false or misleading information could be considered. Another solution could be to use penalties that affect an importer's reputation such as 'adverse publicity orders'. Selectively monitoring for designated diseases at certain times may improve overall risk-management especially if accompanied by credible threats of increased penalties and increased monitoring of potential vectors. Government may want to encourage information holders to be more active in detecting diseases by providing information rewards to discover evidence of an incursion.

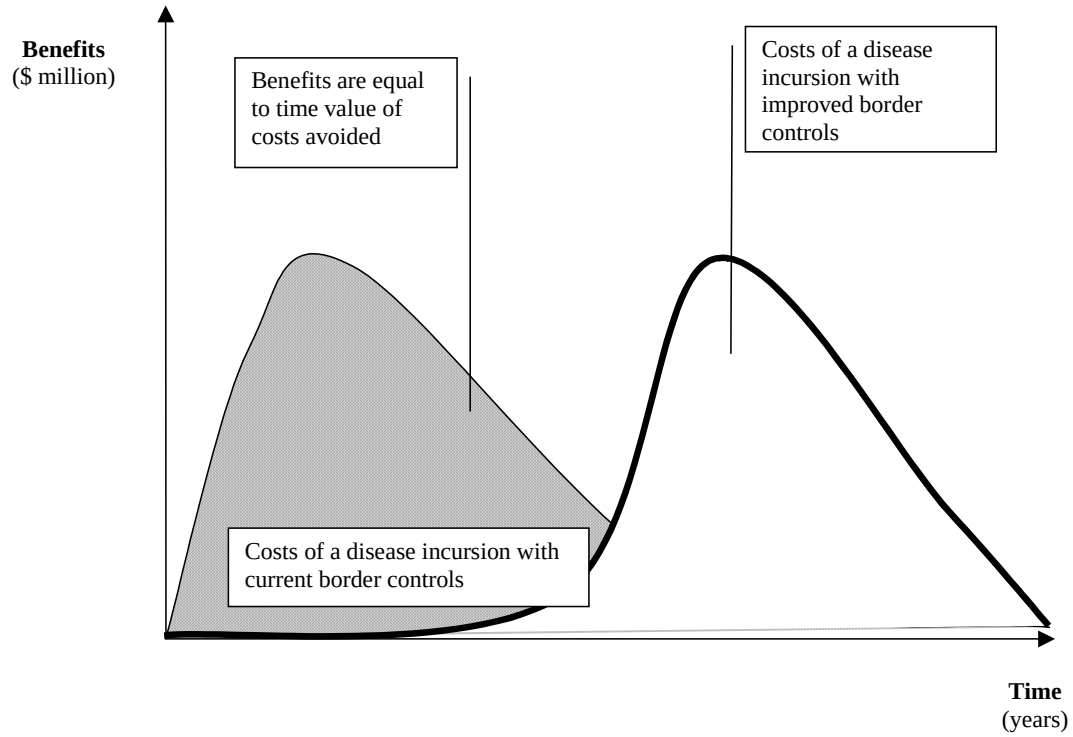
Under the existing *Plant Health and Plant Product Act*, an incentive-based system of co-regulation incorporating risk-management principles is used. Co-regulation reduces costs on the individual or business by not requiring external inspections and reduces regulatory costs on government by requiring less inspectors. Non-compliant behaviour is punished by moving the individual or business onto a high-cost regulatory regime which requires regular audits. If monitoring is credible, then co-regulation will be incentive-compatible. However, there may be more effective or less costly incentive-compatible mechanisms that could be explored.

Key issues:
Designing incentive compatible mechanisms including a combination of rewards for revelation and threats of loss of import certificates/licences for declaring false or misleading information could improve efficiency and effectiveness of border controls.

Post-border intervention actions - Once a disease has spread into Victoria an extended range of actions could be contemplated including eradication, containment, holding pattern while research is completed, through to no action. Determining which strategy to pursue is difficult because decision-makers operate in an environment of incomplete information. Both epidemiology and economic skills will be needed to analyse alternative strategies. Epidemiologists can provide information about the characteristics of the disease threat including likely spatial patterns of spread, vectors for spread and species hosts. Benefit-cost analysis (BCA) is the framework in which alternative strategies, involving different timing of costs and benefits can be compared. The most cost-effective response is the one that has the greatest net benefits. Improved epidemiological capabilities and use of BCA can potentially improve existing responses.

ABARE has recently developed a technique that synthesises the information needed to evaluate these actions into a benefit-cost framework. This analysis provides some important insights into the factors that influence the optimal response to disease incursions. ABARE argues that the benefits of incursion management strategies take the form of *costs avoided* (Beare et al 2005). Costs avoided include the economic damage attributable to the pest or disease and any adopted control measures. For example, where the costs associated with an eradication strategy are lower than the costs associated with the `do nothing' scenario, the difference in these two sets of costs can be considered the expected net benefit of the eradication program. In Figure 2 below, the benefits of improved border controls are shown. In this case, improved controls would mean a lower probability of entry of a pest or disease incursion. The costs of a pest or disease incursion have been delayed. *The value of the strategy is the time value of the costs avoided.*

Fig 2: Benefits from improved border controls



To make strategic decisions about the response to an incursion, the following information is needed:

- *Appropriate reference case*--against which alternative managements strategies can be compared. This is the `do nothing' case.
- *Epidemiology*--key assumptions about the spread of a pest or disease, and how these assumptions affect the performance of alternative eradication and containment strategies.
- *The probability of successful eradication or containment*
- *The probability that the identified incursion is localised* and there is no reinfestation from another source.
- *Expected cost information*--for alternative eradication and containment strategies and for the `do nothing' situation.
- *Size of quarantine area.* While a large area increases the probability of successful containment, it also imposes costs on those inside the area in terms of foregone agricultural production or limited market access.

ABARE has developed an Exotic Incursion Model (EIM) to bring all the key information together so that the benefits and costs of alternative strategies can be compared. This is described in Elliston et al (2004).

While epidemiology provides information about the spread of pests and diseases in populations of plants and animals, this capability rests on the availability of basic

information about the status of plant and animal populations with respect to disease status, movement patterns, production information, etc. There are essentially two methods employed to collect this data - passive surveillance and active surveillance. Statistical design of these data sources will improve the scope for statistical inference from these data sets.

Another important idea that could improve data availability concerns the incentives that apply to information revelation. The objective would be to design an incentive-compatible mechanism that could reveal information from information holders such as farmers. If this were possible, it would provide more accurate information on the extent of the incursion and could provide more timely information. Designing such a system would involve understanding the information holders' incentives not to reveal such information. Revelation of disease status could, for example, adversely influence the current and future profitability of the landholder. The designer of this incentive mechanism would also need to avoid embedding perverse incentives to fabricate information and incursions. It seems likely, however, that a system of incentives could be built by combining penalties, compensation and other incentives. A systematic approach needs to be adopted to ensure voluntary, truthful information revelation is in the best interest of the information holder. However, it needs to be kept in mind that awareness of disease is low so complementing an incentive-compatible mechanism with a well-targeted education campaign may maximise information disclosure.

Disease control programs have generally employed command and control approaches to disease management. Biosecurity authorities, supported by legislation, are given powers usually reserved for police or military forces to ensure that the level of investment in disease control is sufficient to achieve the objective - often eradication. While this approach seems appropriate for certain exotic diseases where eradication of the disease is needed because of the threat to entire plant industries, they appear to be less relevant to endemic disease problems. It some cases the cure (eradication) can be worse than the disease.

Recently, economists have been investigating alternative ways of stimulating investment in actions that generate collective but not private benefits. While applications to this point have been to environmental management problems, there are similarities with the disease control problem where individual actions may generate collective benefits but inflict financial harm to the individual. The basic idea is that some of the information needed to form agreements between the disease management authority (the state) representing the collective interest, and the private individual is hidden and this prevents fair agreements from being developed. The information missing is a) the cost on individuals of taking disease control actions and b) the collective impact (in terms of threat reduction) of these actions. This information is needed by decision-makers before cost-effective decisions can be made. Fortunately, there are ways to address the hidden information problem and if these can applied successfully to biosecurity, they may offer new policy mechanisms for endemic disease control problems. Specifically, the idea of auctioning disease

control contracts appears to warrant further investigation. Auctions can be specifically designed to reveal the "true" costs of changing disease/threat management on farm. The concept has been applied to biodiversity conservation on private land with the BushTender program as explained by Stoneham et al (2003). If the benefits of reduced disease/threat can be estimated, administrators can compare alternative actions, on different locations and allocate funds to those actions that generate the best value for money investments. Other elements such as contract design and monitoring and enforcement policy will also need to be designed specifically for the biosecurity application.

Key issues:
Analysis of alternative incursion management strategies is an important role for a biosecurity agency. Benefit-cost analysis is the appropriate framework for this analysis, but specific information is needed to facilitate meaningful analysis. Epidemiology and economic skills are essential elements of this capability.

- *Passive and active surveillance procedures underpin the ability of epidemiologists to make predictions about the rate and location of potential disease threats.*
- *Statistical design will improve the ability to infer from these data sets through well-targeted sampling.*

Incentive design (complemented by an education campaign) could also add to the scope and quality of data sets. An incentive compatible information revelation could be designed by combining penalties, compensation and other incentives. A systematic approach needs to be adopted to ensure voluntary, truthful information revelation is in the best interest of the information holder.

New approaches can be considered for managing endemic disease threats. Auctioning disease control contracts is one idea that has been developed for other policy problems but has resonance with the endemic disease control problem. For example, growers could be asked to voluntarily contract to change farming practices to reduce their pest and disease risk and to name a price for participating. The government can pick the most attractive 'bids' by comparing the cost and benefits of each contract. The use of an auction mechanism introduces competition, which lowers the cost of cooperation in endemic incursion management.

3.2 Cost sharing

The Victorian Government's 2002-03 review of biosecurity (2005a, 2005b) explained that governments throughout the world tend to intervene in the biosecurity sector because of the human health implications of some animal and plant diseases and because there are economies of scope associated with the provision of biosecurity services. In other words, it is more efficient for government to supply one set of biosecurity infrastructure for all relevant sectors (eg. pigs, cattle, sheep etc. in the case of animals and wheat, barley, canola, pastures in the case of plants) than for each of these industries to duplicate these services and costs.

In addition, biosecurity activities may generate total benefits (both economic and environmental) which far outweigh the costs. When this is the case, it is desirable to undertake the activity. However, the benefits of this activity to any *one* player or group may not be large enough for them to undertake it. In principle all the relevant players could band together to undertake the activity required, and settle their costs via negotiations. However, such coordination and 'deal making' is costly and difficult in practice. A key problem with making deals here is the 'free rider' problem. A firm that may benefit from an action may claim that it did not, in the hope that others will pay for the service, and so hope to continue enjoying the benefits in the future. Hence, there is potentially a role for government action, to coordinate and 'bind together' the beneficiary group.

In the case where benefits are spread very wide (eg. cancer research) then the group that shares costs is the general taxpayer. However, in the case of biosecurity, it may be that the beneficiary group can be more strictly defined (depending on the particular disease). In these cases, there may be room for some cost sharing between government and industry (provided a cost-effective cost-sharing mechanism can be designed).

This raises the problems of how to apportion the costs involved to develop and maintain a biosecurity system between the different parties with an interest in the outcomes of this system. When considering this question it is helpful to examine the benefits and beneficiaries of biosecurity activity.

Biosecurity services provide economic and environmental benefits in a number of categories including the following:

- *Use* values are generated by the use of environmental goods – for example land can be used to grow profitable crops
- *Existence* value is the value that community members might gain from knowing that environmental goods (such as disease free amenity or land) exist, even if they do not directly use it.
- *Option* value is generated by preserving the option to enjoy an environmental good at some point in the future.

- *Bequest* value describes the value which is generated by being able to pass-on environmental goods to future generations.

In broad terms, biosecurity services will enhance all these values, and the resulting benefits will flow to individuals, to industry more broadly, and to the wider community. Accordingly costs can, in principle, be shared among these groups. When considering the design of a cost sharing mechanism, some simple economic criteria can assist in guiding policy. Ideally, such a mechanism will contribute toward:

- Administrative efficiency - it would be an inefficient use of resources to spend (say) $2 million per year to recover costs of (say) $1million per year. The application of this criteria may lead to the identification of some activities for which cost sharing is applicable, and other areas where cost sharing is less applicable.
- Allocative efficiency – any mechanism should promote the allocation of resources toward biosecurity in such a way that generates the maximum net benefit. Both over-investment and under-investment in biosecurity are undesirable from an economic perspective. An important benefit of cost sharing is that is likely to generate feedback from industry players to government concerning desired levels, areas and types of biosecurity investment, and so enhance allocative efficiency.
- Government Commitment – the mechanism should provide incentives for government to maintain commitment toward cost sharing. The credibility of such government commitment is important for preserving intended funding arrangements and policies. If parties to any cost sharing arrangement are able to challenge this commitment so that credibility is undermined then it can be costly and difficult to rebuild.
- Comprehensiveness - the more comprehensive is the coverage of any cost sharing arrangement (across identified beneficiaries) the more likely it is that industry players will be committed to it. Also, the more likely that it will be to raise the funds needed to support biosecurity programs. Comprehensiveness implies that coverage of any cost sharing arrangement needs to apply beyond the membership of industry associations, as such membership can be as low as twenty per cent of industry members. Ideally coverage would extend to all establishments. Such comprehensiveness may require a mechanism for identifying and communicating with establishments, which is responsive to industry entry and exit.

These criteria can then be used to evaluate alternative cost sharing arrangements for both ongoing costs (for regular activities such as endemic management and surveillance) and 'lumpy' costs (for irregular activities such as emergency response). Key considerations include:

- Should costs be shared on an up-front basis (on the basis of expected costs) or an ex post basis (on the basis of actual costs)?
- Should any scheme be mandatory or voluntary? Should it be included in legislation, regulation etc?
- Should the level of funds in any scheme be 'capped' so they cannot exceed a certain level, or 'uncapped'. This is of particular relevance for 'lumpy costs'.
- On what basis should costs be shared (eg. a flat rate fee per establishment, shared on the basis of the value of production, volume of production, value of land in production, amount of land under production etc)?

The design of a cost sharing mechanism will benefit from close consultation and input from industry, as they will likely have good information and face strong incentives to develop a low cost mechanism for cost sharing.

In relation to cost sharing for quality assurance and related activities similar principles will be applicable. Activities can be assessed to determine beneficiaries (individuals, industry or the community more broadly) and costs shared accordingly. As noted in Figure 1, where product attributes are revealed by producers there is no role for government and need for cost sharing arrangements - costs will be shared by market players on the basis of market decisions. Where product attributes are not revealed by producers and credence attributes are present there may be a role for government in the provision of information systems or the regulation of product specifications. Potential activities in this area include product/process testing, the development of metrics (systems of measurement) for labelling, and certification and enforcement. It seems likely that the benefits of such activities will flow overwhelmingly to producers, thus providing scope for cost sharing.

Key issues:
It makes sense to spread the human and physical infrastructure needed for biosecurity systems across many different industries. Developing sound and robust cost sharing principles will therefore be a key element of an efficient biosecurity system. It is important to design cost sharing procedures to achieve administrative and allocative efficiency. Careful design of cost sharing protocols will give industry the responsibility of adjusting contributions in light of the benefits received.

3.3 Information systems

Information plays a central role in the economy. It underpins management decisions, is exchanged in contracts and agreements and is now known to play a central role in the efficiency of markets. Information also plays a key role in biosecurity systems. As noted above, information relevant to biosecurity is scattered throughout the various agents that participate in a biosecurity system ie, farmers, marketing authorities, private veterinarians, government agencies etc. This information is often private to the information holder and clever approaches may be needed to expose this information before good decisions and be made. There are three general sources of data that could be used to support a biosecurity system: active surveillance, passive surveillance, active revelation and passive revelation. Active surveillance refers to information gathered through a statistically designed process. This information is collected through deliberate actions to observe and record the status products and the actions taken by producers. Passive surveillance refers to information that is collected as a by-product of an existing process that exposes information. Active revelation refers to information voluntarily offered, such as advice about a pest or disease incursion. Passive revelation refers to information that is revealed when humans take actions. The nature of actions infers information that is often important from a biosecurity perspective.

Benefit-cost analysis of alternative courses of action is a useful capability for biosecurity systems. Benefit-cost analysis introduces discipline into the decision environment by clarifying the type and quality of information needed and by imposing standard treatment of information to allow for comparison of different strategies and actions. Recent benefit-cost analysis completed by ABARE highlights the value of:

- Clarifying and quantification of the objectives of biosecurity systems - There are advantages in defining ways to measure the benefits conferred through a biosecurity system. Quantitative measures of changes in status of disease and other biosecurity threats allow decision-makers to compare the benefits of alternative actions. ABARE has developed a *metric* that expresses benefits as the delay in future incursions.

- Highlighting the role of epidemiology skills in decision -making - Information that improves our understanding of the way diseases spread in populations can significantly improve the cost-effectiveness of biosecurity systems. Not only can epidemiology improve sample fractions relevant to active surveillance as noted above, it also improves the power of benefit-cost analysis to estimate costs and benefits associated with alternative actions allowing decision-makers to consider responses to various disease threats in strategic and emergency situations.

- The value of early detection for pests and diseases that have a major economic impact on plant and animal industries.

Another important information problem for biosecurity systems is in providing information about product attributes to markets. As illustrated in Figure 1, quality assurance processes provide information about the attributes of products. This information creates value in markets by differentiating products from other suppliers. Australia's freedom from a range of animal diseases, such as mad cow disease, is an example of how information about product attributes can significantly increase the value of products. As noted above, there are strong incentives for some of these attributes to be provided by producers. Other attributes, however, may be expensive to ascertain for each transaction or may be credence attributes where consumers want information about the attributes of products that are not able to be discerned from the product itself. It could inform consumers about the disease status of the production regions, the way that the product has been produced or the chemicals uses as part of the production processes. In either case, the costs of providing this information for each unit of sale may be prohibitive but consumers may still value information from which these attributes can be inferred, preferably with some known error margin. Attention to statistical design could improve the ability to infer about the status of the population as a whole - thereby improving cost-effectiveness. Combining epidemiological tools with the design of statistical information systems offers further scope to improve cost-effectiveness.

Key issues:
Biosecurity systems rely on information both to inform decision-making with respect to the incursion management and quality assurance functions.

Incursion management - Passive and active surveillance procedures underpin the ability of epidemiologists to make predictions about the rate and location of potential disease threats.

- *Statistical design will improve the ability to infer from these data sets.*
- *Clarifying the goals of the biosecurity system can help define information needed*
- *Investment in, or access to, epidemiology skills seems essential.*

Quality assurance - Information about product attributes can create value. It is in the interest of producers to generate this information to take advantage of market premiums. Some information about products can only be inferred from the population from which products are drawn. This information will be generated from the biosecurity system.

- *Statistical design of information systems will strengthen the scope for statistical inference from population to product and reduce the cost of providing this information.*
- *Cost sharing principles will be important to allow industry to determine the level and type of investment needed in product attribute information provision.*

3.4 Institutional design

Institutional design refers to the internal structures adopted to manage the various components of a biosecurity system. Institutional design creates systems that identify those skills that are valued within an organisation. Institutions also identify the mechanisms that are used to gather and process information before decisions are made and enshrine global/corporate objectives into the processes of an organisation. Designing the framework on which organisations are built is very important because this enshrines process into organisations. These processes promote the broad objectives of an organisation and protect it from the narrower objectives of individuals that operate within the organisation. The preceding sections of this paper have identified many new ideas and approaches that appear to have relevance to an efficient and effective biosecurity system. It follows, therefore, that analysis of institutional design of biosecurity systems is likely to be rewarding.

Key issues:
Within the biosecurity system, there seems scope to institutionalise processes that will:

- *Ensure relevant information (epidemiology) and analysis (benefit-cost) is bought to light before important incursion management and quality assurance decisions are made.*
- *Reward relevant skills and capabilities valued for efficient and effective biosecurity management*
- *Reveal information needed by managers to allocate resources between competing intervention activities (eg. pre-border, border, post-border and quality assurance).*
- *Create incentives for innovation leading to improvements in efficiency.*
- *Efficiently share costs with industry.*

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