# final report

Project code: A.MFS.0091

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Date submitted: June 2006

PUBLISHED BY
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# MLA's food safety program and the evaluation framework

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

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# 1 MLA's food safety program and the evaluation framework

MEAT AND LIVESTOCK AUSTRALIA'S Food Safety Program seeks to maintain product integrity through mitigating risks and reducing costs of addressing food safety issues. Some risks are well understood, for example threats from *Salmonella* and generic forms of *E. coli*. These diseases already have regulatory sampling and testing requirements. One of the challenges for MLA's food safety program is to find more efficient ways of meeting existing regulatory requirements. By reducing the existing compliance costs MLA may reduce the cost of supplying red meat to both domestic and international markets. Other challenges include staying abreast of emerging issues and assessing their potential impact on Australia, and ensuring that Australia is well-placed to handle existing threats such as Bovine Spongiform Encephalopathy (BSE).

The evaluation framework developed for MLA provides a way for the Food Safety Program to communicate what it has done to stakeholders. It also provides an internal tool to help decide on allocation of funding and priorities for future investment.

## 1.1 The purpose of this report

This report applies MLA's evaluation framework to its Food Safety Program Plan 2006-2009 (FSP). It provides an assessment of how FSP's many and varied inputs map through to outputs, outcomes, impacts and benefits to the red meat industry and the Australian economy.

The mapping tracks the logic of project investments. It sets out the changes in practice and/or behaviour that MLA's projects are expected to bring about. It provides guidance on how these changes translate to impacts — changes in demand, supply, risk, environment or social outcomes. These impacts form the basis for evaluating the benefits of MLA's Food Safety Program to the red meat industry, the economy and consumers.

The evaluation framework is aimed at improving learning within MLA about what can be expected from its projects. Projects should be evaluated before they start. Once they are complete, evaluations can guide expectations of future MLA work. The evaluation framework also provides a basis for comparing very different MLA projects. The mapping through from impacts to benefits will also assist project managers to identify which stakeholders are likely to be affected. Understanding how research is to be used promotes development of effective communication channels between researchers and stakeholders. Moreover, it provides valuable information to researchers about the likely adoption and practical applications of their research and may help to tailor or improve research outcomes.

The report also provides guidance on developing Key Performance Indicators (KPIs) at the outcome level that project managers could use to monitor the success of their projects. These KPIs will assist MLA to evaluate and compare the effectiveness of various projects in the FSP.

## 1.2 Applying the MLA evaluation framework to Food Safety

The MLA evaluation framework manuals provide a description of the framework. However, for ease of applying the framework to the FSP a brief description of the key factors in the framework is provided below.

**An overview of the framework**

One of MLA's main stakeholders is government. They are interested in seeing that MLA funding through levies and R&D grants is having positive impacts on the industry and Australian welfare. They are also interested in seeing that MLA has a process in place to ensure it is achieving the best outcomes possible. Likewise, MLA's other stakeholders want to see that money is well invested. The framework provides program managers with a tool for considering how research outputs, through adoption by industry or changes in consumer behaviour, lead to impacts and benefits both for the industry and Australia as a whole.

The most important concept behind the MLA evaluation framework is the logical mapping from inputs to impacts.

## 1.3 Steps in applying the framework

Each MLA project uses inputs to produce outputs. Outputs typically generate some outcomes, and these outcomes generate impacts that deliver benefits to producers, consumers and the wider community. While MLA should have control over the outputs from the investment, external events will influence the outcomes and impacts achieved. These concepts and their relationship to each other are shown below in chart 1.

Note that inputs, outputs, outcomes and impacts have a time profile. In some cases the impacts that result from a project will occur with considerable lag, while with others the impacts will be immediate but transitory. It is important to always remember that the terms discussed below have a value at each point in time.

***Inputs***

Inputs are the investment in the project. These can be 'in kind' as well as in cash. The investment in management should also be included. These costs include MLA expenditures and the contributions by others. The implementation/adoption costs (often paid for by industry members) are also inputs that contribute to achieving outcomes and must be tracked.

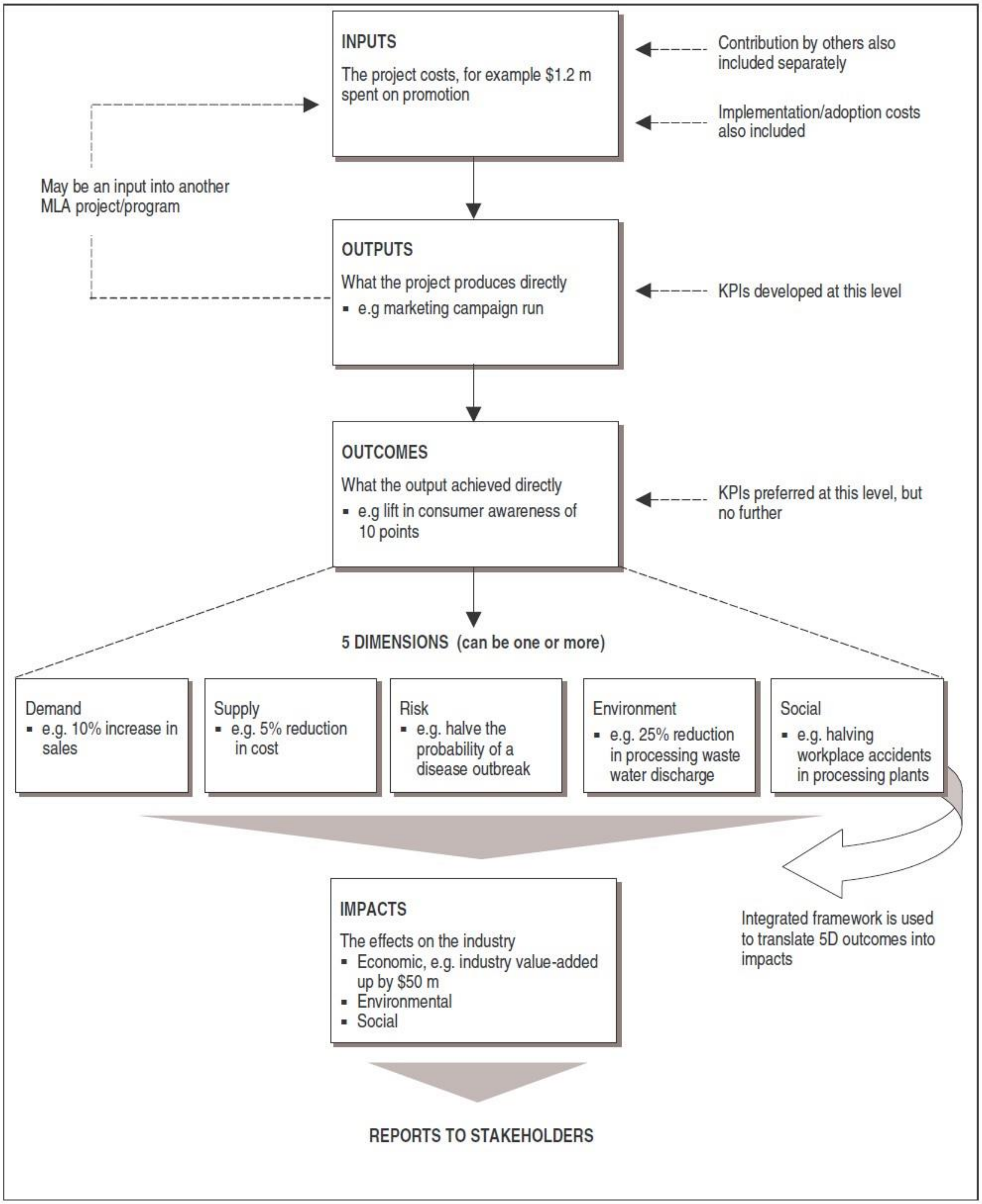
These costs can usually be given a dollar value.
All inputs that contribute to the outcomes being measured should be included in the evaluation. This can be best achieved by using MLA's project evaluation questionnaire to collect information on inputs and outputs for each project and using a full questionnaire to evaluate a group of projects.

***Outputs***

Outputs are the goods and services (including knowledge) that a project produces. For example, scientific papers on the distribution of *E. coli*, a marketing campaign on food safety or the development of a new technology that can reduce processor costs are outputs.
Key Performance Indicators (KPI) are often based on outputs, for example the number of scientific research papers published. Setting outputs as KPIs means that the MLA project can be

held directly responsible for achieving (or not achieving) its KPI. However, meeting an output KPI does not guarantee that a project has led to any changes in practice or behaviour (outcomes). Some outputs are largely inputs into other projects later in the project cycle, and can only be evaluated as a part of a cluster of projects.

1.1 **Inputs to impacts**



***Outcomes***

Adoption rates are an important indicator of outcomes often measured by MLA. Active adoption provides evidence that producers, processors and other private parties perceive value in using MLA's outputs. Adoption is an intermediate step between outputs and outcomes – if nobody adopts then there will be no outcome following from the project.

Outcomes are the consequences of adoption and/or influence of the output of a project and result from changes in practice or behaviour. Outcomes can follow directly from the application, use or influence of the output, such as the examples below.

- Lower risk of contamination due to improved hygiene following processors' training on food safety risks.
- An increase or continuation in market access following implementation of stricter food safety requirements for particular international markets.
- A reduction in the incidence of foodborne pathogens in exports following the implementation of new sampling and testing methods.
- A decline in the costs of meeting regulatory requirements as a result of the introduction of new treatment methods.

To compare project outcomes and to estimate the net benefits of the investment, outcomes need to be linked to impacts.

## 1.4 The five dimensions of impact

The evaluation framework developed for MLA divides the impact of a program into five possible dimensions – demand, supply, risk, environment and social. Demand and supply capture the traditional economic impacts, but do not cover many other important MLA activities.

Risk needs to be captured as this is an important determinant of economic welfare. This impact category encompasses projects that change the probability that an event occurs or the impact of that event should it arise.

Risk impacts are really demand and supply impacts that are associated with an event that may or may not occur.

Other impacts that are important to the welfare of Australia are captured in the environment and social impacts. These are often not captured as economic impacts because the environmental and social impacts do not have a market or are public goods.

These five categories capture the impact that MLA is having on the welfare of Australians.

***Demand***

A rise in demand occurs when consumers are either willing to pay more for a given quantity of the product, or they are willing to buy more at the same price, or some combination of these. Some of MLA's activities aim to increase demand by:

- changing the quality or perceived quality of red meat products;
- improving market access
- such as through improved food safety; and
- advertising (both domestic and overseas), which also changes perceived quality. Actual or perceived quality can be changed by factors such as meat tenderness, consumer attitudes or perceived food safety.

***Supply***

An increase in supply occurs when production costs fall (at any point in the value chain) due to a change in input mix, cost and/or quality. This means that producers increase the quantity they will supply at a given price or lower the price they would accept for supplying a given quantity. FSP projects might increase supply by reducing processing costs or transport costs associated with maintaining adequate food safety measures.

***Risk***

Many FSP projects are aimed at reducing the probability of an adverse event or reducing the cost if an adverse event occurs. For example, reducing the risk of a food safety event or the reaction of consumers to such an event is a risk impact. These impacts fall under the change in risk impact category in the evaluation framework. The key characteristic of a risk is that the event has a probability associated with it (that is, it may or may not happen). The actual impact of an adverse event or opportunity should it arise is usually a change in demand or supply.

***Environment***

Environmental impacts generally change either the amount of a resource being used (for example, water, soil, nutrients, biodiversity and fuel) or the quality of a resource being used (for example, salinity impacts, erosion, air, water and noise pollution). In many cases, projects with environmental objectives also impact on supply and demand and may be addressing risks associated with access to natural resources and/or right to practice.

***Social***

MLA's Food Safety Program has social benefits through health benefits from improved food safety. It could also impact on occupational health and safety. As with environmental impacts, social impacts will often occur in conjunction with other impacts.

***Impacts to benefits – allowing for adjustment over time***

The final level of evaluation is to transform the five dimensional impacts into dollar values over time to allow for comparability. More important is the adjustments over time that may enhance or dampen the economic impact such as adjustment of prices and copying by competitors. Aspects of environment, social and risk impacts that are not quantifiable in dollars must still be reported, as does the extent to which these impacts are maintained or eroded over time given the external context. If there are complex adjustments in response to changes in demand or supply, quantification of the equilibrium effects of the economic impacts for the industry requires the use of a general equilibrium model of the industry, such as the CIE's *Global Meat Industries (GMI) model*. For example, a project that improved market access in one country by meeting a set of standards brings value in the extent to which a higher price can be obtained in this market. The gain is the price difference as the product sold here is not sold in another market. It must also be adjusted for higher costs if meeting the standard imposes additional costs. In the long run producers may expand production to replace that diverted, and may try to expand product into the higher price market driving down the prices somewhat. If this is the adjustment pathway, consumers end up better off in the market with standards, worse off in the market without, and while producers gain, the amount depends on their cost structures.

## 1.5 Structure of this report

The structure for the remainder of this report is as follows. Chapter 3 outlines the Food Safety Program motivation, objective and strategies. It also sets up how to evaluate the impacts of investment made by FSP. There are three main categories of impact – cost of compliance (supply), risk to industry returns (through impacts on demand) and social impacts (through improved health). Chapter 4 provides estimates of the baseline costs/risk and describes the trends in these costs/risk. The companion evaluation work uses this data to estimate changes against the baseline in terms of compliance costs, the probabilities of food safety events and the costs of events should they arise. These evaluations are in separate reports. Finally, chapter 5 provides indicative KPIs so that MLA can measure a project’s effectiveness both during and after the investment period.

# 2 Fitting FSP into the evaluation framework

MLA investment on its food safety program is aimed at improving food safety, reducing the risk of a food safety event for the industry and reducing the costs to industry of achieving food safety standards.

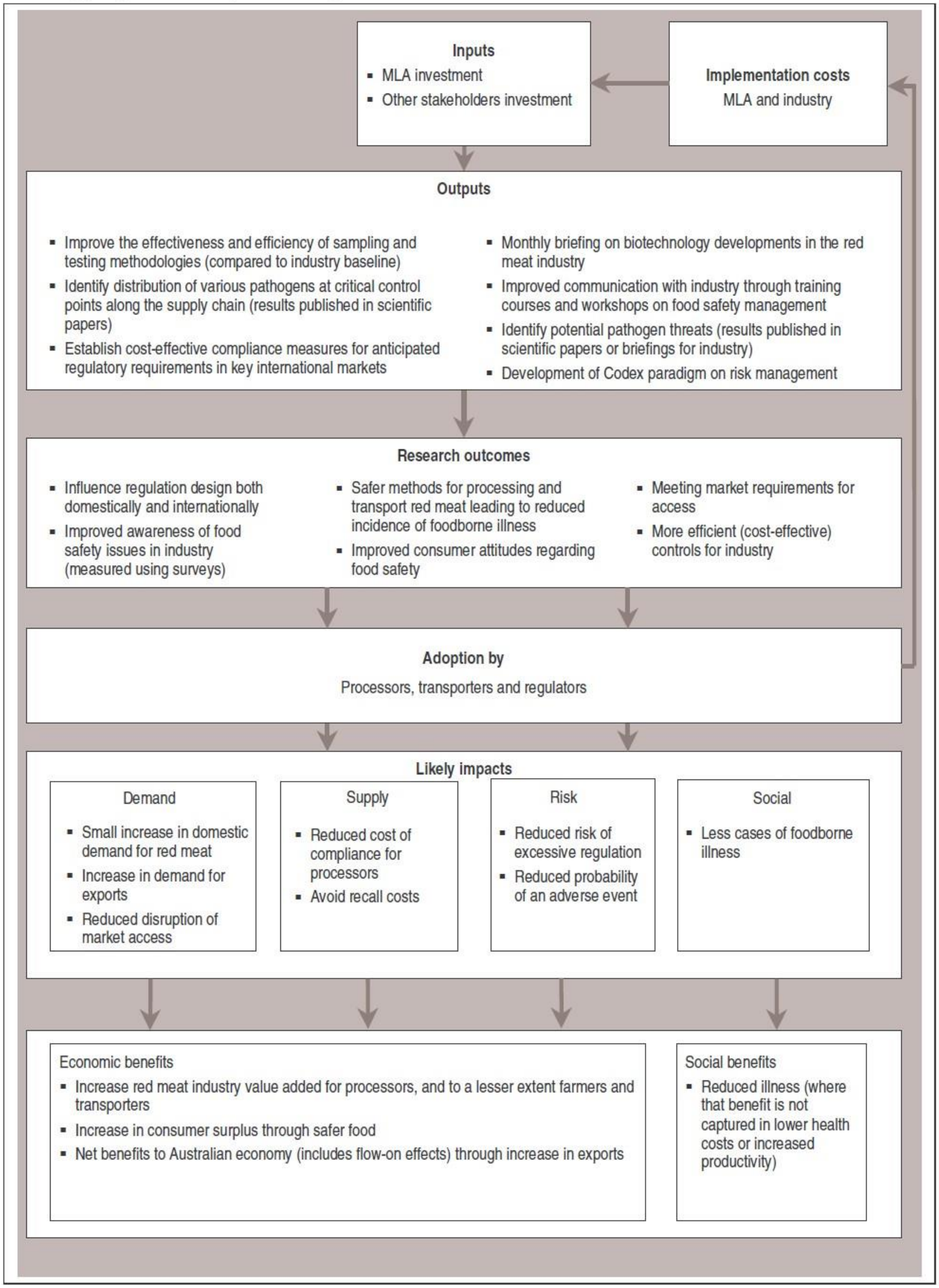
This chapter fits the Food Safety Program into MLA’s evaluation framework, providing a context for program managers to identify how their projects are likely to impact on the industry, the Australian economy and consumers. Project managers should be able to use this report to guide their evaluations.

## 2.1 Fitting FSP into MLA’s evaluation framework

MLA’s evaluation framework provides a logical method for understanding how the objectives of the FSP could be achieved. This involves mapping the inputs through to the impacts and considering whether these impacts align with the objectives of the program.

A mapping of the FSP’s inputs through to their impacts and benefits is provided in chart 2.1.

## 2.1 Mapping of FSP’s inputs to outputs



**FSP objectives**
MLA's Food Safety Program Plan 2006-2009 (FSP) objectives, based on the strategic plans of RMAC[1] and SAFEMEAT, include:

- developing pathogen management programs with an emphasis on risk management;
- contributing, where appropriate, to the development and implementation of national policies and programs designed to protect Australia from exotic animal diseases;
- establishing cost-effective techniques that comply with access requirements for key markets;
- providing a through-chain, 'world best practice' approach for managing food safety risks in the red meat industry;
- ensuring industry is positioned to meet changing market and consumer demands in relation to emerging issues; and
- providing input into national and international standards for the regulation of emerging issues.

Nearly 90 per cent of the proposed funding and hence most of the FSP's research is targeted toward pathogens. The objective of the pathogen subprogram is to develop pathogen management programs with an emphasis on risk management.

***FSP impacts***
A mapping of FSP's objectives to impacts is provided in table 2.2. All objectives align with reducing risk and often also link to reducing costs, maintaining market access and reducing illness from foodborne disease. FSP primarily aims to:

- reduce the cost of supply: through reducing food safety costs in processing and transport; and
- reduce risk: through affecting the probability of a food safety incident and the cost of that incident. The cost of a food safety incident will be either a demand and/or supply side change.

[1] See RMAC (2003)

## 2.2 The areas of impact of FSP

| *FSP’s objectives* | *Demand* | *Supply* | *Risk* | *Social* |
|---|---|---|---|---|
| Developing pathogen management programs with an emphasis on risk management | | ✓ | ✓ | ✓ |
| Contributing, where appropriate, to the development and implementation of national policies and programs designed to protect Australia from exotic animal diseases | | | ✓ | |
| Establishing cost-effective techniques that comply with access requirements for key markets | ✓ | ✓ | ✓ | |
| Providing a through-chain, ‘world best practice’ approach for managing food safety risks in the red meat industry | | ✓ | ✓ | ✓ |
| Ensuring industry is positioned to meet changing market and consumer demands in relation to emerging issues | ✓ | | ✓ | |
| Providing input into national and international standards for the regulation of emerging issues | | | ✓ | |

*Source*: CIE

**FSP outcomes**
Under these broad strategies lie a number of more detailed strategies that are reflected in the selection of projects and the design of the programs under FSP (such as Safemeat). Measurement of outcomes needs to be undertaken at this more detailed level. Outcomes of the FSP include:

- lower compliance costs for food safety (supply impact);
- reduced incidence of pathogens in red meat products that cause foodborne illness (the extent of change is likely to vary for the different pathogens) (risk impact related to demand and supply); and
- provision of evidence required to avoid compliance with some international market requirements (impacts on demand through market access or supply through processor costs).

Adoption rates provide a useful intermediate measure of the impacts of a project or program and are necessary to estimate the overall benefits of a project/program. A low adoption rate might indicate that the research outcome is not useful, cost-effective or widely known by industry. On the other hand a high adoption rate indicates that industry views the practical outcomes of the research favourably (and that implementation costs are low relative to the benefits). The FSP project, ‘Communication and adoption’, aims to measure the impact of implementing research outputs. Some FSP projects may have few, if any, immediate outcomes. This is particularly likely for research into emerging issues and pathogens that currently are not thought to have implications for human health. Such research is an input into other research and may not have any direct consequences for ten to fifteen years. The value of such scientific research is that there is a small chance it might prevent the next BSE-like incident and it supports diagnostic and technical capabilities that may prove essential in responding to actual or perceived threats to food safety in red meat products.

**FSP outputs**

All projects in the FSP should have one or more directly observable outputs. Outputs are the direct result of the investment that MLA and other stakeholders have made in the FSP. Outputs have to be able to be measured to be useful in evaluating projects and programs.

For the FSP some of the likely outputs include:

- number of scientific papers published in refereed journals on a specific topic;
- producing software to be used by 50 per cent of processors linking temperature and microbiological growth;
- training 80 per cent of processors in a particular risk management technique by 2008; and
- developing a new testing method for beef trim.

Each of the outputs the program produces will result from one or more of the projects that comprise the FSP. The list of projects in the FSP is presented in table 2.3. A full description of the projects is contained in appendix B.

### 2.3 List of projects in MLA's Food Safety Program Plan 2006-2009

| *Project* | |
|---|---|
| Tests for RAM in feeds | Listeria in unfermented ready-to-eat meats |
| Scaling up surveillance of BSE | Physiology of pathogens under supply chain conditions |
| Plant and fungal toxins | Toxoplasma in sheep (meat and) offal |
| Identification of hazards | Enterococcus on carcases |
| Understanding risk | Staphylococcus on carcase and trim |
| Managing risk | Mycobacterium paratuberculosis |
| Implementation of risk management | Microbiological quality or retail cuts |
| Responding to market requests for information | Antibiotic resistant organisms |
| Microbial contamination of meat through transport and processing | Opportunities for efficiency gains |
| Offal microbiology | Communication and adoption |
| *E. coli* in beef trim | Biotechnology developments |

*Source*: MLA (2006)

## 2.2 Applying the evaluation framework

Applying MLA's evaluation framework requires:

- measuring the outputs of the project/program;
- quantitatively linking outputs to outcomes; and
- quantitatively linking outcomes to impacts.

Initially, these linkages will not be well understood. The process of understand and measuring will build up knowledge over time and make evaluation easier and more effective. This approach also forces project managers to document the answers to questions such as such as:

- Who will this project affect? (Processors, producers, particular region, adoption.)

- What products will this project affect? (Beef, sheepmeat, part of these markets, domestic, export.)

Measuring the outputs of a project/program has been discussed above. The following sections go through the qualitative linkages that are relevant for the FSP and methods of measuring outcomes. It also discusses key concepts in evaluating projects such as the baseline. Chapter 3 provides quantitative information for a number of benchmarks.

**Linking outputs to outcomes**

The qualitative links between the outputs of the FSP and a set of outcomes are shown in Table 2.4. Knowing what outcomes a project has provides a project manager with information on who should be consulted and how this should be done.

Typically, quantitative links between outputs and outcomes will require measuring changes in outcomes and attributing this to the particular output of the project/program. For example, there is no fixed relationship between the output of a software tool for processors and the use of this tool. Processors have to be consulted to understand whether they use the tool and how it has changed their behaviour.

2.4 **Example FSP outputs and potential outcomes**

| *Outputs* | *Validate performance of current testing methodology* | *Plan for rapidly scaling-up surveillance of BSE* | *Process risk model* | *Scientific paper that demonstrates the safety of offals* | *Develop intervention measures for microorgan-isms in the suply chain* | *Develop alternative food safety procedures for beef trim* | *Technique to prevent growth of pathogens in processed meats* |
|---|---|---|---|---|---|---|---|
| **Who adopts?** | Producers | Producers | Processors | Processors, regulators | Processors, transporters | Processors | Processors |
| **Adoption rate** | xx% | xx% | xx% | xx% | xx% | xx% | xx% |
| **Products affected** | Beef, sheepmeat | Beef | Beef, sheepmeat | Offals | Beef, sheepmeat | Beef trim | Beef, sheepmeat |
| **Outcome changes:** | | | | | | | |
| Improved industry awareness of food safety issues | | ✓ | ✓ | ✓ | | | ✓ |
| Meet market requirements for access | | | ✓ | ✓ | | ✓ | |
| Cost-effective sampling methods for industry | ✓ | | | | ✓ | ✓ | ✓ |
| Improved consumer attitudes to food safety | | | | ✓ | | | ✓ |
| Safer methods for processing and transporting | | | ✓ | ✓ | ✓ | | |
| Improved risk management techniques by industry | ✓ | ✓ | ✓ | | ✓ | ✓ | |
| Improved Occupational Health and Safety procedures for processing plants | | | | | | ✓ | |

*Source*: CIE

***Measuring outcomes***

Measuring outcomes typically requires input from stakeholders. Table 2.5 shows some methods that can be used to quantify outcomes. In doing this, project managers should ensure that the outcomes reported by stakeholders are attributable to the project.

2.5 **Methods for measuring outcomes**

| *Outcome* | *Survey of processors* | *Survey of consumers* | *Consultation with domestic regulators (AQIS, FSA, FSANZ, etc.)* | *Consultation with international regulators (e.g. FSIS in US)* | *Scientific modelling* | *Comparisions with historical data or international research* |
|---|---|---|---|---|---|---|
| Improved industry awareness of food safety issues | ✓ | | ✓ | | | |
| Meet market requirements for access | | | ✓ | ✓ | | |
| More cost-effective sampling methods for industry | ✓ | | | | | |
| Improved consumer attitudes to food safety | | ✓ | | | | ✓ |
| Safer methods for processing and transporting | ✓ | | | | ✓ | |
| Improved risk management techniques by industry | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Improved Occupational Health and Safety procedures for processing plants | ✓ | | | | | |

*Source*: CIE

Ideally, surveys of processors and consumers would cover a number of MLA and FSP projects at once. MLA is planning on benchmarking processors. This could be an opportunity to cheaply evaluate some of FSP's projects.

***Linking outcomes and impacts***

Once project managers have identified outcomes for their projects the next step is to identify how those outcomes link to impacts. Again, this will require careful consideration of attribution of changes in impacts to the particular project or program. Table 2.6 shows the qualitative linkages between FSP outcomes and impacts. Not all changes will necessarily be positive, for example improvements in occupational health and safety (OH&S) may cause an increase in operating costs for processors.

Understanding how outcomes link to impacts means:

- linking incidence of pathogens in red meat to foodborne illness;
- linking incidence of pathogens in red meat and foodborne illness to changes in demand; and
- linking compliance costs to total processor costs.

## 2.6 FSP outcomes and potential impacts

| | *Improved industry awareness of food safety issues* | *Meet market requirements for access* | *Cost-effective sampling methods for industry* | *Safer methods for processing and transporting* | *Improved risk management techniques by industry* | *Improved Occupational Health and Safety procedures for processing plants* |
|---|---|---|---|---|---|---|
| **On demand: changes in** | | | | | | |
| Domestic demand for the product | | | | | | |
| Export demand for product | | ✓ | | | | |
| Market access for product | | ✓ | | | | |
| **On supply (production): changes in:** | | | | | | |
| Fixed costs for processors/producers/regulators of product | ✓ | | | | ✓ | |
| Operating costs for processors/producers/regulators of product | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Recall costs for processors/producers/regulators of product | | | | | ✓ | |
| **On probability of changes in demand or supply:** | | | | | | |
| Risk of additional regulation | ✓ | | | ✓ | ✓ | |
| Adverse event at processing stage | | | ✓ | | ✓ | |
| Adverse event for consumers (foodborne illness) | | | ✓ | | ✓ | |
| **Changes in environmental and/or social outcomes:** | | | | | | |
| OH & S conditions for processor employees | ✓ | | | ✓ | | ✓ |

*Source*: CIE

Table 2.7 shows the impacts expected from selected projects within FSP.

## 2.7 Impacts of selected FSP projects to affect impacts

| | *Ability to affect* | | |
|---|---|---|---|
| | *Risk* | | *Supply* |
| ***Project name*** | ***Probability of event*** | ***Cost of event*** | ***Compliance costs*** |
| Test for RAM in feeds | ✓ | ✓ | ✓ |
| Scaling up surveillance of BSE | ✓ | ✓ | |
| Plant and fungal toxins | ✓ | | |
| Microbial contamination of meat through transport and processing | | | ✓ |
| Offal microbiology | | ✓ | |
| *E. coli* in beef trim | ✓ | | ✓ |
| *Listeria* in unfermented ready-to-eat meats | ✓ | | |
| Physiology of pathogens under supply chain conditions | | | ✓ |
| Toxoplasma in sheep (meat and) offal | ✓ | | |
| Enterococcus on carcases | ✓ | | |
| Staphylococcus on carcase and trim | ✓ | ✓ | ✓ |
| Mycobacterium paratuberculosis | ✓ | | |
| Microbiological quality of retail cuts | | ✓ | ✓ |
| Antibiotic resistant organisms | ✓ | | ✓ |

*Source*: CIE, MLA

***The baseline***

The outcomes and impacts of a project have to be measured relative to baseline. For example, in the absence of MLA, processors may find more efficient ways of meeting food safety standards. In this case processing costs related to a particular food safety standard may fall over time. MLA may have projects that lower the cost of meeting food safety standards. The temptation is to attribute all the change in costs to MLA. In fact, MLA's investment is only responsible for a part of this change.

Alternatively, not understanding the baseline may understate the benefits of MLA's investment. An MLA project that avoids cost increases has to be measured against what would have happened in the absence of the program rather than measured relative to current costs.

*External factors that may affect outcomes without MLA*

To help MLA to correctly identify the baseline, this section outlines a number of external factors that may be subject to change and that impact on measures used by FSP.
The program has at best only marginal control over these factors, which include:

- trade driven requirements;
- changing consumer requirements for food safety;
- emerging threats (for example through changing pathogen risks);
- major commercial buyers implementing their own standards; and
- new technologies that will affect costs.

Trade driven requirements are increasingly of concern for some of the industry's key international markets. Under the World Trade Organisation (WTO) countries are given provisions for restricting trade based on their own scientifically based Sanitary and Phytosanitary (SPS) measures. Many countries are using such measures and this can have the effect of restricting trade if the exporting country is unable to comply with the requirements. Changes in consumer preferences for food safety occur both domestically and in international markets. For example there is an increasing concern in China about the integrity of Australia's offal exports. Domestic perceptions about the quality of Australian red meat remain high with 81 per cent of respondents indicating they had no concern about the safety of Australian beef (Millward Brown, 2003).

Threats to the integrity of the Australian red meat industry are changing. While the FSP targets emerging issues and conducts research into pathogens that have not as yet been identified as a major threat, there is a potential that unknown threats might emerge. *E. coli* O157:H7 seems the best example of a pathogen that has come from relative obscurity to prominence. This particular strain of *E. coli* was unknown until 1982 (WHO, 2006).

Commercial buyers may impose more stringent conditions than national SPS requirements for exports from Australia or imports to various international markets. This is most commonly occurring in the US, where several major fast food purchasers of beef implement their own food safety standards for beef processing. Such commercial obligations may be influenced by research outcomes from the FSP.

Another external factor that might influence the objectives of the FSP is the emergence of new technologies. These are likely to enhance the value added of the FSP to the industry, although they may make some aspects of the FSP redundant. For example if the FSP is researching cost-effective methods of testing for generic *E. coli* and a technology emerges that allows *E. coli* to be eliminated at a low cost with no impact on quality it will undermine the relevance and value of MLA's research.

***Using the framework is a learning process***

Mapping from outcomes to impacts and working out how to quantify the impacts from measured outcomes is something that can only be learned by doing. The framework provides a structure for undertaking this analysis, but it does not map all possible pathways, nor can it provide a set of measures that will always do the job. Applying the framework is as much about the learning process as it is justifying the decisions on program investment. Measurement is important not just for accountability, but to test the priors on which investment decisions are based. An analysis of expected benefits is always part of an investment decision. The framework helps to make this analysis explicit, making the process more transparent, accountable and hence robust and defensible.

# 3 Benchmarks for evaluating FSP projects

FOODBORNE PATHOGENS COULD POTENTIALLY cause significant harm if they enter the food supply chain. A few isolated, but well-known incidents have focused attention on food safety in Australia and other international markets. These have led to an increase in food safety awareness among consumers as well as increased regulations (and costs) for industry.
Reducing the risk and/or the consequences of pathogen incidents reduces the expected cost of such incidents to the industry.

The FSP targets all three of these areas – the likelihood of a negative event, the costs of a negative event and the compliance costs of achieving food safety outcomes.
This chapter discusses the above three impacts in detail. It provides benchmarks of:

- the likelihood of a negative food safety event;
- the costs of different types of food safety events; and
- the compliance costs for industry to meet particular obligations.

Project managers can use this information as a guide in undertaking evaluations. Project managers can transfer the benchmarks in this report to their projects through applying appropriate scaling factors to provide a rough guide as to the magnitude of impacts from a project.

## 3.1 Costs of compliance

Compliance with food safety regulations often entails additional production costs. These may include investment in new equipment or hiring new staff (such as a meat scientist). This section presents estimates of various compliance costs associated with current regulations and commercial obligations and past changes in regulations.
Costs of some current regulatory measures are shown in table 3.1. Some of these costs are imposed by regulators (such as for AQIS). Other costs, such as microbiological testing of beef trim sent to the US, are imposed by commercial parties such as fast food chains.

### 3.1 Current costs related to food safety

| *Item* | *Costs* | *When incurred* |
|---|---|---|
| Electronic copy of a meat health certificate | $11 | Each export shipment to any market |
| AQIS meat inspector annual fee | $51 589 | Once per year for each export processor |
| Microbiological testing (current) | $35 per sample | Each time testing is required |
| | $175 per carton tested | |
| Current microbiological testing (overall) | 1 to 2 per cent of total processor costs | All the time for processors of beef trim. This is required under commercial obligations. |

*Source*: FSANZ (2002), AQIS (2006a),

Examples of a range of impacts on compliance costs arising from past and hypothetical changes in regulations are provided in table 3.2.

## 3.2 Change in compliance cost due to change in regulations

| | *Implementation cost* | *Annual operating costs* |
|---|---|---|
| Moderate–increase in no. of samples tested by 200 per cent | Na | $84 000 per plant |
| Moderate – mandatory installation of decontamination unit | $1.5m to $2m per plant | Na |
| Moderate – introduction of PR/HACCP style regulations | $346 989 per plant | $151 515 per plant |
| Major – potential testing of beef trim to US (20 times increase) | Na | 14.1 per cent increase in overall costs |
| ARMCANZ Standards | Na | $84 million across the industry |

*Source*: FSANZ (2002), ERS (2004), AACM International (2006) CIE

Following the introduction of Pathogen Reduction/Hazard Analysis and Critical Control Point (PR/HACCP) rule in the US in 1996 the increase in compliance costs for plants processing raw meat in the US was estimated at $US116 500 (A$151 515) per plant per year. In addition, there were implementation costs of US$266,800 (A$346 989) per plant (ERS, 2004)[2].
Potentially, the US could require the mandatory installation of decontamination units. This could cost each plant between $1.5m and $2 million in implementation costs.

Domestic regulations can also impose significant costs. The increase in operating costs due to the ARMCANZ's standards was estimated at $68 million per year, which is equivalent to $84 million per year in today's terms (AACM International, 1996).
Other estimates of compliance costs can be found in the evaluations of MLA's Predictive Microbiology project and MLA's E. coli in beef trim project.

***Purchaser requirements***
Compliance costs are not always imposed through government regulations. Several large wholesale purchasers of meat products, including some of the major fast food companies in the US, demand stricter food safety measures than those of the US' Food Safety Inspection Service (FSIS). For example, Australian exporters of beef trim to the US already test for *E. coli* O157:H7 in their product despite FSIS currently not requiring importers to specifically test for that strain of *E. coli*.

Commercial obligations are driven through a firm's concern about maintaining its reputation. It mandates controls down its supply chain to ensure that a food safety incident does not arise in one of its products. These controls are likely to be factored into the price the firm sells the product for, although it is unlikely that such costs would be passed through entirely to the price. That is processors would absorb some of the costs associated with food safety.

***Changes in compliance costs***
Compliance costs often change, especially due to changes in international conditions. Australian producers must comply with requirements in key international markets to ensure their product continues to have access. These requirements change frequently for example Japan recently changed the way it regulates residues[3]. If imported foods have residues above the prescribed levels then Japan will increase its own monitoring by 50 per cent. A second breach means that 100 per cent testing becomes mandatory (a cost incurred by the importer).

[2] Conversion to Australian dollars based on an exchange rate of A$1 = US$0.7689 (RBA, 2006).
[3] As of 29 May 2006.

## 3.2 Risk and consequences of food safety events

The overall costs of a food safety event is a product of the cost if the event occurs and the likelihood of the event occurring. The FSP seeks both to lower the probability of an event and to reduce the probability that the event occurs. This section outlines these two aspects of a food safety event and the role of the FSP.

***Risks of a food safety incident for the industry***
A food safety incident could involve:
- illness or other health effects following the consumption of red meat; and/or
- a change in demand following an outbreak or persistent health effects.

There are many cases of foodborne illness that do not result in substantial shifts in demand.
MLA's FSP can change the likelihood of a food safety event through reducing the prevalence of pathogens in food. Reducing the prevalence of a pathogen by 10 per cent will not reduce the amount of illness by 10 per cent, however. This is because the illness can sometimes occur even if there is only one organism present. In addition, the level of pathogens in food when it is consumed depends on the entire process up to its consumption, including how it is cooked and handled by the consumer or food retailer. Typically an incident of foodborne illness requires the failure of several safety measures along the supply chain. The pathogen must be in the meat to begin with, it must fail to be detected through standard sampling and testing techniques, survive processing and transportation and survive cooking.

Despite the complexity of these relationships, if MLA can reduce the prevalence at the processing stage of production it minimises the impact of later mishandling.
The incidence of foodborne illness in the US is shown in table 3.3. This is total foodborne incidence rather than just that allocated to red meat. Red meat tends is not often associated with foodborne illness. According to one study, only 5 per cent of 214 outbreaks were attributable to either beef or lamb (Dalton et al., 2004). Although, risk rates can vary between pathogens.
For example, 41 per cent of *E. coli* O157:H7 outbreaks are linked to ground beef (Rangel et al., 2005).

### 3.3 Estimated average annual cases of foodborne illness in the US[a]

| *Disease or agent* | *Estimated foodborne cases* | *Hospitalisation rate* | *Case fatality rate* |
|---|---|---|---|
| | no. | % | % |
| *Campylobaccter* spp. | 1 963 140 | 0.102 | 0.0010 |
| *Escherichia coli* O157:H7 | 55 594 | 0.295 | 0.0083 |
| *Listeria moncytogenes* | 2 493 | 0.922 | 0.2000 |
| *Salmonella* (non-typhoidal) | 1 341 873 | 0.221 | 0.0078 |
| Staphylococcus | 185 060 | 0.180 | 0.0002 |
| *Toxomplasma* | 112 500 | na | na |

[a] For all food types, not just red meat. [b] Based on total number of cases of the pathogen.
*Source*: Mead et al. (1999)

In Australia only 13 per cent of reported foodborne illness cases were attributable to contaminated primary produce between 1995 and 2000 (OzFoodNet, 2005). The same study showed that only 4 per cent of foodborne illnesses in that period were directly attributable to consumption of beef or lamb[4]. Data for the study was gathered using a survey of state and territory health departments in a selection of years[5]. This means that it is likely to understate the number of outbreaks foodborne illnesses in Australia as foodborne illnesses is generally under-reported (Mead et al, 1999). In addition, there were a substantial number of unknown causes of foodborne illness in the study.

Another study showed that there were 9 foodborne disease outbreaks that could be attributable to beef and 2 for lamb between 1995 and 2000 (an outbreak involves more than one case of foodborne illness from the same product). There were 313 cases involved in the 9 outbreaks associated with beef and 16 cases associated with the two lamb outbreaks (Dalton et al 2004). There were a substantial number of outbreaks that could not be allocated to a particular food.

Qualitative relative risks of a foodborne illness due to consumption of red meat are presented in table 3.4. Quantitative estimates could not be found that were attributable directly to red meat and that were directly relevant to the processing sector. This may be an area for MLA to undertake further research and consultation.

### 3.4 Relative likelihood and cost of foodborne disease due to excessive levels of pathogens remaining in red meat after processing

| *Microbacterial agent* | *Relatively likelihood of an excessive level of foodborne pathogen in product*[a] | *Consequences (for industry) of a case of excessive levels of foodborne pathogens*[b] |
|---|---|---|
| Salmonella (non-typhoidal) | Medium | Medium |
| Generic E. coli | High | Medium |
| E. coli O157:H7 | Medium | High |
| Staphylococcus | High | Medium |
| Listeria monocytogenes | Low | High |
| Campylobacter | Low | Low |

[a] Relative ranges based on consultation with MLA. [b] Likely to occur through detection of an excessive level of a foodborne pathogen in Australian exports by inspectors of a foreign country or a case of foodborne illness in the domestic market.

*Source*: CIE and MLA

***Costs of food safety incidents to the industry***

The costs (to the industry and public health) of a food safety incident can be enormous (see box 3.5 for BSE). Most pathogens are unlikely to cause the same extreme production/demand impacts as BSE.

The costs of a food safety event vary between demand-side costs and supply-side costs or in some cases both. Demand-side costs occur through consumers reducing demand for Australian red meat or through loss or limitation of market access. Supply-side costs might occur from changes in processing, labelling or other requirements for access to overseas markets or for the domestic market. The FSP has the potential to add value through reducing the consequences of

[4] The study also reports additional cases which it attributes an 'other meat' category. This includes meats that might be mixed together and meats not elsewhere classified, or instances where the type of meat was not known. If 'other meat' is included with the beef and lamb category this would represent 9 per cent of the cases of foodborne illnesses in Australia between 1995 and 2000.

[5] In Australia, doctors must notify foodborne disease outbreaks to state and territory health departments under state public health laws.

a food safety incident. For example the FSP could increase consumer awareness of food safety measures and hence reduce their negative reactions to an isolated food safety incident.
The costs of a food safety event are contingent on the size and concerns of the relevant market. For example the Japanese market might be particularly sensitive to an incident caused by staphylococcus.

### 3.5 The effect of BSE on US beef exports

Bovine spongiform encephalopathy (BSE) was first discovered in the US in December 2003. Its discovery led to about 70 countries banning imports of US beef and cattle. US beef exports fell from 2.5 billion pounds in 2003 to 461 million pounds in 2004, with $2.5 billion wiped off its export value (Blayney et al, 2006). The ban was in place for more than two years for some of the US' previously major beef export markets. However, US reliance on beef and cattle exports is not as great as Australia, with only about 10 per cent of total US production exported (ERS, 2006). Nevertheless, the increase in domestic beef supplies caused a reduction in domestic prices (ERS, 2006).

In response to the discovery of BSE US regulators announced a raft of new regulations and testing objectives to reduce the spread of BSE. The regulations were also designed to reassure consumers regarding the safety of beef products. As the Economic Research Service notes:

> The regulations affected producers, processors and consumers, depending on each level's ability to pass on the increased costs. The full effect of additional regulations will be felt over a longer period than will the effects of trade bans and price declines for cattle, beef, and beef products observed thus far. (p5., ERS, 2006)

The impact of BSE on the US beef market was mitigated by strong domestic demand for high quality, grain-fed beef and low cattle inventories. Consumer responses in the US were also different from those in other countries. The consumer response to BSE did not lead to reduced beef consumption at lower prices (ERS, 2006).

In most cases the cost of an isolated food safety incident is relatively minor effectively meaning the loss of part of a shipment to the respective export market. If such an incident occurs in some of Australia's key export markets, such as Japan or the US, then there is also a temporary increase in sampling and testing costs for the plant identified as the source of the contamination. Further sampling may lead to further positive samples, escalating the problem.

For example, in the US market the major pathogen of concern currently is *E. coli* O157:H7, which it has adopted a 'zero tolerance' attitude towards. This means that if the pathogen is detected the lot that has the pathogen will be refused entry and the next 15 shipments from the establishment that provided the product will undergo thorough testing. A major exporter indicated that the value of product that has to be diverted when a lot is refused entry typically ranges from $80 000 to $200 000. While this is insured, in the long term insurance costs will reflect the amount of product that gets diverted.

Major food safety incidents might cause a temporary loss of market access in some of Australia's major export markets. The impact of a temporary loss of market access for the US, Korea or Japan is indicated in table 3.6.

The results were modelled using the CIE's *Global Meat Industries* model. Program managers could base calculations for the loss of market access on these results. However, care should be taken as the results are not additive, so they could not be used to demonstrate the simultaneous loss of access to all three markets. The results reflect a temporary ban in one export market still allowing Australia to divert its products to other export markets.

### 3.6 Effect of a temporary (1 year) loss of access to selected international markets[a]

| *Country* | *Producers* | | *Processors* | |
|---|---|---|---|---|
| | Beef | Sheep | Beef | Sheep |
| | $m | $m | $m | $m |
| Japan | -2 684 | -230 | -576 | -9 |
| Korea | -745 | -22 | -122 | -1 |
| USA | -2 444 | -571 | -91 | -23 |
| USA (beef trim only)[b] | -1 540 | -360 | -58 | -14 |

[a] Measured as the change in value added for the industry (including both processors and producers). [b] It is possible to pro rata the cost of impacts based on the value of the relevant product, for example beef trim is 63 per cent of the value US exports.

*Source*: CIE

Increased testing for a specific pathogen might lead to greater levels of detection and hence wastage of product in addition to increasing compliance costs for the firm. The levels of wastage and the cost of loss of market access depends on the alternative markets for the product. The worst case scenario is that it has to be destroyed, the best case is that it can be diverted into other high value, but less pathogen sensitive, markets.

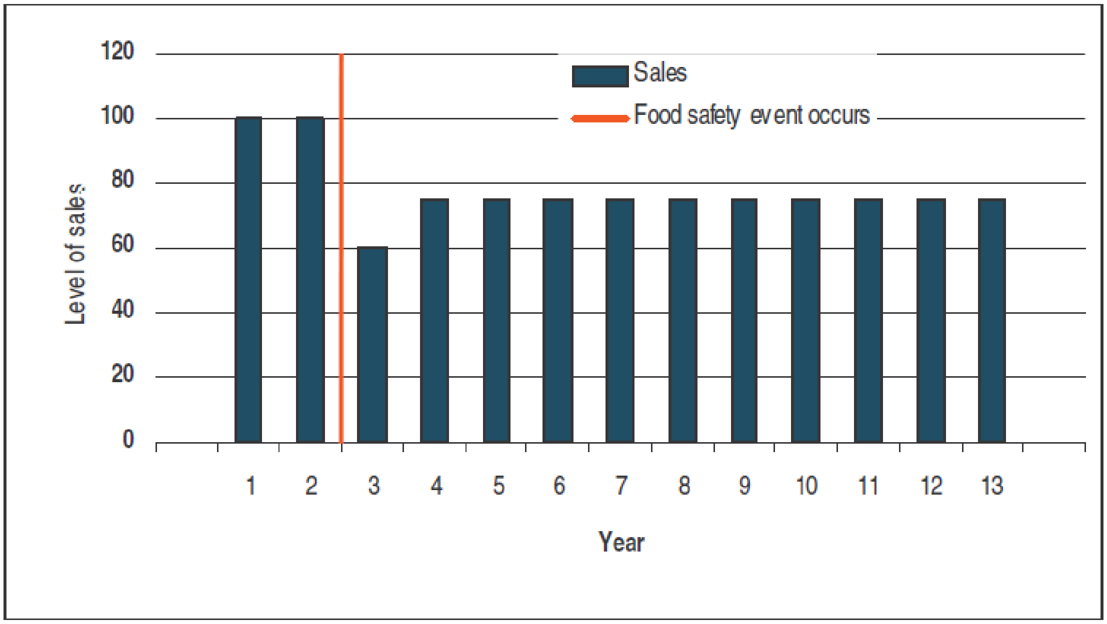
Although once rejected it becomes harder to divert products to other markets. For example in 2003 Saudi Arabia rejected the *Cormo Express*' consignment of 57 937 live sheep due to an unacceptable level of scabby mouth (6 per cent). The Saudi owner of the consignment was unable to find another market, despite subsequent veterinary tests for scabby mouth finding a much lower incidence (0.35 per cent) (AQIS, 2006b).

The cost of an isolated food safety incident can also have severe domestic implication. In 1995, the 'Garibaldi incident' heightened Australia's sensitivity to the threat of foodborne illness. The incident saw one child die, and a number of others permanently affected following consumption of Garibaldi brand mettwurst. The mettwurst was contaminated with *E. coli*.

Following the incident sales of mettwurst fell by 40 per cent and an estimated 400-500 small good producers went out of business (FSANZ, 2006b). Despite the illness being attributable to one business the cost from a loss of consumer confidence in the product can affect the whole industry.

The Garibaldi incident provides a benchmark for the general downturn in demand following a significant food safety event. Demand in the relevant market (including products associated with the contaminated product) can fall by 40 per cent in the first year and remain 25 per cent below baseline levels for the next 10 years (chart 3.7)

## 3.7 Impact of a major food safety event on sales




*Data source*: FSANZ (2002), CIE

There can be less significant demand impacts. For instance, it is estimated that each product recall of E. coli 0157 following an outbreak leads to a decline in beef prices of 2 to 2.5 per cent for the next five days (NCBA 2004).

***Social costs of a food safety incident***

Food safety research also reduces the social cost of foodborne illness. A food safety incident is likely to affect the health of consumers, requiring associated health and medical costs both for the individual and for the economy. Foodborne illness also costs the economy more broadly as workers taking sick leave. A recent estimate of the social costs of foodborne illness in Australia is presented in table 3.8.

## 3.8 Social cost of foodborne illness per year

| *Pathogen* | *Hospital* | *Morbidity*[a] | *Fatalities* | *Other*[b] | *Total* |
|---|---|---|---|---|---|
| | $'000 | $'000 | $'000 | $'000 | $'000 |
| C. perfringens | 49 | 18 133 | 10 464 | 280 | 28 926 |
| Campylobacter | 22 785 | 152 270 | 62 369 | 990 | 238 414 |
| E. coli | 5 295 | 1 306 | 5 598 | 9 | 12 208 |
| Listeria monocytogenes | 11 299 | 1 427 | 134 771 | 8 | 147 504 |
| Salmonella | 23 607 | 44 621 | 208 396 | 388 | 277 012 |
| Staphylococcus aureus | 197 | 1 281 | 281 | 20 | 1 779 |

[a] Morbidity is defined as lost productivity and lost enjoyment of life and is based on quality adjusted life years (QALY).
[b] Includes visits of general practitioner, medication, laboratory tests and transport.

*Source*: FSA & MEC (2002)

These values provide an indicative baseline estimate for the social costs of selected foodborne pathogens (not all attributable to red meat). Costs per case are reported in Table 3.9. The measures are derived from medical treatment costs, which depend on the severity of the illness and which may comprise a visit to a GP, prescription medication or the cost of hospital admission and treatment.

### 3.9 Costs per case for red meat related pathogens

| Pathogen | Cases | Costs | Costs per case |
|---|---|---|---|
| | No. | $000s | $/case |
| E. coli | 1 345 | 12 208 | 9 077 |
| Listeria monocytogenes | 135 | 147 504 | 1 092 622 |
| Salmonella | 101 136 | 277 012 | 2 739 |
| Staph. aureus | 5 199 | 1 779 | 342 |
| Campylobacter | 247 351 | 238 414 | 964 |

*Source*: FSA & MEC (2002)

Estimates for the cost of morbidity are based on the value of lost productivity and lost leisure time. They are based on estimating the value of lost wages using such sources as the Australian Bureau of Statistics (ABS). The social cost of morbidity reflects the number of days of labour lost due to a foodborne illness.

For a pathogen outbreak that causes one or more fatalities economic costs are calculated based on the value of a statistical life. The value reflects how much the community is prepared to spend to reduce the risk of fatality to avoid one death. In a recent Australian study of food safety $5 million was used as the value of a statistical life (FSA&MEC, 2002).

Another method of valuing health impacts is to calculate disability adjusted life years (DALYs). For instance, increasing a person's life by two years at full health is equivalent to two DALYs. Increasing their life by two years but at a lesser level of health, say half, is equivalent to only one DALY.

Australian government reports typically use a value of a DALY of $60 000 (Commonwealth Department of Health and Ageing 2003).
A single case of mild gastroenteritis could be estimated to cost about $250. This reflects 3 days where quality of life is only 50 per cent of full health.

***Trends in these risks and costs***
Pathogens can often be well-known before being considered a significant threat to human health. For example salmonellosis has been reported for decades, however in the last 25 years the incidence of foodborne illness caused by the disease has increased. Other diseases might have long had an effect but only recently been recognised for their role in foodborne illness.

*Listeria monocytogenes* is a particular severe example of such a pathogen. Listeria infections in pregnant woman can cause an abortion or a stillbirth. In infants the pathogen can lead to septicemia or meningitis. *E. coli* O157:H7 is increasingly perceived as high risk in many countries and the FSP is focussing many of its resources on targeting this pathogen, particularly in beef trim. The pathogen was first detected in 1982 and has emerged as a major cause of bloody diarrhoea and acute renal failure. The World Health Organisation states that outbreaks of *E. coli* O157:H7 are "generally associated with beef"[6]. In 2003 the US had an outbreak of foodborne illness caused by *E. coli* O157:H7. It resulted in the hospitalisation of two patients and was

[6] WHO (2006)

believed to be caused by the consumption of beef in the weeks preceding the illness (CDC, 2005).
The increased awareness of the effects of foodborne pathogens has led to a growing emphasis on food safety issues. These have been reinforced by several domestic and international food safety incidents.

## 3.3 Baseline information on costs and risks

The above sections have outlined a number of benchmarks for the cost of an event, likelihood of an event and compliance costs associated with food safety. These are summarised in table 3.10.

3.10 **Summary table of indicative baseline costs**

| *Event* | *Estimate* | *Notes* |
|---|---|---|
| **Compliance costs** | | |
| Minor | $20 000 per plant | 50 per cent increase in microbiological testing |
| Moderate | $150 000 per plant | Ongoing costs of HACCP style regulations |
| Major | $400 000 per plant | Expected testing from new US regulations for beef trim |
| **Cost of an event – export** | | |
| Moderate | $80 000 - $200 000 | Loss of part of a shipment due to contamination |
| Major | $3 129 m | Loss of access to US market for one year |
| **Cost of an event - domestic** | | |
| Minor | 2% loss in demand for one week | Reaction in US to product recall following E. coli detection |
| Major | 40% loss in demand in first year, 25% for next 10 years | Reaction following Garibaldi incident |
| **Social cost** | | |
| Minor | $250 | One case of mild gastroenteritis |
| Moderate | $27 390 | 10 cases of Salmonella with average costs as per FSA&MEC (2002) |
| Major | $148m | Annual costs associated with listeriosis |

*Source*: CIE

Project managers could use the above benchmarks to provide a rough evaluation of their projects. This would require comparing the changes expected by their project with the changes that lead to the benchmarks. For instance, if the project increased the likelihood of maintaining access to the US market for a year by 0.01 per cent, then this probability would be multiplied by the industry impact from losing the US market ($3.129 billion). That is, the industry benefit would be $312 900.
As MLA undertakes more evaluations in this area, the number of benchmarks that can be used will increase. This will make it easier to find an appropriate benchmark for each outcome.

# 4 Establishing KPIs for the FSP

MLA'S EVALUATION FRAMEWORK provides the FSP with a method for determining the effectiveness of its projects. To facilitate this the FSP should establish KPIs to determine how successful projects are in achieving their overall objectives. KPIs will help indicate the successfulness of individual projects and how much projects have contributed to the overall objectives of the FSP. For KPIs to be effective they must be framed in the right context. Understanding how the outcomes of projects can influence impacts is critical to establishing effective KPIs.

## 4.1 Project KPIs

The distinction between the projects that directly should impact on risks, consequences or compliance costs, and those that do so indirectly is important for establishing KPIs. The expected impact of a project provides the basis for establishing outcome KPIs. For the projects that require additional investment in R&D or are complementary to the R&D (such as those promoting adoption) the KPIs should be based on intermediate outcomes, such as follow-on investment in development, or higher adoption rates.

KPIs are generally quantitative measures indicating the success, or otherwise, of a project in achieving what is was expected to achieve. However, there is scope for non-quantitative KPIs where a definitive result can be determined. For example, a KPI might be to prevent any food safety related disruption of beef trim in exports to the US over the next three years. There is little point setting a KPI that cannot be linked to an impact or if the KPI cannot be measured.

KPIs should be set at both the project level and the program level. KPIs that are project contingent should closely align with each project's goals. Within that context, project goals should align with the overarching objectives of the FSP. KPIs should also be set at the program level to indicate the overall effectiveness of the program, and the accrual of benefits that are difficult to attribute to any specific project.

***Developing outcome KPIs***

Outcome KPIs should be measurable, and clearly linked to the adoption or use of the project outputs. Ideally, prior to a project commencing, project managers should establish a baseline estimate of risk, consequences or compliance costs as they pertain to their project. MLA projects with a heavier focus on pathogen risks are likely to estimate baseline risk as part of the scientific process. For other projects emphasis should be placed on who the project is affecting.

Outcome KPIs are different from output KPIs. For example demonstrating a method results in an improvement in microbiological quality is an output, and the KPI might be the production of a peer reviewed paper that sets out the evidence. The related outcome KPI might be the percentage reduction in the risk of a microbiological event for the relevant segment of the industry, and the target might be set at 10 per cent. The outcome KPI is a measure of how the behaviour of industry participants or others has changed as a result of the project rather than of what the project has produced.

Adoption rates are an important KPI for the FSP. In particular, research aimed at changing processors' behaviour will only have benefits if industry uses it. Adoption measures could also include transporters or retailers and domestic and/or international regulators.

Compliance costs represent one of the areas where the FSP could deliver the greatest benefits. A KPI for such a project would be a measure of the change in compliance costs for some part of the market. For example a KPI might be to reduce the compliance costs export processors face for testing for generic *E. coli* by 5 per cent within one year. When quantifying compliance costs program managers need to consider whether the compliance costs are wholly attributable to the pathogen they are studying or are part of broader compliance costs for food safety. For example HACCP plans in a processor aim to reduce the level of pathogens generally rather than targeting specific pathogen threats. MLA currently has no benchmark of regulatory compliance costs or comparison of these costs relative to international competitors. This could be an area for future work.

Consumer perceptions are an important influence on the cost of a food safety event. Projects that seek to reduce negative consumer reactions to a food safety incident could establish KPIs based on consumer surveys or focus groups. It is important to monitor other events that are also likely to change consumer perceptions so that false conclusions of the impact can be avoided.

Developing outcome KPIs for projects that are inputs to other work, or seek to influence adoption can be more challenging. In these situations an intermediate outcome needs to be identified. The desired outcome might be to change regulator’s views and hence influence regulations, that in turn impact on compliance costs. The time lag, and many other influences on achieving this final impact makes setting reductions in compliance costs, or even changes in regulations as a KPI inappropriate as MLA managers and the researchers cannot be held accountable for achieving this. In this case an intermediate outcome KPI is appropriate. For example, the ‘Biotechnology developments’ project produces a monthly newsletter for its SAFEMEAT stakeholders. An intermediate KPI for the project might be a measure of the number of readers finding the information useful.

***Some guidance on developing outcome KPIs***

Typically, KPIs should not measure inputs. For example, the KPI “Four R&D contracts signed with partners” is not a measure of achievement but a measure of inputs.

KPIs that are too broad to be attributable to an FSP project are also poorly formulated. For example a project that reduces the probability of BSE entering Australia should measure the change in probability due to the project given the myriad of other protocols in place to prevent the event occurring. Just as the project is not a failure if BSE does enter the country, if the project did in fact reduce the probability of the event occurring. Because of this, it can be difficult to verify KPIs related to probabilities. Generally KPIs are only one of a number of measures that will be needed to estimate the benefits flowing from a project. While a KPI can provide an indication of the success of project, they are not capable of capturing every aspect. Focussing on a single KPI might limit effective analysis of the project. Most projects should have multiple KPIs. For example KPIs for the ‘Staphylococcus on carcase and trim’ project might include:

- 2 scientific research papers published in refereed journals (output KPI);
- 60 per cent processing plants adopt new intervention process for staphylococcus control over two years (intermediate outcome KPI); and
- 10 per cent reduction over three years in staphylococcus detection from random sampling in plants that adopt the new system (impact KPI);

Table 4.3 provides a non-exhaustive list of KPIs that would be suitable for projects in the FSP. The list provides an indication of the projects that are suitable for using specific types of KPIs. The KPIs are the measures, performance is then assessed relative to agreed target values. Target values for the KPIs should be set by project managers based on their knowledge of the industry and the specific parameter of their project.

4.1 **The suitability of different KPIs for FSP projects**

| *Projects* | *Adoption rate of n per cent by relevant industry sector* | *Reduction in detection of pathogen/residue by n per cent due to improved food safety measures* | *Improved market access requirements reducing costs for industry of $n* | *Increase in consumer perception about food safety by n basis points* | *Specified number of research papers published in peer-reviewed journals* | *Improve cost-effectiveness of sampling and testing by $n (ie reduced compliance costs)* |
|---|---|---|---|---|---|---|
| Tests for RAM in feeds | | ✓ | | | | |
| Scaling up surveillance of BSE | | | | ✓ | | |
| Plant and fungal toxins | ✓ | ✓ | | | ✓ | |
| Idenitification of hazards | | | ✓ | ✓ | | |
| Understanding risk | | | ✓ | | | |
| Managing risk | | ✓ | ✓ | | | |
| Implementation of risk management | | ✓ | ✓ | ✓ | | |
| Responding to market requests for information | | | ✓ | ✓ | | |
| Microbial contamination of meat through transport and processing | ✓ | ✓ | | | ✓ | ✓ |
| Offal microbiology | ✓ | | ✓ | ✓ | ✓ | |
| E. coli in beef trim | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Listeria in unfermented ready-to-eat meats | ✓ | ✓ | | | ✓ | |
| Physiology of pathogens under supply chain conditions | | ✓ | | | ✓ | ✓ |
| Toxoplasma in sheep (meat and) offal | ✓ | ✓ | | | ✓ | |
| Enterococcus on carcases | ✓ | ✓ | | | ✓ | |
| Staphylococcus on carcase and trim | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Mycobacterium paratuberculosis | | ✓ | | | ✓ | |
| Microbiological quality of retail cuts | ✓ | ✓ | | ✓ | | |
| Antibiotic resistant organisms | | ✓ | | | ✓ | |
| Opportunities for efficiency gains | ✓ | | | | | ✓ |
| Communication and adoption | ✓ | | | ✓ | | |
| Biotechnology developments | | | | ✓ | | |

*Data source*: CIE

## 4.2 Program KPIs

The FSP should also establish its own KPIs to measure its overall effectiveness in achieving its objectives. Its KPIs will capture the synergies of projects within FSP. The KPIs for the FSP are likely to be more general in nature but should still be measurable.

Program KPIs for the FSP could include:

- a defined number of scientific papers for the program as a whole (output KPI);

- new sampling and testing methodologies that lower cost of sampling by x per cent, improve detection rates per unit cost by y per cent and reduce contamination per unit cost by z per cent (output KPI);
- adoption rate of x per cent across FSP projects that yield systems or techniques for industry (intermediate outcome KPI);
- improve awareness of safety issues among processors by a defined number of basis points (measured through a survey) (intermediate outcome KPI);
- x number of regulatory changes based on the FSP advice and information (intermediate outcome KPI)
- x per cent reduction in microbiological quantity found in red meat measured through MLA's benchmarking of microbiological quality (intermediate outcome KPI);
- compliance cost savings (measured as a percentage change) for processors (impact KPI);
- increase in consumer perceptions about food safety (measured in number of basis points in a routine survey) (impact KPI);
- no new restrictions on Australian product's access to any international markets due to food safety issues (benefit KPI); and
- demonstrable decrease in the expected cost of a foodborne illness by a defined dollar amount (benefit KPI).

In many instances MLA already has processes in place to collect information required for KPIs. For example *Meat expectations 2003* examines consumers attitudes toward the integrity of beef and sheep meat (Millward Brown, 2003). The FSP can use such information to establish benchmarks and set target values for the KPI.
Where MLA does not currently collect information, the FSP should move toward establishing some benchmarks for comparing costs at the beginning of the program and following completion of the program. Benchmarks should be quite specific and relevant to areas the FSP is targeting.

For example, industry sources indicate the cost of refrigeration is $9000 per tonne of product for slow chill and $26 000 per tonne of product for fast chill. This facilitates analysis of the outcomes of projects as part of MLA's evaluation framework as it allows program managers to directly measure the change in costs (or other factors). Measuring the outcomes in such a way then provides a means of quantifying impacts and assessing the value added of the FSP for the industry.

## 4.3 Using the evaluation framework in the context of the FSP

Using the evaluation framework impels project managers to consider how projects at a micro level meet the strategic objectives of the industry. The FSP begins with the relevant strategic objectives of *More from Less*; this report indicates how projects within the FSP map to those objectives and the impacts they are likely to have on industry.

This report illustrates how to use MLA's evaluation framework in the context of the FSP. It highlights important factors for consideration by program managers, including:

- identifying areas where projects are likely to have impacts for industry, that is,
  - compliance costs,
  - consequences of a food safety incident, and
  - risks of a food safety incident;
- identifying how impacts translate to tangible benefits from projects;
- providing indicative KPIs to assist program managers (and MLA) gauge the effectiveness of their projects for industry;

- formulate KPIs so as to collect information that helps contribute to measuring the value added of a particular project and the FSP as a whole; and
- indicate instances where current data might be insufficient so that program managers might consider data collection processes as part of their project.

This report, together with MLA’s evaluation framework, will assist the FSP in determining the effectiveness of its individual projects as well as identifying how to evaluate its value added contribution to the industry as a whole.

## 4.4 Description of pathogens

The following is a description of some of the major pathogens identified by the FSP as either being or potentially being a risk to the Australian red meat industry.

***Salmonella***
Most people infected with *Salmonella* develop diarrhoea, fever and abdominal cramps 12 to 72 hours after infection (CDC, 2006). The disease lasts 4 to 7 days and most people recover without treatment (ibid.).

*Salmonella* live in the intestinal tracts of humans and other animals, including birds. The disease is usually transmitted to humans through eating food contaminated with animal faeces. The food is usually of animal origin, including beef. Contamination occurs through consumption of raw foods since cooking kills *Salmonella*.

***Generic E. coli***
Generic *Escherichia coli* causes bacterial diarrheal illness. Generic E. coli is a bacterium that normally lives in the intestines of humans and other animals. Most types of E. coli are harmless but some do cause diseases.
E. coli can cause diarrhoea and abdominal cramping as well as fever or nausea, which may or may not be accompanied by vomiting. Other effects include the loss of appetite, headaches, muscle aches and bloating. The illness usually takes 1-3 days to develop following exposure and last about 3-4 days.

***Escherichia coli (E. coli) O157:H7***
*E. coli* O157:H7 is an emerging cause of foodborne illness. In the United States it is estimated that 61 deaths occur each year due to *E. coli* O157:H7 (CDC, 2006). Most infections occur due to people eating undercooked, contaminated ground beef. *E. coli* O157:H7 is a Shiga toxin producing form of *E. coli* causing severe bloody diarrhoea and abdominal cramps. The illness typically lasts about 5 to 10 days. In young children and the elderly the infection can haemolytic uremic syndrome, which causes acute kidney failure in children.

***Staphylococcus***
*Staphylococcus aureus* is a common bacterium found on the skin and in the noses of up to 25 per cent of healthy people and animals. It has the ability to make seven different toxins that cause food poisoning. Staphylococcal food poisoning is a gastrointestinal illness. The most common way for food to be contaminated is through contact with food workers who carry the bacteria. Staphylococcal toxins are resistant to heat and cannot be destroyed by cooking. Once infection occurs symptoms usually occur within one to six hours. Typically the disease causes nausea, vomiting, stomach cramps and diarrhoea. Generally, the illness is mild and patients typically recover in 1-3 days.

***Listeria monocytogenes***

This disease primarily affects pregnant woman, newborns and adults with weakened immune systems. Infections caused by *Listeria monocytogenes* can cause fever, muscle aches and occasionally gastrointestinal symptoms such as nausea and diarrhoea. *Listeria monocytogenes* can cause perinatal or neonatal infections in pregnant women. The bacterium is found in soil and water. Animals can carry it without appearing ill thereby contaminating food of animal origin.

***Campylobacter***
This bacterium can cause diarrhoea, cramping, abdominal pain and fever within 2 to 5 days of exposure. The diarrhoea may be bloody and accompanied by nausea and vomiting. Typically, illness lasts one week. In the US it is estimated that about 100 people die each year due to a *Campylobacter* infection (CDC, 2006). Generally, *Campylobacter* occurs in birds (including poultry).

## 4.5 Projects in the Food Safety

***Program***
A description of projects in the Food Safety Program Plan 2006-2009 is provided below. The list is divided into the FSP’s four key program areas:

- animal diseases (as they relate to food safety);
- residues;
- pathogens; and
- emerging issues.

***Animal diseases (as they relate to food safety)***
*Tests for Restricted Animal Material (RAM) in feed*
The project compares different screening and Polymerase Chain Reaction (PCR) tests for detecting and identifying Restricted Animal Material (RAM) in animal feed. The project’s objective is to validate the performance of the various tests and compare the various techniques. The project will also include a pilot study of compliance with existing bans.

*Scaling up surveillance of Bovine Spongiform Encephalopathy (BSE)* Bovine spongiform encephalopathy (BSE), commonly known as mad cow disease, has affected several countries already, resulting in significant reductions in the value of Australian beef. This project’s objective is to learn how to rapidly scale-up surveillance through studying aggregation points for sample collection. Th laboratory capacity and capability has been running since 2004 and will conclude in 2006.

***Residues***
*Plant and fungal toxins*
The project will address two key concerns. The first is the effect on animal health of toxic chemicals in animal feeds arising from plants (or bacterialplant infections) or fungi growing in stored grain. The second concern for the project is the implication that this will have for human health.

***Pathogens – generic risk management***
*Identification of hazards*
Researchers for this project will collect and analyse information that is relevant to the industry on potential hazards concerning meat safety issues. The project will focus on issues that affect market access, identifying and anticipating issues in the industry’s key export markets. The project will develop early warning knowledge management systems to assist in the evaluation of emerging data and provide reports and articles that contribute to the scientific literature in the field.

*Understanding risks*
MLA will update parts of the industry risk profile completed in 2003. Emphasis will be updating information on priority pathogens. The risk profile will provide both a knowledge base and identify gaps MLA knowledge concerning particular pathogens. A process risk model will be developed which will allow the behaviour of relevant pathogens to be modelled throughout the supply chain and assist in understanding risks and developing risk management options.
*Managing risks* Activities in this project will evaluate risk management options and determine whether new approaches for either systems or procedures need to be taken. The project offers a flexible approach to managing R&D relating to potential risk. Without thorough understanding of the risk and efficacy of existing or potential risk management options it is difficult to be prescriptive in the application of risk management approaches.

*Implementation of risk management*
MLA will convene an expert panel comprising industry representative, scientists and regulators. The panel would look at implementing risk management options and help clarify appropriate risk management approaches for industry and regulators. It is expected that the panel will heavily rely on research projects conducted by MLA in other parts of the FSP, but there might be some case where the panel wishes to initiate research projects to answer specific questions.

*Responding to market requests for information*
Previous versions of this project have primarily conducted research and consultations to develop a technical market access position. It is expected the new version of the project will continue this role. Furthermore, MLA anticipates that in the future there will be a greater need to collaborate with industry, regulators and scientists to collect, collate, analyse and interpret data and practices to support market access arguments. It is also planned that microbiological baseline of carcases and trim would recommence towards the end of the planned period.

***Specific pathogen product investigations***
*Microbial contamination of meat through transport and processing*
Contamination of meat through transport and processing is an important facet of the microbiological quality in both national and international trade. This project aims to develop knowledge of process to improve effectiveness and efficiency of reducing contamination in product. Some parts of the process that will be examined include:

- contamination of hides prior to processing;
- contamination from hides to carcases;
- role of equipment in contamination;
- interventions to control contamination (in the case of *E. coli* and Salmonella);
- growth of psychotolerant organisms in chilled product and its impact on shelf-life; and
- development of a predictive model of shelf-life.

The collection of this information will contribute to the development of the process risk model and other studies on specific issues (such as E. coli O157:H7 contamination on trim).

*Offal microbiology*
Several markets, notably China, are becoming increasingly concerned with the quality of offals. This project aims help demonstrate the safety of offals and the hygienic status of processing compared to muscle meat. The project will initially concentrate on describing the microbiological quality of large volume/value offals by developing baseline studies. Once knowledge of the microbiological quality of offals produced is established possible intervention methods will be examined.

*E. coli O157:H7 in beef trim*

The USA is currently undertaking a baseline study on beef trim and MLA anticipates that regulatory measures requiring testing for *E. coli* O157:H7 will follow. If this happens it is probable that Australia will need to change its sampling and testing methodology to a procedure that will isolate *E. coli* O157:H7 more frequently. The project will compare the accuracy and cost-effectiveness of various sampling and testing methodologies on isolating *E. coli* O157:H7. To do this the project will produce several scientific papers that identify the distribution of *E. coli* O157:H7 and other *E. coli* types in beef trim, the interactions between animals and *E. coli* and the behaviour of *E. coli* O157:H7 in the chilling and freezing process.

*Listeria in unfermented ready-to-eat meats*

Listeria monocytogenes has been the subject of extensive research over a number of years. Preventing the growth of Listeria in processed meats and/or post-packaging interventions to greatly reduce the initial levels was necessary to have a significant public impact. This project continues previous work on additives to prevent the growth of Listeria. It is expected that work on growth prevention will come to end in the first year of the FSP with communication and adoption activities to continue following this date.

*Physiology of pathogens under supply chain conditions*

The project will match information collected on the behaviour of microogranisms in the supply chain. It will identify and describe the behaviour of pathogens (particularly *E. coli* and *L.monocytogenes*) under conditions encountered in the supply chain. MLA expects this information will lead new and enhanced intervention.
The project will be performed through the Australian Food Safety Centre of Excellence.

*Toxoplasma in sheep (meat and) offal*

The significance of Toxoplasma as a human pathogen is increasing and the role of (undercooked) meat in the aetiology of the disease is a continuing concern. The pathogen might also be a problem in uncooked comminuted fermented meats. The project will provide further surveys of the prevalence of Toxoplasma in various meat products to help develop a better risk profile. It is expected that the output from this project will inform risk management options.

*Enterococcus on carcases*

Enterococcus is frequently found on both beef and sheep carcases. The pathogen is known to often carry antibiotic resistant genes. The project will identify the concentration of pathogens found on carcases. This will assist evaluation of antimicrobial resistance data. The project also aims to examine the behaviour of Enterococcus along the supply chain.

*Staphylococcus on carcase and trim*

Previous studies have found high prevalence at low concentrations levels in abattoirs and high concentrations found frequently in some retail products. This could potentially become an issue in trade with markets such as Japan particularly sensitive to Staphylococcus. The project will define specific interventions in meat processing to target this issue. It will determine appropriate processes and/or systems in processing plants that lower the prevalence of staphylococcus on meat carcases.

*Mycobacterium paratuberculosis*

*Mycobacterium paratuberculosis* may be isolated from the lymph nodes and muscle of subclinically affected sheep. Although no subclinically affected cattle have been tested similar results were found for clinically affected sheep and cattle. Little is known about the resistance of the organism to heat. The project will produce further studies on the numbers of organisms found

in sheepmeats, beef and offals. It will also determine effective controls for cattle and sheep in processing and the heat resistant abilities of the organism in meat matrices.
*Microbiological quality of retail cuts* Highly manipulated (minced, diced) beef and lamb products at retail level indicate high Total Variable Counts (TVC) as well as high levels of *E. coli* and Staphylococcus. The latter two organisms indicate either cross contamination, poor temperature control or some other problem in the supply chain. This project will examine and identify systems that will ensure that these microbes are controlled through to the point of purchase.
It will consider how such control systems can be effectively implemented.

*Antibiotic resistant organisms*
The project will investigate the behaviour of *E. coli* and enterococci through the retail supply chain. Any differences in behaviour between resistant and sensitive organisms will be investigated. As part of the project through chain surveys of product will be conducted to determine possible cross contamination. The project will draw on the information it garners through this research to develop a risk framework to inform and facilitate discussion about public health.

*Opportunities for efficiency gains*
This project will consider alternative procedures and/or new technologies that more cost-effectively meet customer requirements or national and international standards. One specific area that the project will consider is an alternative procedure for risk-based post-mortem inspection. The project will follow a process of:

- identifying targets that meet industry needs for efficiency and are likely to gain outcomes-based regulatory acceptance;
- collecting data on the food safety context of existing practices;
- collecting data to validate a change in practice; and
- negotiation of a change in practice nationally and in other markets.

*Communication and adoption*
The FSP recognises that effective communication of results both to stakeholders and those who might implement change is critical to its success. Perhaps the most important aspect of the project is to develop a technical resource for processor Quality Assurance (QA) managers. The resources would help QA managers implement the best available science into their QA programs and help justify any choices that they make.

More generally the project will help to identify the benefits of the R&D from other projects. The project will draw on various forms of communication including seminars, videos and publications. The project will also help measure the impact of the implementation of R&D outputs.

***Emerging issues***
*Biotechnology*
For the past two years SAFEMEAT has received a monthly briefing on developments in biotechnology relevant to the industry. The project will continue to stay abreast of research and international policy development relating to biotechnology, continuing to publish this information in a bulletin for SAFEMEAT. Previous incarnations of the project have already had results with SAFEMEAT expected to develop policies on the application of GM technology in the red meat industry by mid 2006.

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