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evaluationseries | 1.1 Enhancing product integrity

Food safety:
predictive microbiology
The industry impact

Promise

Safer products, lower compliance costs, competitive advantage, improved market access.

Progress

Program outputs have been widely adopted by Australian export processors and industry regulatory bodies.

Performance

A $4 million investment is expected to return an industry value-added benefit of $44.4 million over 30 years: a benefit-cost ratio of 11:1 based on net present value.

Definitions

Predictive microbiology
Predictive microbiology investigates how microorganisms grow or are inactivated, and how this will affect food safety and storage. The scientific findings inform mathematical models that predict the impact of industrial processes on meat safety.

Refrigeration index
The refrigeration index is a new tool that is a scientifically validated measure of refrigeration effectiveness.

Export (Meat & Meat Products) Orders [EC(MMP)Os]
The Export Control (Meat & Meat Products) Orders 2005 replaced the Export Meat Orders on 1 July 2005. The Orders rely on the refrigeration index to regulate export meat chilling and cold storage.

Approved Arrangements (AA)
Approved Arrangements (AA) stipulate how EC(MMP)Os and importing country requirements can be achieved to ensure processing operations protect meat integrity.

Alternative procedures
Alternative procedures include new equipment, procedures or processes which contradict EC(MMP)Os or importing country requirements but can achieve the objectives of EC(MMP)Os or overseas requirements (applicable only to establishments with AAs)

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All benefit-cost ratios in this report come from the MLA program evaluation framework unless otherwise stated. The figures in this report represent the net present value of industry and consumer benefits to 2028 and are based on the MLA global meat industry model (CIE).

BACKGROUND

Meat & Livestock Australia (MLA) strives to build demand, increase market access, develop a competitive advantage from 'paddock to plate' and, by partnering with industry, build capability.

Remaining accountable to stakeholders and providing quantifiable returns on government and industry investment are central to this.

In 2005 MLA engaged the Centre for International Economics (CIE) to conduct an independent review, and to develop an effective evaluation framework* to assess the industry impact of its programs and their compliance with government priorities.

The framework provides independent estimates of the net industry benefits of MLA programs – including achievements relative to targets and the net present value relative to a 'no investment' situation.

It also incorporates interactions with the national economy. The benefits arising are expressed as improved red meat consumer welfare and the net change in value added to the rest of the economy, supporting a rigorous triple bottom line evaluation of MLA initiatives.

Food safety underpins meat demand

Consistent with MLA's strategic objective to lift demand, and increase market access and competitive advantage, the Food Safety program pursues excellence through initiatives including the predictive microbiology project and the refrigeration index. The independent evaluation identified these and other key program outcomes.

Predictive microbiology provides scientific information for assessing pathogen growth at each point in the processing chain and has been adopted by every sector of the meat processing industry with positive outcomes for sheepmeat, beef, domestic and export markets, and various types of production.

Microbiological quality of red meat has improved almost four-fold since 1993. The MLA program is an important driver of this change and has increased market demand.

MLA's Food Safety program has provided a strong scientific foundation for the refrigeration index – a mandatory tool for beef, sheepmeat, pig meat and goatmeat export processors that measures refrigeration effectiveness. The index underpins new risk-based meat export regulations acceptable to more than 100 trading partners and has seen Australian companies trade without disruptions such as those endured by many international competitors.

An independent review by CIE revealed that a $3.8 million investment in predictive microbiology by MLA and its research partners over 30 years should return a net industry benefit of $44 million. The industry benefit-cost ratio from predictive microbiology is 11:1.

The investment in predictive microbiology represents less than 20 per cent of the total invested in the Food Safety R&D program since 1998. The total MLA investment in Food Safety over this period was actually more than 20 times this amount. It is important to acknowledge that predictive microbiology is a core enabler for a much broader-based industry effort to build demand for red meat products in both domestic and export markets.

MLA's predictive microbiology project has provided an inexpensive, effective and flexible method of validating processing techniques, minimising overall costs required to achieve higher food safety standards.

The investment has reduced the risk of illness and death from listeriosis, and has produced positive flow-on effects for the Australian economy. The Food Safety program is calculated to deliver extra spill-over benefits of $162 million over 30 years, incorporating significant gains for the Australian smallgoods industry, and ensuing benefits from cost savings to processors. Benefits flowing to the Australian community, measured by changes in consumption after price and quality impact adjustments, equate with increased consumer welfare valued at more than $60 million over 30 years.

*MLA's evaluation framework is explained in full in the booklet, *Why does MLA need a framework for independent evaluation?,* that accompanies the MLA program evaluation series.

SAFER MEAT PRODUCTS

Peter Greenham

Science-based regulation cuts costs and boosts confidence

Beef trim for hamburgers accounts for more than 60 per cent of Australia's $1.4 billion US beef export market and about 70 per cent of total beef volume sold to the US.

The commodity's value was emphasised in recent years when hot boning came under increased scrutiny from regulators. Predictive microbiology played an important role in establishing that hot boning was not compromising food safety, and has subsequently been used to inform an objective model-based regulatory framework.

MLA-funded R&D outputs have validated the hot boning process, providing significant processor savings, industry security and export market confidence.

"We have used predictive microbiology to prove to regulators that we can operate at higher temperatures in the boning room without additional risk to product safety. This means production can continue during days of extreme summer temperatures."

– Peter Greenham, HW Greenham & Sons Pty Ltd

Paul Vanderlinde

Predictive microbiology assures meat safety

Predictive microbiology has equipped regulators and industry to verify meat quality and safety following events such as refrigeration breakdowns, to help determine whether products are fit to enter the food supply chain. Use of the predictive microbiology tool is now recommended in the *AQIS Meat Notice: 2001/19 - Assessment of deterioration of refrigerated meat affected by refrigeration breakdown, incidents and accidents.*

The cost of additional testing required in the wake of such events was previously substantial, however predictive microbiology has hastened the verification process and significantly reduced compliance costs.

"The refrigeration index calculator is used by AQIS to predict the food safety of meat affected by refrigeration breakdown. Our ability to verify product safety at little cost and to avoid additional testing by predicting whether a product is fit for human consumption means that meat can be released earlier at a much lower cost to industry."

– Paul Vanderlinde, Australian Quarantine and Inspection Service (AQIS)

Lynne Teichmann

Greater confidence in processed meat

Predictive microbiology has been used to develop an alternative standard for cooling cooked meats including hams, roast beef and large processed meats. This has subsequently been incorporated into the Australian Standard, avoiding the need for processors to increase chilling capacity.

MLA also offered predictive microbiology as a tool to enforce an appropriate standard for uncooked comminuted fermented meat (UCFM) following the Garibaldi outbreak in 1996.

The ability to evaluate processes using the predictive model has resulted in a higher number of UCFM processes achieving the required reduction in *E.coli* (Food Standards Australia New Zealand [FSANZ] 2002).

"The predictive microbiology tool has been used by both manufacturers and regulators, allowing standardised assessment of the performance of UCFM processes. This has resulted in increased process knowledge and greater confidence in the safety of traditionally fermented salamis, with minimal costs to manufacturers."

– Lynne Teichmann, Research and Development Manager, Hans Continental Smallgoods Pty Ltd

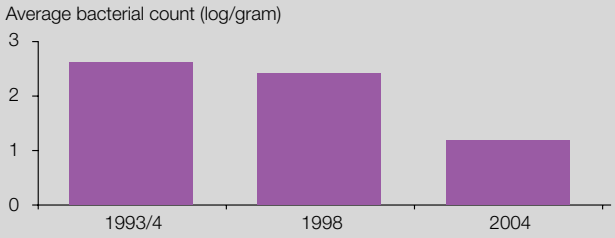
Protecting market value

The application of predictive microbiology in a range of situations has produced safer, more widely accepted processes that have a market value of more than $1.2 billion per year as shown in the table below.

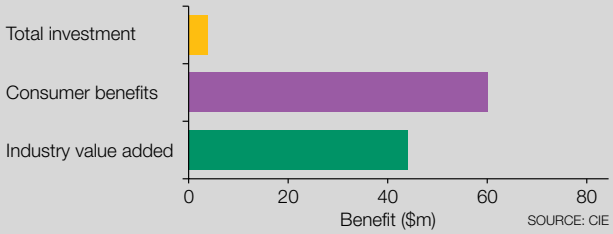
	Value ($m) per annum
Hot boning	300
Weekend chilling	600
Refrigeration breakdowns	150
Cooling of cooked meats	60
Uncooked fermented meats	150
TOTAL	**1260**

Raw meat

Boneless beef
(1993/4 to 2004)



Benefits from predictive microbiology
(net present value 2006)



SOURCE: CIE

Meat safety builds confidence

The third national abattoir study of Australian red meat microbiological quality in 2004 measured hygienic processing using the total viable count (TVC) and *E. coli* count indicators. The survey revealed a 35 per cent reduction in the TVC of beef and sheepmeat carcases and a 35 per cent reduction in *E. coli* counts on beef. The study also confirmed a 50 per cent reduction in TVC and a 75 per cent reduction in *E. coli* for boneless beef and sheepmeat in the decade since 1994 (refer graph above).

Tracing the impacts

Predictive microbiology investment - raw meat

Food safety and integrity are important drivers of demand for red meat in international and domestic markets, and MLA's investment in the predictive microbiology project has paid off.

In present value terms (using a five per cent real discount rate), the predictive microbiology project has attracted funding of $3.8 million including a $3.2 million MLA investment plus Australian Research Council (ARC) grants and Australian Quarantine and Inspection Service (AQIS) support to train its staff and processors to use predictive microbiology outputs. Most of MLA's $3.2 million contribution supported University of Tasmania researchers at the Australian Food Safety Centre of Excellence. Costs incurred by meat processors linked to regulatory adoption of predictive microbiology are accounted for as future supply costs and have been subtracted from forecast future industry benefits.

Inputs to outputs

The predictive microbiology project has produced 11 papers in refereed scientific journals and a book, *Predictive Microbiology for the Meat Industry*. In addition, results from the predictive microbiology project have been presented at numerous international conferences and have influenced the scientific literature on food safety. Improved knowledge has been converted into products to assist industry including:

- the refrigeration index – a tool used by processors to map temperature/time paths to microbiological growth
- numerous models for specific industry sectors linking environmental factors and microbiological growth/death, including predictive microbiology software products.

More than 800 AQIS and industry personnel have been trained to use the refrigeration index and the MLA refrigeration index calculator tool.

Fast financial facts

Industry investment to 2006	$3.8 million
Forecast investment over 30 years*	$3.8 million
Forecast industry benefit over 30 years*†	$44 million

Predictive microbiology outcomes

The predictive microbiology project has contributed to a superior food safety record for the red meat industry and positive community attitudes, with consumer acceptance and purchasing decisions indicative of the industry's successful food safety systems.

A 2003 consumer survey‡ showed that more than 75 per cent of respondents were confident that government and industry would maintain Australian beef and lamb safety. A similar survey in 2005§ found that 71 per cent of consumers deemed that the Australian red meat industry was ethical and trustworthy.

At a glance: predictive microbiology – raw meat

1. Inputs: MLA $3.2 million; ARC, AQIS $0.6 million; one-off adoption cost to export processors (less than one per cent increase in processing costs).
2. Outputs: Refrigeration index tool and other software products; 11 refereed scientific articles; MINTRAC industry training modules.
3. Outcomes: Refrigeration index adoption into the Export Control (Meat & Meat Products) Orders 2005.
4. Impacts: Lower compliance costs for processors; increased regulatory confidence in product safety; more than 800 AQIS and industry personnel trained.
5. Benefits: $44 million in red meat industry added value; safer meat products; more than $60 million in benefits to Australian consumers.

Note: all A$ values are in 2006 dollars

Predictive microbiology impacts

The predictive microbiology project has changed the food safety landscape significantly by bringing scientific rigour to processing standards with two key impacts on raw meat processing:

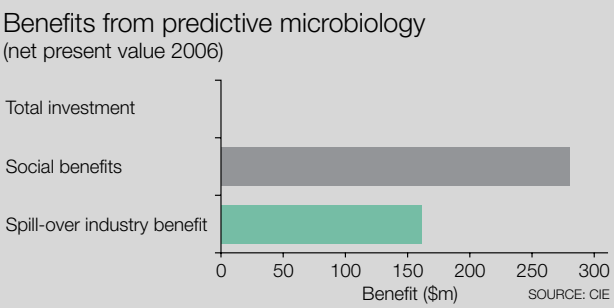
- lower compliance costs are attributed to the development of a cheap and easy-to-use tool to verify process safety
- improved food safety standards producing higher domestic and export demand for red meat.

Predictive microbiology benefits

A $3.8 million investment in the predictive microbiology project is estimated to generate $44.1 million in red meat industry added value over 30 years, providing the industry with a benefit-cost ratio of 11:1.

This is in addition to Australian benefits measured by community changes in consumption after price and quality impact adjustments, which has confirmed increased consumer welfare valued at more than $60 million.

* 1998-2028 † Benefits are presented as changes in industry added value. All results are net present values in 2006 dollars, calculated over a 30-year horizon (1998 to 2028) using a five per cent real discount factor. ‡*Meat expectations*, Millward Brown Australia, 2003. §*Meat tracking*, The Leading Edge (Jan-Mar), 2005.



Safety standards save lives

Predictive microbiology has transformed the behaviour of processors and regulators, enabled access to new markets and become entrenched in food safety regulations. Predictive microbiology offers regulators increased certainty about food quality; industry benefits from lower compliance costs; the development of new, cheaper processing techniques; and consumers benefit from reduced health risk.

The predictive microbiology project has defined how antimicrobial additives can be added to luncheon meats, pates and cooked sausages at the processing stage to reduce the number of potentially fatal listeriosis cases in Australia by 86 per cent. Reliance on predictive microbiology to predict health impacts and guide additives use is calculated to generate health benefits of $17.4 million per year, with total social benefits of $281 million over 30 years.

Tracing the impacts

Predictive microbiology investment – processed meat

The $3.8 million investment in predictive microbiology has delivered direct benefits to consumers of red meat products and consumers of processed meat products at no additional cost to the processed meat industry. Although only a small percentage of red meat is included in processed meat ingredients, the consumer health benefits that spill over from predictive microbiology R&D outputs translate into improved consumer safety perceptions for all meat and heightened consumer demand.

The R&D investment produced a package of scientific and technical initiatives which help to extend the capability and capacity of the industry through MLA's partnership with the Australian Food Safety Centre of Excellence (AFSCoE). The AFSCoE was established by the National Food Industry Strategy and MLA is represented on its Advisory Board.

Inputs to outputs

MLA forged a partnership with the AFSCoE and participated in the Meat Standards Committee, which is composed of state-based regulators and owns the Australian Standard for hygienic processing. MLA provides advice on the application of science to ensure efficient regulation and implementation of the Australian Standard, which governs all meat processing.

Predictive microbiology outcomes

The science-based risk management tools developed under the MLA-AFSCoE partnership have produced three key outcomes:

- modification of the Standard to allow smallgoods manufacturers to meet food safety regulations
- *MLA Guidelines for the Safe Manufacture of Smallgoods* accepted as the best practice guide to industry compliance
- demonstration that anti-microbial additives could lower the listeriosis risk, reducing the number of cases by 86 per cent.

Predictive microbiology impacts

The predictive microbiology project has delivered two key impacts on the processed meat industry:

- predictive microbiological modelling has reduced the incidence of illness and death resulting from listeriosis, with consumer health benefits translating into improved perceptions of meat safety and heightened demand
- impacts that initially affect consumers and processors will flow on to other parts of the supply chain, for example reduced processing costs will ensure lower prices for consumers and greater on-farm output.

At a glance: predictive microbiology – processed meat

1. Inputs: MLA partnership with the Australian Food Safety Centre of Excellence (AFSCoE); technical advice to the Meat Standards Committee
2. Outputs: Refrigeration index tool and other software products; 11 refereed scientific articles; better relationship between industry and regulators
3. Outcomes: Adoption of predictive microbiology and other risk management tools to ensure efficient regulation and implementation of the Australian Standard
4. Impacts: Lower compliance costs for processors; increased regulatory confidence in product safety; reduced illness and death resulting from listeriosis
5. Benefits: $162 million in industry added value by 2028 (pork industry major beneficiary); safer meat products; $281 million-plus in social benefits to Australian consumers by 2028*

➧Note: all A$ values are in 2006 dollars

Predictive microbiology benefits*

Only five per cent of beef, or 37,100 tonnes, is diverted to smallgoods†, while about 55 per cent of pig meat for domestic consumption is used in smallgoods. Predictive microbiology is responsible for a $161.7 million increase in Australia's GDP over the 30-year period to 2028, predominantly due to the impact on the Australian pork industry.

Social benefits of predictive microbiology are calculated at $281 million over 30 years to 2028.

Fast financial facts

Industry investment to 2006	no additional
Forecast spill-over industry benefit over 30 years‡	$162 million
Forecast social benefit over 30 years‡	$281 million

* Benefits are presented as changes in industry added value. All results are net present values in 2006 dollars, calculated over a 30-year horizon (1998 to 2028) using a five per cent real discount factor. † MLA Market Information ‡ 1998-2028

Regulatory benefits

Regulatory overhaul and new export control orders major milestones

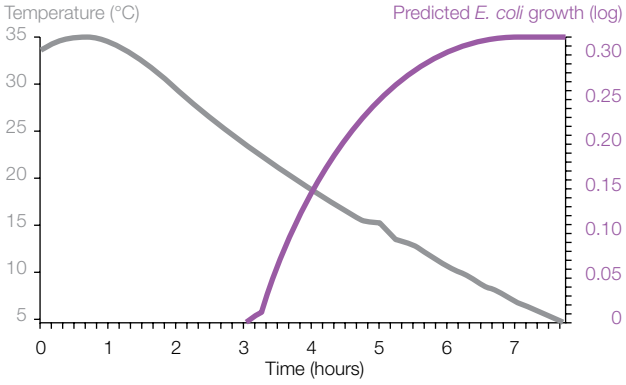
The Food Safety program delivers numerous industry benefits, including:

- influence over both domestic and international regulation design
- development of safer methods for processing and transport
- assistance to processors to meet technical requirements for market access
- reduced regulatory compliance costs.

The *Welsman Report* (Meat Industry Council, 1998) signalled the need to reduce the regulatory burden on industry. Its acceptance facilitated a transition from a highly prescriptive, adversarial regulatory context to a more co-operative, co-regulatory relationship between the Australian Quarantine and Inspection Service (AQIS) and industry.

Before 1994, regulators maintained responsibility for product hygiene with very limited processor ownership. Since then Hazard Analysis Critical Control Point (HACCP) programs have been developed and adopted by meat processors, and AQIS has introduced the Meat Hygiene Assessment (MHA) concept as the basis for continuous improvement and to objectively benchmark product hygiene.

Example of a refrigeration index calculation



The refrigeration index = 0.32

Adoption of the MLA refrigeration index provides further evidence of the emergence of a co-regulatory relationship between government and the processing sector. The new outcomes-based Export (Meat & Meat Products) Orders 2005 is a key milestone on this journey. The ultimate outcome is an overall improvement in food safety and the international competitiveness of the meat industry.

MLA has played a critical role in facilitating a more collaborative affiliation between AQIS and industry, which has crystallised as a value adding relationship between the National Meat Industry Training Advisory Council Ltd (MINTRAC) and AQIS. MINTRAC has created a well-supported professional development program for QA managers. Consultants who work for MLA also frequently work with AQIS to conduct staff professional development programs.

International meat hygiene committee

MLA advised the Codex Alimentarius Committee on meat hygiene. Codex Alimentarius is a world food standardisation body jointly administered by the United Nations' Food and Agriculture Organization (FAO) and the World Health Organization (WHO). At the Committee's 11th meeting in New Zealand in 2005, MLA hosted an informal conference with international industry representatives to discuss how the meat hygiene code, which was finalised at the meeting, would impact on regulations in their country. MLA's leadership in this initiative is vital to ensuring market access and competitive advantage is maintained for the Australian industry.

World Meat Hygiene and Inspection Congress

MLA was the only non-government body invited to address the 2004 World Meat Hygiene and Inspection Congress in the UK – an international event for meat hygiene regulators attended by delegates from more than 35 countries. The congress provided an opportunity for veterinarians from government authorities to promote risk-based meat inspection and hygiene control initiatives, and the presentation by MLA stimulated information requests from various regulatory agencies.

Alignment with national research priorities – consumer health

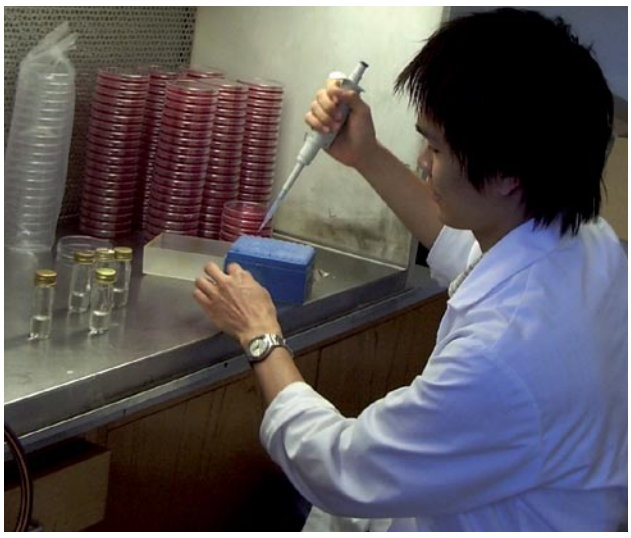
MLA's Food Safety program meets the objectives of the National Research Priorities set down by the Australian Government through its commitment to consumer health, particularly groups most susceptible to food-borne diseases – the young and the elderly. The Food Safety program aims to prevent illness by providing a scientific basis for improving the safety of Australia's red meat supply. R&D outcomes equip industry with tools to ensure contaminated meat does not reach consumers. MLA has also developed a website, www.foodsafety.net.au, and other materials to educate consumers and food service workers in safe food handling, in an effort to reduce the five million cases of food-borne infectious illness in Australia each year.

Alignment with national research priorities – food safety research

MLA's Food Safety program undertakes breakthrough scientific research to develop frontier technologies in the areas of quantitative microbial risk assessment and predictive microbiology. Current projects in bacterial physiology and genetics are working towards control of food-borne pathogens. Contractors are actively involved in international scientific endeavours and building up their own local research groups. MLA supports, and is a member of, the Advisory Board for the Australian Food Safety Centre of Excellence (AFSCoE), which was established through the National Food Industry Strategy to stimulate local expertise and create a critical mass of researchers.

Australian Food Safety Centre of Excellence

Food Safety: the essential ingredient



Australian Food Safety Centre of Excellence

Tom McMeekin

"Predictive microbiology is now the new paradigm of food safety management. It provides essential support to underpin internationally accepted food safety management systems such as HACCP, quantitative microbial risk assessment (QMRA), and evolving systems such as food safety objectives (FSO). The predictive microbiology research was a collaborative effort between the meat industry, through MLA, and relevant government departments. It has been critical to the enhancement and maintenance of Australia's food safety systems."

– Professor Tom McMeekin, AFSCoE

Alternative procedures produce safer products

Alternative procedures include new, or new applications of, equipment or procedures for meat, offal or meat product slaughter, dressing or processing that are not prescribed in the Export Control (Meat & Meat Products) Orders or overseas country requirements but are able to achieve their objectives (applicable only to establishments with AAs).

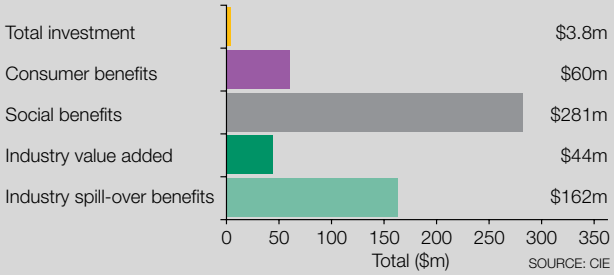
Proficiency of regulatory and quality assurance (QA) personnel in the meat industry contributes to ongoing market access for Australian meat products. This is particularly important when applying to use alternative procedures in the context of the 'outcomes-based' regulatory environment, which is anticipated for the future.

The meat processing and smallgoods sector employs about 900 meat safety officers (meat inspectors), 200 QA managers and 600 quality assurance officers. Traditionally there has been insufficient professional development opportunities for meat inspection staff and limited uptake of formal training by QA staff. This impedes their ability to: validate food safety programs under changes to outcomes-focused standards, regulations and legislation; develop greater expertise and competency in this area, as required by regulatory and customer auditors; and access the latest R&D outcomes from Australia and overseas.

MINTRAC has facilitated a state-based QA network of researchers, regulators, trainers and practitioners which has proven to be the most efficient distribution mechanism for new information. In future this network will contribute to heightened professionalism and improved communications between researchers, trainers, regulators and industry personnel.

Production to plate: the predictive microbiology pay-off

Economic benefits from predictive microbiology (net present value 2006)



Inputs to impacts

Total program

- A $3.8 million investment in predictive microbiology has paid off for the red meat industry, which is expected to increase its added value by $44.4 million over the next 30 years*.
- Total benefits exceed the cost of the project to MLA and partners 11-fold.
- The internal rate of return is 37 per cent.
- The pork industry will benefit from $162 million in spill-over added value over 30 years*.
- Benefits to Australian consumers are calculated at more than $60 million.
- Social benefits arising from predictive microbiology are estimated at $281 million over 30 years*.

Raw meat

- Total industry costs include a $3.8 million investment by MLA and partners plus a one-off adoption cost to export processors.
- The refrigeration index has been adopted as part of the Export Control (Meat & Meat Products) Orders 2005, producing lower compliance costs for processors and increased regulatory confidence.
- Predictive microbiology is forecast to generate $44 million in industry added value and more than $60 million in benefits to Australian consumers over 30 years*.

Processed meat

- MLA has forged a partnership with the Australian Food Safety Centre of Excellence.
- Predictive microbiology and other risk management tools have been adopted.
- The Food Safety program has reduced illness and death resulting from listeriosis, producing more than $281 million in social benefits over 30 years*.
- The pork industry will benefit from $162 million in spill-over added value over 30 years*.

* 1998-2028

Lessons learned from this evaluation

The industry investment in predictive microbiology has been traced back to 1995. It took 10 years to translate early research outputs into a formula that could be used to predict the safety status of red meat and processed meat products. While benefits for the processed meat industry were not envisaged as a key outcome, the breakthrough has made a major contribution, with ongoing social and consumer benefits.

Collaboration between industry and the Australian Quarantine and Inspection Service (AQIS) evolved from a shared vision, leadership from industry and AQIS champions, and mutual investment in training and implementation to maximise predictive microbiology benefits. The result is evidence that the 'outcome-based' approach to regulation both reduces regulatory compliance costs and, importantly, improves meat product safety. Incorporation of research outcomes into regulations has driven their broad adoption and culminated in a more strategic approach to demonstrating compliance with importing countries' requirements.

It is important to acknowledge that predictive microbiology is a core enabler for a much broader-based industry effort to build demand for red meat products in both domestic and export markets. The value of total industry investment is more than 20 times the investment in predictive microbiolology.

The benefit-cost ratio for this project would be much lower if total program costs were taken into account.

Fast financial facts

Food safety

Industry investment to 2006	$3.8 million
Forecast investment over 30 years*	$3.8 million
Forecast industry benefit over 30 years*	$44 million
Forecast consumer benefit over 30 years*	$60 million
Forecast spill-over industry benefit over 30 years*	$162 million
Forecast social benefit over 30 years*	$281 million

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