PRODUCTIVITY COMMISSION

STUDY INTO PUBLIC SUPPORT FOR

SCIENCE AND INNOVATION

Submission from the State Government of Victoria

August 2006

EXECUTIVE SUMMARY

The study into Public Support for Science and Innovation comes at a very important time in Australia's economic development. Australia like most open economies is subject to increasing and ever more vigorous competition from the global market place. A focus on science and innovation is critical to Australia's response.

The Victorian Government has made a major commitment to developing Victoria as an innovative state. Innovation is a central goal of *Growing Victoria Together* and the Government's commitment to achieving this goal is reflected in a number of key economic statements and through the budget commitments it has made since 1999.

There is a significant evidence base that confirms that innovation is critical to productivity and sustainable economic growth. Yet in the face of growing competition and increasing investments from competitor nations, we see a decline in the level of support for science and innovation as a percentage of gross domestic product (GDP) from the Federal Government. While State Governments are investing more than they have in the past they lack the revenue base or the national responsibility to address the shortfall.

This is why the Victorian Minister for Innovation, the Hon John Brumby MP, has called for the development of a National Innovation Agenda to complement the National Reform Agenda that the Federal, State and Territory Governments have recently agreed to. Consultation to date has found strong support for the development of five key areas as part of the National Innovation Agenda. These are:

- Increased public investment in innovation infrastructure;
- Incentives to increase private research and development (R&D) and innovation spending;
- A supportive regulatory environment;
- Increased investment in science, technology and innovation skills; and
- More and better connections, linkages and collaboration.

The Productivity Commission's Study into Public Support for Science and Innovation will be an important input into the development of the National Innovation Agenda.

Section 2 of the Victorian Government submission provides information on a wide range of science and innovation programs and activities undertaken by Victorian Government Departments. It provides case examples of practice and outcomes related to the terms of reference for the study.

The Victorian Government's science and innovation activities are addressing challenging issues across the spectrum of society, the environment and the economy. Science and innovation pervade the activities of modern governments and society and the boundaries between public and private activities are also blurring. This means analysing an issue such as public support for science and innovation is a significant challenge.

The need to build stronger collaboration between the Federal and State and Territory Governments is a theme that runs through this submission. Collaboration, as well as

competition, is fundamental to the effective operation of innovation systems. There are many opportunities to address system blockages through a more collaborative approach.

CONTENTS

INTRODUCTION

The Victorian Government welcomes this opportunity to provide a submission to the Productivity Commission's Study into Public Support for Science and Innovation. The Victorian Government recognises the importance of science and innovation to Australia's productivity and economic growth.

For the purposes of this submission the definitions of science and innovation are aligned with those outlined in the Productivity Commission's issues paper. In summary, that is:

- *Science* – the production and adoption of new scientific knowledge in the context of the innovation system as a whole; and
- *Innovation* – product and process innovation resulting in new or improved products and services, or methods of production.

The Victorian Government recognises that both are broad concepts and that while science in some form will underpin most innovation, there may not be a direct link between the two processes.

Growing Victoria Together is the Victorian Government's overarching policy framework which guides programs, strategies and service delivery. Through *Growing Victoria Together* the Government has identified ten goals that are a focus for Government priority setting to 2010. While science and innovation support all the goals, innovation has been identified as an area for particular attention through the goal of developing **more quality jobs and thriving innovative industries across Victoria**. This recognises that improved living standards and opportunities for all Victorians will be built on a thriving and adaptive industry base that creates rewarding jobs.

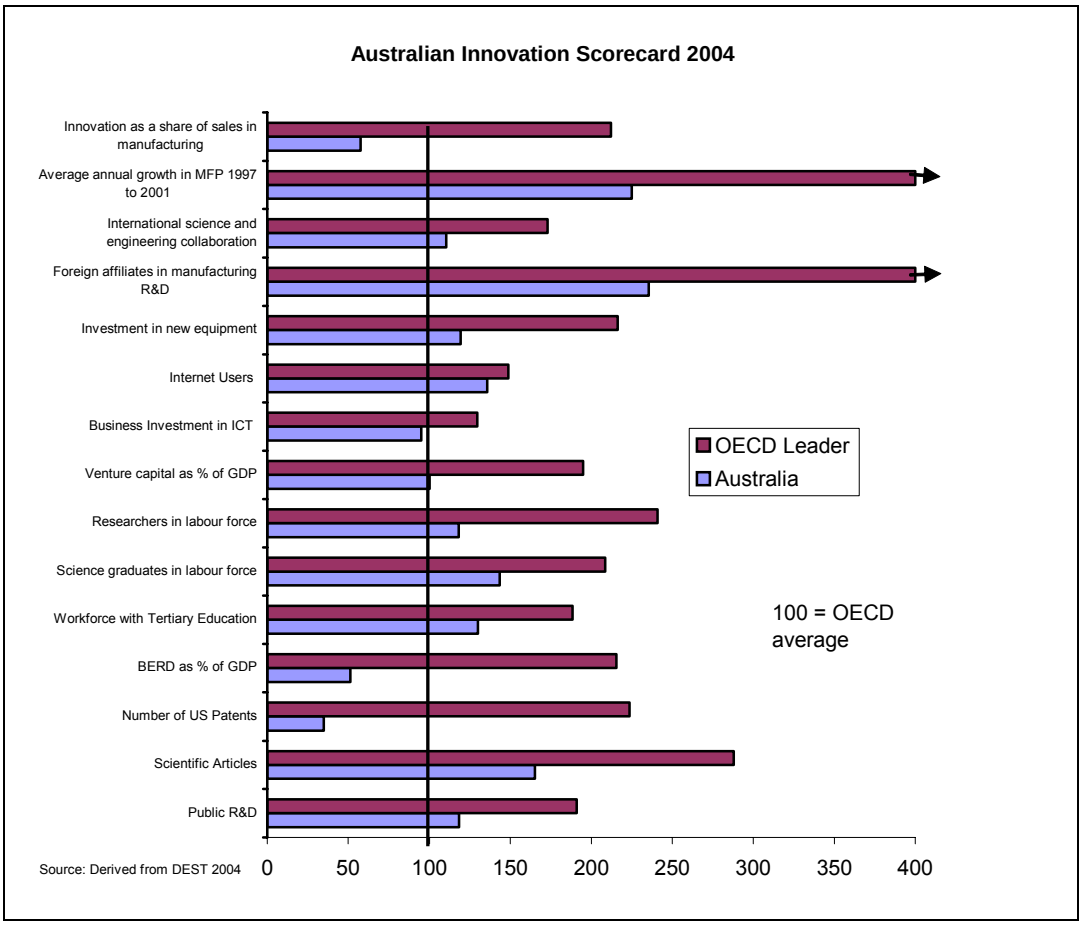
The Victorian Government has translated this goal into action through a series of policies and statements, including:

- Innovation Economy Policy – 2001;
- *Building Tomorrow's Businesses Today* - Business Statement April 2002;
- *Victorians: Bright Ideas. Brilliant Future.* - Innovation Statement October 2002;
- *Victoria: Leading the Way* - Economic Statement April 2004; and
- *Healthy Futures* – The Victorian Life Sciences Statement – April 2006.

Victoria's commitment to innovation as an important driver of economic growth is also reflected in the creation of the Innovation portfolio in 2002 and the appointment of a senior economic Minister to lead that portfolio.

Since the early 1980s Australia's performance on most science and innovation measures has been positive. As indicated by the measures in the Federal Government's Innovation Scorecard (Figure 1), Australia is performing reasonably strongly relative to other OECD economies on productivity, scientific input and output and workforce measures, although notably Australia does not lead in any category. Australia's weaknesses relate to industry aspects of the innovation system with low levels of investment in business innovation and R&D, and very low levels of US patenting. The Innovation Scorecard also highlights the reliance on foreign companies in manufacturing R&D. Overall, it points to a need to improve Australia's environment for business R&D and innovation.

Figure 1. Australian Innovation Scorecard 2004[1]



While the overall direction that Australia has taken since the 1980s is positive, growth on a number of performance measures has slowed and, in some instances, reversed since 1996. Productivity growth is now slowing and there is a need to reinvigorate our innovation agenda alongside other important reform measures. Like most areas of economic reform the productivity enhancements through innovation will come in the medium to long term. There is substantial evidence that learning is cumulative and innovation requires sustained investments over the long term.

Many of Australia's competitors are investing heavily in innovation skills and research - recent examples include the American Competitiveness Initiative and Ireland's Strategy for Science, Technology and Innovation. Yet the Federal Government's support through the budget is declining as a percentage of GDP. In 2005-06, Federal Government support for science and innovation was 0.6 per cent of GDP, down from a peak level of 0.77 per cent in 1992-93 and 1995-96[2]. OECD data indicates that government funding of R&D in Australia is 0.55 per cent of GDP, which is well below the OECD average of 0.78 per cent and places Australia in the bottom ten countries in the OECD on this measure.[3]

[1] Australian Innovation Scorecard, Department of Education, Science and Training (DEST) 2004. Table derived from page 9

[2] Australian Science and Innovation System: A Statistical Snapshot 2005, Department of Education, Science and Training (DEST), page 45

[3] Science, Technology and Industry Scorecard 2005, Organisation for Economic Cooperation and Development (OECD), page 35

In Victoria, low levels of investment in science and innovation that had occurred since the mid 1990s led the Kennett Government to announce the first allocation of $310 million to the Science Technology and Innovation (STI) initiative in 1999. This commitment has been extended significantly by the Bracks Government, with some $1.8 billion committed to new innovation projects since 1999.

A number of other state governments are also making large investments in science and innovation. The growth of science and innovation support that now is occurring through the States suggests a need for better coordination and collaboration between the Commonwealth and the State and Territory governments to avoid duplication and maximise outcomes.

There are significant opportunities for Australia to enhance its science and innovation base and develop new growth and productivity opportunities. There are areas where growth funding is needed, for example support for business innovation and science, technology and innovation skills. There are also opportunities to increase the efficiency and effectiveness of current investments. These include:

- reducing the regulatory burden which sees risk averse boards of Australian companies focussed on compliance rather on opportunities for innovation and growth;
- increasing collaboration and a focus on excellence and scale in our research infrastructure and capability. The current NCRIS process and discussions on primary industries research provide examples of this (see page 41).
- improving collaboration between all levels of Government. The application of subsidiarity principles could see the development of a coordinated suite of science and innovation programs, resulting in improved efficiency, increased reach and greater effectiveness.

These issues have led the Victorian Minister for Innovation to call for a National Innovation Agenda to address innovation as an element of Australia's microeconomic reform agenda and as a means to position Victoria and Australia for future productivity and economic growth. This submission will briefly describe the Agenda.

The Victorian Government submission is presented in two key sections:

- *Section 1* – Presents a brief overview of the importance of science and innovation in the economy and summarises the call for a new National Innovation Agenda.
- *Section 2* – Provides examples of program design and evaluation outcomes of specific Victorian Government science and innovation programs and activities

SECTION 1 – SCIENCE, INNOVATION AND THE ECONOMY

This section provides a short summary of the importance of science and innovation to the economy and supports the call for a National Innovation Agenda. Key points are:

- Innovation is a critical driver of productivity and economic growth.
- Innovation is key to Victoria's and Australia's response to globalisation and increased competition.
- Innovation operates as a system and is the result of a complex interaction between various organisations and institutions.
- Innovation leads to creative destruction, whereby firms and industries are replaced by new alternatives.
- A competitive market is essential for innovation.
- Market failure, information asymmetries and systemic failure are among the reasons for government intervention to support science and innovation.
- A National Innovation Agenda is required as an adjunct to the National Reform Agenda to boost Australia's productivity and growth.

1.1 Science, Innovation and the Economy

The OECD has found that in advanced industrial economies, innovation and the exploitation of scientific discoveries and new technology have been the principal source of long-run economic growth and increasing social well-being. It predicts that the role of science and innovation will be more important to OECD countries' competitiveness in the future. This is particularly so with the rise of newly industrialising economies such as China and India, which are able to compete on the basis of lower labour costs − even for highly skilled jobs − and on the ability to rapidly master current technologies and business methods. [4]

The Victorian Government has recognised that innovation is central to the future growth and development of the Victorian economy in a competitive global economy and also a means to meet community needs and address environmental issues. This understanding is reflected in its 2002 Innovation Statement *Victorians. Bright Ideas. Brilliant Future.* and a number of more recent statements such as the 2006 *Healthy Futures* policy statement.[5]

The central challenge for government in economic development is how to create the conditions for sustained productivity growth. This challenge is one shared by all countries and regions across the world. It is however the differences in regional values, culture, economic structures, institutions, skills and histories that lead to specific advantages which contribute to competitive success.

The complex and dynamic interactions within innovation systems – at local, regional, national and international levels – are means by which these advantages can be identified and realised. Innovation systems involve: the innovative activity of firms; the marketing of innovative products and services; the financial, legal and social frameworks that influence innovation; research infrastructure; the activity of research organisations; a wide range of

[4] Innovation Policy and Performance: A Cross Country Comparison, Organisation for Economic Cooperation and Development (OECD) 2005, page 35

[5] Copies of these statements have been provided to the Productivity Commission in advance of this submission

government programs; and the development and availability of appropriate skills. Successful innovation also depends on linkages and networks that support the production, dissemination and sharing of knowledge. It also relies on societal values and attitudes to risk which support the level of entrepreneurialism in an economy.

This systemic view of innovation underpins the innovation policies of the Victorian Government. The Victorian Government recognises that innovation is more than research and development (although this is an important input). Business and industry are the key players in converting knowledge and ideas into products and services for the local and global economy. It also is clear that the policies and actions of governments in providing a supportive environment for innovation have a significant impact on long-term capacity to meet the challenges of the changing global economy.

Innovation and Productivity

The major driver of sustainable higher living standards in Australia will be productivity growth, i.e. the growth in the ratio of output produced to inputs used in a given time period. Productivity shapes a country's international competitiveness and determines the wages of workers and profits of companies.

Innovation, broadly defined, is the key determinant of productivity in an economy. Innovation improves productivity by allowing greater efficiencies in production, increases the value of products and services that a nation produces, and creates higher quality and better value products and services for consumers.

As the Business Council of Australia (BCA, 2006) notes:

> Innovation is becoming ever more significant in driving the productivity performance and international competitiveness of many developed economies. Increasing global competition, particularly from low-cost emerging economies, and the steadily increasing rate of global technological change means that competing through efficiencies delivered by structural reform and competition is no longer enough for many developed economies.
>
> More than ever before, developed economies are competing on the basis of unique value delivered through the application of knowledge in the production process. Knowledge has come to be recognised as an indispensable business resource, and its application in the production process is now seen as a vital way for many businesses in developed economies to compete and create sustained value[6].

Research and development (R&D) is a subcomponent of innovation activity. Economists have found it difficult to measure the link between R&D and productivity. From a survey of international literature the US Congress Budget Office found:

> The consensus view of the link between R&D and productivity is probably the correct one: it is quite likely that R&D has a positive impact on productivity, with a rate of return that is at least equal to the return on other types of investment. However, shortcomings of the available data and the difficulties associated with current estimating methods make it difficult to identify with any precision the size of the contribution that R&D makes. Thus, estimates of the R&D elasticity span a wide range; they depend on the sample, the estimating method, and the period being considered.[7]

[6] Business Council of Australia, New Concepts in Innovation: the keys to a Growing Australia, 13 March 2006

[7] Congresional Budget Office, (2005) R&D and Productivity Growth (p 2).

Similarly, in the Australian context a Staff Working Paper from the Productivity Commission considering a wide range of modelling approaches to explore the effects of R&D on productivity was unable to find a consistent robust measure of the impact of R&D on productivity. Issues raised included data and data measurement, the complexity of the issues under investigation and also disruption due to other factors impacting on industry. [8]

Innovation and creative destruction

Creative destruction describes the process of industrial transformation that accompanies innovation. According to Schumpeter, creative destruction 'revolutionises the economic structure from within … destroying the old one [and] creating a new one'. Innovation in business – new goods, new markets, new methods of production, and new ways of organising firms – is the 'fundamental impulse that sets and keeps the capitalist engine in motion'[9].

Innovations improve a nation's living standards by reallocating resources towards more productive uses, increasing consumption possibilities and providing new opportunities for employment. At the same time, innovations can also render existing technologies, industries and occupational skills redundant.

Empirical evidence supports the notion that creative destruction is a key driver of productivity, growth and living standards in modern market economies. For example, between 1977 and 1997, half of all multi-factor productivity (MFP) growth in the US manufacturing sector was due to the reallocation of resources away from less productive to more productive uses, while the entry and exit of firms accounted for a quarter of all MFP growth[10]. Similarly, in a study for the OECD using firm-level data from ten countries, Scarpetta et al (2002) found that the entry and exit of firms accounted for 20 to 40 per cent of total productivity growth between 1987 and 1997[11].

The process of change can be "gale force" or a "slow incremental creep". While the process of creative destruction is positive for the economy as a whole there are adjustment costs for workers and industries. For example, workers displaced from one industry may not have the right skills to meet the jobs requirements of emerging industries. Governments can play a role in ensuring that adjustment occurs smoothly, by addressing disincentives and other barriers to change, for example through the provision of training or reducing the risks of innovation.

Innovation and international sources of knowledge

There are many sources of knowledge which are inputs to the innovation process. These can be generated locally by firms themselves or through universities or research institutes. They can also be sourced from overseas. International transmission of innovations is vitally important to small open economies like Australia. Australia's readiness to embrace

[8] Shanks, S & Zheng, S, 2006, Economic Modelling of R&D and Australia's Productivity, Staff Work Paper, Productivity Commission.

[9] Schumpeter, A. (1975) Capitalism, Socialism and Democracy, New York, Harper

[10] Innovation and the Economy, Strategic Policy Group, Department of Treasury and Finance (Internal Paper) 2001

[11] Scarpetta, S, Hemmings, P, Tressel, T and Woo, J. (2002) 'The role of policy and institutions for productivity and firm dynamics: evidence from micro and industry data', OECD Working Paper No. 329, OECD, Paris

and adopt new technologies pioneered internationally, and the pace at which this process occurs, will influence whether Australia remains internationally competitive.

Tentative conclusions from the recent Productivity Commission Staff paper indicate with regard to Australian productivity:

> The effect of foreign R&D is positive and very economically significant. Both foreign knowledge stock and patent measures are shown to have a large impact on Australian productivity[12].

An important question in this regard is whether Australia can reduce its own investment in research and rely on overseas knowledge. There are two key arguments against this. First there are local problems and opportunities which require deep knowledge of the local environment and the development of local solutions. The canola case study provides one example of this (see pages 40 & 46). An equally important reason for Australia to invest in research and innovation is that a country's ability to absorb foreign technology is enhanced by investment in education and by investment in its own R&D. Dowrick argues that:

> …although the rest of the world provides a huge source of ideas and technologies, a country like Australia cannot rely on a strategy of passive absorption to maintain strong productivity performance. In order to benefit from the global public good of world knowledge, countries need to have well trained scientists, a technologically capable workforce and active engagement in cutting edge research[13].

Innovation and Competition

Competitive markets are an important precondition for innovation. When competition intensifies and companies face the prospect of lost customers and lower profits, managers have an overwhelming incentive to pursue creative ways to cut the costs of their operations and increase the value they provide to their customers. Productivity improvements flow and consumers benefit from lower prices and higher quality.

The BCA has noted:

> The internationalisation of the Australian economy and the new performance standards it requires are the predominate drivers of enterprise innovation. They have led to broad improvements in standards, moves to increase value to customers, the search for new products, the ability to turn problems of scale into competitive advantages and the successes of international niche marketing[14].

The crucial role played by competition in spurring innovation is supported empirically. In a detailed study of innovation across 20 industries in the US, France and Germany in the 1990s, the McKinsey Global Institute found that in sectors where competition was promoted – primarily through the dismantling of regulatory constraints – innovation flourished and productivity soared. By contrast, where regulation or other forces distorted the competitive environment, innovations failed to develop or to spread rapidly, and productivity slackened[15]. Similarly, in a comparative study of OECD countries, Bassanini et al (2002) provides evidence that enhancing competition in the product market – while

[12] Shanks, S & Zheng, S, 2006, Economic Modelling of R&D and Australia's Productivity, Staff Work Paper, Productivity Commission. (Page 251)

[13] Dowrick, S. (2003) "A review of the Evidence on Science, R&D and Productivity", paper prepared for the Department of Education, Science and Training (DEST)

[14] Carnegie, R and Butlin, M (1993) Managing the Innovating Enterprise: Australian Companies Competing with the World's Best, Business Council of Australia

[15] Farrell, D. "The Real New Economy'" Harvard Business Review, October 2003

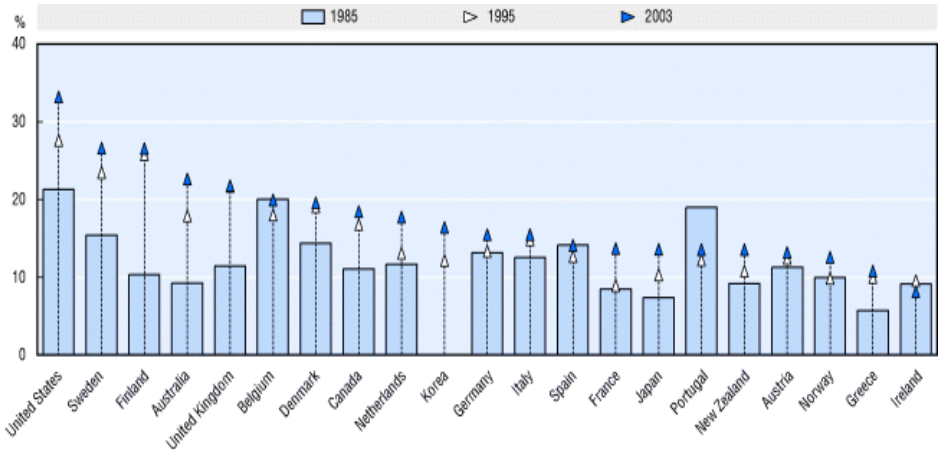
guaranteeing intellectual property rights – has a positive impact on the innovative performance of an economy[16].

In relation to R&D spending, the Productivity Commission[17] noted that increasing levels of competition in Australia, following successive microeconomic reforms and reductions in trade barriers, contributed to a doubling of business expenditure on R&D as a percentage of GDP since the mid-1980s. The need 'to create a competitive advantage' was also identified as the foremost influence on R&D expenditure in a Bureau of Industry Economics survey of 900 firms[18].

Innovation includes organisation and managerial process improvements. According to the most recent ABS Innovation Survey, approximately 21 percent of businesses performed this type of innovative activity[19]. This is in part driven by the very competitive markets that these firms are operating in.

Competitive pressure also promotes the diffusion of new technologies. For instance, competition resulting from two decades of deregulation saw Australia's investment in information and communications technologies (ICT) as a proportion of business investment increase substantially between 1985 and 2003, from among the lowest level in the OECD to among the highest (Figure 2).

Figure 2. Investment in ICT equipment & software as a percentage of gross capital formation



Source: OECD (2005)

The US has also undertaken substantial investment in ICT, led by its retail and wholesale trade, transport and stock broking industries, all of which were subject to intense competition in the 1990s[20]. By contrast, countries that have lagged in their reform efforts and retained significant barriers to competition, such as France, Germany and Japan, have lagged in their adoption of ICT. Barriers to market entry and other constraints on firms can

[16] Bassanini, A, Scarpetta, S and Hemmings, P (2001) Economic growth: the role of policies and institutions − panel data evidence from OECD countries, OECD Economics Department, Working Paper No.283

[17] Productivity Commission (PC) (2003), Annual Report 2002-03

[18] Bureau of Industry Economics (BIE) (1993) "R&D, Innovation and Competitiveness: An Evaluation of the Research and Development Tax Concession", Research Report no. 50, AGPS, Canberra

[19] Australian Bureau of Statistics, 2006, Patterns of Innovation in Australian Businesses 2003, 8163.0.

[20] Farrell, D. "The Real New Economy'" Harvard Business Review, October 2003

impede innovation by narrowing the bounds within which firms take risks and experiment with different approaches.

The above analysis suggests that governments can play a major role in stimulating firms to innovate and adopt new technologies by encouraging competition through deregulation. According to Smith and West[21] innovation involves continuous interaction between market opportunities, technological capabilities, and learning processes within firms. The ability to perceive opportunities and to invest in realising them are key characteristics of innovating firms.

Governments can also facilitate innovation by maintaining stable macroeconomic conditions. Steady economic growth enables higher profits to be earned, and promotes confidence in the future of the economy and in the potential returns from particular innovations. Low and stable inflation and interest rates are also conducive to risk-taking and financing of innovation.

Market failure and the role for government

While competitive markets and stable macroeconomic conditions are important preconditions for innovation, there are circumstances when markets do not function effectively and direct government intervention is desirable to achieve socially optimal levels of innovation.

Innovation has public good characteristics (non-rivalry and non-excludability) that result in some of the benefits from innovation spilling over to society[22]. As innovating firms may be unable to fully capture the benefits from innovation, they will typically invest less than is socially desirable in innovation, with the result that some desirable innovative projects will not be undertaken, while others will be undertaken more slowly, later, or on a smaller scale than would be socially desirable.

Innovation also requires a sustained investment under conditions of uncertainty. Firms cannot know the future and their innovation choices can be very risky.[23] Uncertainty over the outcome of R&D and information asymmetries associated with research can also make it difficult for enterprises to obtain financing for R&D, resulting in under-investment.

In a submission to the Inquiry into Pathways to Technological Innovation, Smith and West argued that:

> ..innovation rests on complex capabilities that extend well beyond those possessed by firms, and it requires long-term investment in conditions of great risk and uncertainty. These characteristics of innovation performance imply serious market and system failures. This is why successful

[21] Smith, K., and West, J. 'Australia's Innovation Challenges: The key policy issues' from Submission to the House of Representative Standing Committee on Science and Innovation (HRSCSI), Inquiry into Pathways to Technological Innovation, 2005

[22] Non-rivalry occurs when one firm's use of an idea does not reduce the amount of the idea available for others to use. Non-excludability occurs when it is difficult for innovating firms to prevent others from using the idea.

[23] Smith, K., and West, J. 'Australia's Innovation Challenges: The key policy issues' from Submission to the House of Representative Standing Committee on Science and Innovation (HRSCSI), Inquiry into Pathways to Technological Innovation, 2005

> innovating economies invariably possess successful public policy systems. Such systems tend to focus on knowledge creation and risk management[24].

Government support for private sector R&D and innovation aims to reduce these market and system failures. Governments can reduce the costs and risks of undertaking R&D and innovation through measures such as taxation concessions or subsidies, supporting intellectual property rights, or by being a customer that demands innovative solutions.

1.2 A National Innovation Agenda

Recognising the importance of innovation to the Victorian and Australian economies and our sustained international competitiveness, Victoria's Minister for Innovation, the Hon John Brumby MP, has called for the development of a National Innovation Agenda (NIA). The NIA aims to build on the positive national reform agenda which was recently agreed by the Australian and State and Territory governments. The broad requirements for an NIA include:

- Increased public investment in innovation infrastructure;
- Incentives to increase private R&D and innovation spending;
- A supportive regulatory environment;
- Increased investment in science, technology and innovation skills; and
- More and better connections, linkages and collaboration.

The Victorian Government has begun consultations with Victorian and national stakeholders to identify collective and individual actions to progress a NIA. From these initial consultations[25] emerged a strong impetus for a coordinated national approach to innovation that more clearly defined the respective roles for Federal and State Governments and addressed linkages across the innovation system. There was also a consensus that Australia needs to identify and concentrate upon its areas of research strength, to focus on international market opportunities and the strategic linkages our research organisations and businesses require to identify and pursue these.

The issues identified above have resonated with a range of stakeholders. It is not a fixed list and may be extended as consultations continue and a national discussion commences.

The following will provide a short summary of the issues and the directions for each of these elements.

Public investment in infrastructure to support innovation

Innovation infrastructure is broadly interpreted as facilities, organisations and capabilities (skills and knowledge) that underpin and support the generation and dissemination of new knowledge, technologies and approaches. This can include research facilities and equipment, research organisation - industry bridging and commercialisation facilities and organisations and communications platforms that enable knowledge-sharing.

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[24] Smith, K., and West, J. 'Australia's Innovation Challenges: The key policy issues' from Submission to the House of Representative Standing Committee on Science and Innovation (HRSCSI), Inquiry into Pathways to Technological Innovation, 2005

[25] Report on Outcomes of the National Innovation Agenda Roundtables, Department of Innovation, Industry and Regional Development, May 2006

There are a range of areas being explored under the NIA. These include:

- *Research infrastructure* – noting that the current National Collaborative Research Infrastructure Strategy process is addressing a number of priority issues;
- *Development infrastructure* – such as testing and prototyping facilities where there may be benefits in stronger coordination of such facilities and potential to link these to training; and
- *Broadband* – is the fundamental platform an innovation economy. It underpins e-science, e-health, security and all knowledge and content rich sectors and is a critical platform for trade and international engagement.

Increasing private R&D and innovation investment

It is firms and industries which are the main drivers of innovation. Innovation is inherently risky and numerous studies over the past decade indicate that Australia does not have an effective environment, including the right mix of incentives to encourage investment in innovation.

Much attention over the past decade has been given to lack of support being given through the taxation concession for R&D. The BCA in 2004 found that the tax concessions are marginally effective in reducing the cost of R&D activities by business. However, for government policy to noticeably reduce the cost of R&D (and thus increase the level of R&D undertaken by firms), the BCA recommended that the taxation concessions be significantly increased, the coverage expanded (beyond the current scientific definition of R&D) and/or more emphasis be placed on other policies aimed at reducing R&D costs.

The Victorian Innovation Economy Advisory Board argued in a recent submission to the Federal taxation review that there is an erosion of the level of incentive (as represented by the after tax benefit) provided by the tax concession over the last 20 years, from 24.5 per cent (company tax rate at 49 per cent, incentive rate at 150 per cent in 1987-88) to 7.5 per cent (company tax rate at 30 per cent, incentive rate at 125 per cent in 2005-06). If the incentives for business R&D are to return to the levels that we had in the late 1980s, the tax concession rate would need to be raised to at least 175 per cent.[26]

There are a range of other factors that influence firm level innovation and R&D. These include:

- The availability of seed, venture and growth finance. The lack of certain forms of finance have seen Australian technology start-ups move to listing at a much earlier stage of their development than equivalent companies in the US. This places very significant compliance costs and other burdens on these firms.
- Consultation has indicated that depreciation rates are impeding firms' ability to invest in new plant and equipment.

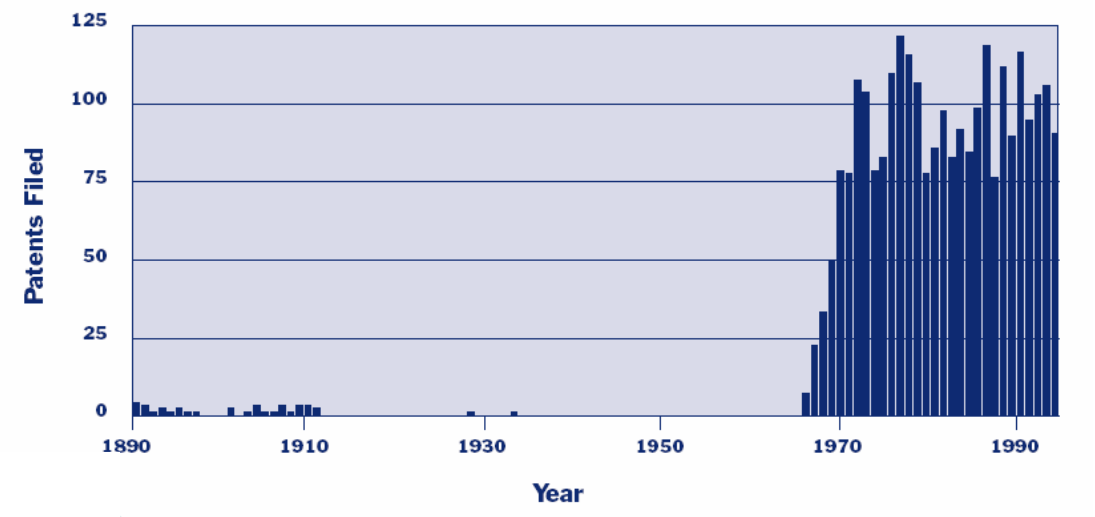
Supportive Regulatory Environment

Effective and efficient regulation around property rights and patents, robust trade practices and competition, sound regulation of financial markets and a low 'red tape' culture are essential to support innovation. Industry or sector specific regulation may also be required to enable the introduction of new technologies (e.g. therapeutic goods regulation, regulation of genetic modification, digital TV and wind farm location).

[26] *Issues Concerning Taxation and Incentives for Business Innovation, Including R&D, op cit*

Regulation can also be a major driver of innovation, particularly in areas of health, safety and the environment. As demonstrated in Figure 3 there was a dramatic rise in the development of sulphur dioxide removal technologies in the United States following the introduction of the Clean Air Act Amendments of 1970 and 1977.

Figure 3. US Patenting Activity in SO_2 Removal Technologies[27]



By contrast, poorly conceived, inefficient and redundant regulation can add unnecessarily to the costs of running a business, stifle innovation, reduce productivity and hamper business growth. These negative impacts on business can, in turn, flow through to the whole economy, dampening employment growth and reducing Australia's ability to be internationally competitive. Excessive regulation also imposes costs on consumers through higher prices and reduced choice.

As part of the National Innovation Agenda Victoria is considering all these aspects of regulation. Issues that have been raised to date include:

- *The current regulation environment and the compliance culture* that it elicits are stifling innovation and productive activity.
- *Legislative barriers to research* such as in the field of stem cell research. The recent Lockhart Review of human cloning and embryo research legislation, for example, noted that several submissions expressed "concerns about the capacity of legislation to respond to research needs in a fast-moving area of technology. These included difficulties in anticipating advances in knowledge and potential new uses of the technology, ambiguities and difficulties in interpretation, and unfair exposure of researchers to potential prosecution".[28] Victoria has consistently argued that the regulatory framework needs to balance ethical considerations with providing a progressive environment for research. Stem cell research is heavily regulated in Australia compared with like jurisdictions around the world. We are seeking to liberalise the legislation to allow for the promising technique of somatic cell nuclear transfer (SCNT) or 'therapeutic cloning' under licence within a regulatory regime that provides the safeguards required by the community.

[27] Taylor, M.R., Rubin, E.S., and Hounshell, D.A. (2003) "Effect of Government Actions on Technological Innovation for SO^2 Control," Environmental Science & Technology, Vol. 37, No. 20, page 4527-4534

[28] Legislation Review: Prohibition of Human Cloning Act 2002 and Research Involving Human Embryos Act 2002, Reports, Legislation Review Committee, Commonwealth of Australia, December 2005, page 182

- *The effective management of intellectual property*. IP arrangements that lock up knowledge and prevent broader use constrain the flow of knowledge transfer. Australia's intellectual property protection regime has been seen as cumbersome and costly.[29] Other approaches to IP management – for example, the creative commons and open source approaches – provide greater opportunity for knowledge flows and innovation by offering permissible use. Consideration of the most appropriate form of IP management in view of the nature of the intellectual capital and intended purpose might broaden the potential for knowledge sharing that drives innovation.

The Victorian Government is already acting to reduce the regulatory burden on industry. As part of the 2006-07 State Budget, the Victorian Government set aside $42 million for new measures to reduce the regulatory burden for businesses and not-for-profit organisations. Under the initiatives, the Government will:

- cut the administrative burden of regulation by 15 per cent over three years, with a target of cutting 25 per cent over the next five years;
- ensure that any new regulatory burden will be offset by a measure in the same area; and
- reduce the compliance burden of regulation by funding government departments to conduct hot-spot reviews and providing incentive payments similar to Commonwealth National Competition Policy – to reward reduction of the burden.

This reduction in regulatory burden will enable businesses to devote more of their resources to innovation, and will continue to reduce barriers to competition and allow markets to work more efficiently, while appropriately protecting Victoria's households.

Increased Investment in Science, Technology and Innovation Skills

The quality of human capital in the production of goods and services across the economy will critically depend upon the levels of education and training achieved by graduates from tertiary and secondary institutions.

Education may be considered a source of human capital which contributes to the overall output of individuals and nations. The concept of human capital is firmly embedded in a number of models of economic growth. For example, new growth theories developed in the late 1980s by economists such as Robert Lucas and Paul Romer explain why some countries have persistently higher incomes than others. These theories emphasise the role of human capital and knowledge accumulation, and suggest that a virtuous cycle can be created as people are more productive when surrounded by educated, innovative people.

There are three distinct pathways through which education and training lead to innovation. First, research and analysis undertaken in and by educational institutions can lead directly to new innovations as well as attract talented researchers from overseas. Second, education is important in ensuring people are actually able to take advantage of new innovations, and third, training provides the workforce skills through which new technologies and approaches can be applied to develop new products and services.

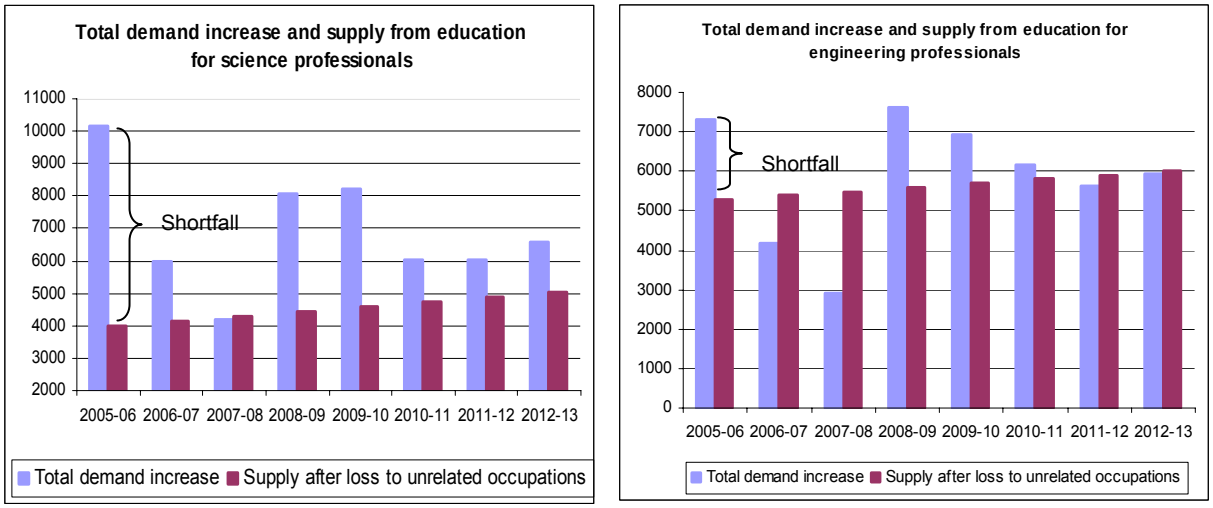
[29] Riding the Wave: The Case for Increasing Business Investment in R&D. House of Representative Standing Committee on Science and Innovation (HRSCSI), June 2003

There has been substantial attention given to education and skills particularly primary, secondary and vocational levels in recent years. Yet there has been little attention given to higher education and little understanding of the science, engineering and technical skills that will be required for the future growth and development of the Australian economy. Victoria's Department of Primary Industries is one of many research organisations reporting skills shortages across a range of scientific disciplines (see page 50).

The Department of Education, Science and Training has recently released an Audit of Science, Engineering and Technology (SET) Skills. The report found that:

- that the number of local students entering SET courses had remained static or was declining;
- that there is a perception that many of these students were ill-prepared for tertiary study and employment in SET fields;
- modelling by the Centre of Policy Studies from Monash University found that there will be a net shortfall of about 20,000 of workforce entrants from domestic sources to meet projected demand for science and engineering professionals. (See Figure 4 below);
- while we may be able to address this shortfall through migration the report comments that that although there has been a net inflow of migrants in these fields between 1998 and 2003, the increasing emphasis and associated expenditure on R&D by OECD countries may result in a net outflow of Australian SET skills in the future.

Figure 4. Science and Engineering Professionals Supply and Demand[30]



Source: DEST 2006

Issues being raised in the National Innovation Agenda consultations are the:

- urgent need for action to respond to the Audit of Science, Engineering and Technology (SET) Skills; and
- need to develop business, commercialisation and entrepreneurial skills.

[30] DEST, 2006 Science, Engineersing and Technology Skills Audit – Summary Report (pages 33 and 34)

More and Better Connections, Linkages and Collaboration

Collaboration is at the heart of the effective and competitive operation of Australia's innovation system. Businesses, research organisations, universities and governments need to collaborate. We need to build enduring linkages to international research centres and markets. A good example of this is the Californian Stem Cell agreement between the Australian Stem Cell Centre, Monash University and the University of California, San Diego. This agreement will enable the Australian researchers to bid for over $US3 billion earmarked for Californian stem cell research.

Collaboration between Governments in Australia is needed if we are to develop and realise the benefits of a NIA. These collaborations can lead to more effective and efficient allocations of resources. The positive work currently being undertaken through the Primary Industries Standing Committee of the Primary Industries Ministerial Council and the National Collaborative Research Infrastructure Strategy are examples upon which we can build.

SECTION 2 - INNOVATION FOR ECONOMIC, SOCIAL AND ENVIRONMENTAL BENEFIT - VICTORIAN GOVERNMENT PROGRAMS

Introduction

This section presents information on the science and innovation programs and activities of the Victorian Government through a number of Government departments. Each department has approached the submission in a slightly different way. The

- *Department of Innovation, Industry and Regional Development,* section 2.1, focuses on a number of the major science and innovation programs and projects that it manages and highlights its role as a strategic investor which aims to build Victoria's science and innovation capabilities;
- *Department of Primary Industries*, section 2.2, which is Victoria's largest research agency, outlines the roles that it plays in research, development and extension for Victoria's primary industries. It highlights a number of key issues it is facing as a research organisation. It comments on decision making and investment principals and also presents a number of illustrative case studies;
- *Department of Human Services*, section 2.3, comments that science and innovation are embedded in the service delivery of the organisation. It however highlights five key initiatives;
- *Department of Education and Training*, section 2.4, outlines a range of programs it is implementing in supporting the development of human capital in the area of science and innovation;
- *Department of Sustainability and Environment*, section 2.5, provides information on a wide range of activities which support the Government's environmental sustainability objectives; and
- *Department of Infrastructure*, section 2.6, comments on the importance of ICT to productivity growth and highlights two important research initiatives of the Department.

The Victorian Government's science and innovation activities are addressing challenging issues across the spectrum of society, the environment and the economy. As pointed out by the Department of Human Services, science and innovation pervade the activities of modern government and it is not always easy to isolate those activities from other elements of service delivery.

Another challenge in preparing this submission is that the Victorian government programs for science and innovation continue to evolve in response to a number of factors. These include:

- changes in the challenges and opportunities facing the Victorian economy, environment and society;
- the latest thinking in terms of innovation systems and related policy;
- the evaluation of Victorian programs; and
- changes to policies and programs of the Federal Government.

2.1 DEPARTMENT OF INNOVATION, INDUSTRY AND REGIONAL DEVELOPMENT

Introduction

The Department of Innovation, Industry and Regional Development (DIIRD) is the Victorian Government's lead agency for economic and regional development. The Department aims to achieve the Government's vision of a dynamic, innovative and sustainable economy in which business is encouraged to grow and prosper.

DIIRD has responsibility for managing the Government's $620 million Science, Technology and Innovation (STI) Initiative and a number of other major science and innovation projects and programs including the:

- Australian Synchrotron;
- Energy Technology Innovation Strategy;
- Operational Infrastructure Support for Medical Research Institutes;
- Biotechnology Strategic Development Plan; and
- *Healthy Futures* – The Victorian Life Sciences Statement.

The Department's operating budget for science, technology and innovation is $143.9 million in 2006-07. In addition, regional development, manufacturing and service industry programs run by the Department all have elements aimed at encouraging innovation.

This submission does not provide information on all of DIIRD's science and innovation programs, rather it will provide a short overview of DIIRD's approach to science and innovation investment. It will also summarise program design aspects and evaluation outcomes for a number of the Department's programs. These are:

- STI Initiative – including support for technology commercialisation;
- Operational Infrastructure Support for Medical Research Institutes;
- Australian Synchrotron; and
- innovation programs delivered as part of the Agenda for New Manufacturing.

The information presented is supported by a series of Appendices and by a number of reports that have been provided to the Commission in advance of this submission.

Overview of DIIRD's Approach to Science and Innovation

The Department recognises that like other relatively small economies, Victoria faces new challenges in successfully operating within this highly competitive and rapidly changing global marketplace. We recognised factors such as:

- The rise of the BRIC economies as a growing force in world trade and competition for investment;
- Worldwide the demand (and hence competition) for skilled knowledge based workers is growing;
- The nature of work is also changing. Information and communications technologies are creating more flexible work arrangements and people are using their skills and knowledge to move more frequently between jobs and industries;
- Successful businesses are increasingly characterised by their take-up of technology, innovative capacity and their global connections with customers and suppliers;

- That companies are increasingly choosing to locate in places with strengths in knowledge, research and technology;
- That this requires a strong science and research base which is well connected to industry and the international science community;
- That there are major challenges facing Victoria, Australia and the world including issues related to the environment, health and an aging population, and energy.

A focus on developing our science and innovation capability is part of the Victorian Government's responses to these challenges and opportunities.

In considering the role of the Victorian Government in building Victoria's science and innovation capabilities the Department considers three key factors:

- The existence of market, system or information failures which may warrant government intervention;
- Gaps in support from the Federal Government or other sources which mean that the intervention of the Victorian Government is needed. Where ever possible Victorian Government support is intended to complement rather than compete with Federal Government programs; and
- That intervention will generate net benefits for Victoria.

While different programs and projects respond to these issues in different ways there are some features which underpin a number of DIIRD programs. These include:

- *Encouraging collaboration.* For example to build scale around areas of science or industry strength, or to build connections across value chains. Encouraging international collaboration is also a critical component of the Department's programs.
- *Encouraging the efficient use of assets.* For example the development of access regimes for shared STI Infrastructure.
- *Building capability.* The STI Infrastructure and other initiatives are not only supporting the purchase of physical infrastructure but the skills and know-how to use it. The VicStart initiative is focussing on commercialisation skills and capabilities rather than providing finance.
- *Demanding good governance and planning.* Most of the larger funding programs require the development and approval of business plans as a precursor to funding.
- *A willingness to experiment;* The Department has been willing to provide a limited amount of funding to determine the benefits of new but not fully tested approaches to address barriers to innovation. For example the Department part-funded the pilot of the InnovationXchange's Trusted Intermediary Service[31] in the Life Sciences sector.
- *A focus on monitoring and evaluation.* Monitoring and evaluation was built into the implementation of the STI Initiative and is now developed during the design phase of new programs in the Department.

[31] For further information see www.ixc.org.au

Science, Technology and Innovation Initiative

STI 1st Generation

In 1998 the then Government's Science, Engineering and Technology Taskforce found that Victorian Government investment in science and technology was low by both international and national standards and that due to low levels of investment by the State, Commonwealth and industry Victoria's R&D base was being eroded in relation to competitor economies.

A detailed review of all public sector science and technology based expenditure in Victoria was undertaken in 1998.[32] This resulted in the recognition of the importance of R&D and innovation as a state wide capability. A whole of government approach was proposed to overcome structural constraints and maximise the leveraging of other sources of funding required to drive economic growth from the science and technology base. It was also noted that levels of private sector expenditure on R&D and Commonwealth investment in infrastructure had both declined since 1995.

To address the underinvestment, a science and innovation initiative of $310 million over five years was announced in the 1999-2000 Budget. This investment represented a substantial change in the role the Victorian Government played in the area of STI, or at the time the role any State Government was playing. The funds were to:

- strengthen the science and technology infrastructure base;
- strengthen the STI support base (including skills and capability building); and
- innovation including commercialisation - increase commercial returns from innovation and R&D through business development.

The funding under this initiative was designed to build on the existing science technology and innovation base to move Victoria closer to levels of economic growth noted in competitors' economies, by using similar policy levers and investment strategies.

The first round of this five-year program commenced with the allocation of funds to several Victorian Government departments in the 1999-2000 budget. Funding was available to specific projects which could demonstrate their contribution to identified priority sectors, the development of strategic technologies and the extent to which they supported collaborative investment.

Two contestable funding rounds followed in 2000 and 2002 with a focus on strengthening the infrastructure base. Applications were assessed by an independent assessment panel. By the second round, short-listed projects were required to prepare a business plan for the proposal prior to final approval. While these were challenging for project proponents to prepare, it placed a planning discipline on the organisations and ensured issues of IP ownership, project governance, access regimes and route to market or users were well thought through.

In addition to the contestable funding, flexible funding was also set aside to enable the Government to respond to strategic opportunities. These funds were allocated to projects such as Bio21, the biotechnology cluster initiative centred in Parkville, and to help leverage

[32] Allen Consulting Group, 1998, Review of Public Expenditure in Victoria on Science, Engineering and Technology.

projects and funding that had become available through the Commonwealth's Backing Australia's Ability Initiative – in particular through the Major National Research Facilities (MNRF) and Federation Fellowships Programs.

The STI Initiative enabled the Victorian Government to become a strategic investor in the State's science and innovation system with the aim of generating high returns for Victoria. As a strategic investor, it aims to produce outcomes for the State which would not necessarily occur, or occur to the same extent, without its involvement. The basis for such strategic investments is the presence of market failures of one kind or another.

STI 2nd Generation

The Innovation Statement released in October 2002 announced the STI 2nd Generation and a second tranche of funding of $310 million over five years. This funding was allocated in a similar way to the first generation of the program. Initial allocations were made to Government agencies and then there was a round of contestable funding. This round focussed attention on development and demonstration infrastructure, building of links to industry and on building strategic capabilities that were recognised as important for Victoria's development as an innovation economy. Appendix 1 provides a copy of the guidelines and Table 1 summarises the allocations to date under the STI initiative.

Table 1. STI Initiative Funding Allocations

STI Initiative $620 million	
STI Contestable Funding Rounds - $168 million **2000 Round 1 - $52.6m, lead projects** ▪ Victorian Neuroscience Consortium ($13.3m) ▪ Alfred Medical Research and Education Precinct ($8m) ▪ Victorian Partnership for Advanced Computing ($6m) ▪ Murdoch Children's Research Institute ($4.9m) ▪ Victorian Bioinformatics Consortium ($4.9m) ▪ Victorian Microarray Technology Consortium ($4.4m) ▪ Emerging Food Process Technologies Centre ($3.1m) ▪ REDlab Test Facility ($2.8m) **2002 Round 2 - $59.1m, lead projects** ▪ Nanotechnology Victoria ($12m) ▪ Clinical Trials Victoria ($8m) ▪ Victorian Centre for Advanced Materials Manufacturing ($5m) ▪ Victorian Institute of Chemical Sciences ($5m) ▪ RABiT ($4.7m) ▪ Centre for Pre-Clinical Drug Candidate Optimisation ($4m) ▪ Victorian Centre for Plant Functional Genomics ($4m) ▪ Collaborative Optical Leading Testbed ($4m) **2005 Round 3 - $56m, lead projects** ▪ Victorian Tissue Bank Initiative ($7m) ▪ Advanced Centre for Automotive Research and Testing ($6.7m) ▪ Centre for Medical Bionics ($6m) ▪ Australian Tissue Engineering Centre Ltd ($5.2m) ▪ Victorian Centre for Advanced Materials	**STI Strategic and Agency- Projects $451 million** ▪ Strategic and Co-investment projects - Bio21 ($35m) - Australian Stem Cells Centre ($11.4m) - Prince Henrys Monash Health Research Precinct ($2m) - St Vincents Institute Medical Research Redevelopment ($2m) - Intellectual Property Research Institute of Australia ($0.5m) - Victorian Neurotrauma Initiative ($3m) - Major National Research Facilities Projects ($8m), including National Neuroscience Facility ($4.5m) - Federation Fellows ($3m) **DIIRD - lead projects** ▪ Technology Commercialisation Program ($20m) ▪ Australian Synchrotron ($57.2m) ▪ VicStart ($30m) ▪ Awareness and Education Program ($5m) ▪ Regional Innovation Clusters ($2.9m) ▪ Building Design Capability ($1m) **DPI - lead projects** ▪ Growing Horizons ($47.5m) ▪ Our Rural Landscape ($50m) **DOI - lead projects** ▪ Victorian Electronic Records Strategy ($4.8m) ▪ Smart Freight ($4.0m) **DOI - MMV lead projects** ▪ Information Technology and Chipskills ($3.7m) ▪ Broadband Innovation Fund ($15m) **DET - lead projects**

Manufacturing ($5m) ▪ Australian Centre for Health Care Innovation ($5m) ▪ Advanced Processing and Innovative Foods Program ($3.5m) ▪ Quantum Communications Victoria ($3.3m)	▪ Science in Schools ($26.7m) ▪ School Innovation in Teaching ($5m) **DHS - lead projects** ▪ Brain Imaging Research Centre ($3m) ▪ Relocation of MacFarlane Burnet Institute ($5m) ▪ e-Prescribing ($24m)

Monitoring and Evaluation

The STI Initiative is a very significant investment in Victoria's science and innovation system, made in the expectation of generating strong returns to the State. In order to demonstrate the returns that are being made, an effective outcomes monitoring and reporting system is essential.

In developing the STI initiative, DIIRD put in place a rigorous monitoring and evaluation framework which enabled it to track outcomes from the investment.

Clear outcome monitoring and reporting obligations on research projects funded by the STI Initiative are important for the effectiveness of the program. They not only help in assessing the performance of projects 'after the event', they also provide an ongoing planning discipline on projects for improved project performance. They assist in the early identification of both problem areas within projects and, just as importantly, identification of the areas within projects that have the highest future potential.

The effectiveness of clear planning and reporting requirements is highlighted by the fact that projects funded through Round 2 of the Infrastructure Grants program appeared to 'hit the ground running' as a direct result of being required to have in place, prior to receipt of funding, a detailed business plan.

DIIRD has developed an Outcome Monitoring Tool to measure the range of benefits achieved over time. This collects both qualitative and quantitative information on STI projects over time to assist the definition and articulation of a range of accumulated outcomes.

A summary of the conclusion from the latest review by the Allen Consulting Group[33] is in Box 1.

Box 1. Review of the Economic Impact of the STI Initiative - The Allen Consulting Group.

The key features of the STI Initiative that are driving strong program performance are that the Victorian Government:

- has acted as an early stage investor;
- has identified high impact areas for Victoria which are also a good fit with Commonwealth Government priorities;
- has provided cash rather than in-kind support;
- has been active in encouraging collaboration amongst project stakeholders; and
- through insistence that funded projects have a fully developed business plan identifying routes to market and through its ongoing performance reporting requirements, the Government has imposed valuable planning disciplines on funded projects.

The high level of leverage of funds associated with the infrastructure grants, and the strong initial overall outcomes associated with the funded projects, suggest that these behavioural features should be incorporated where possible in future science and technology funding programs.

[33] **Allen Consulting Group 2006, *Review of the Economic Impact of the STI Initiative***

Note copies of the 2003 and 2006 Reviews of the STI Initiative have been provided the Productivity Commission previously.

The assessment of outcomes to date from each of the STI Initiative funded projects and the modelling conducted of the economic impacts associated with the program, demonstrate that the STI Initiative will make a significant positive contribution towards the Victorian Government's over-arching goal of increasing living standards for all Victorians.

While there has been a range of performance to date across the STI Initiative funded projects, collectively the funded projects have already achieved very positive outcomes such as:

- attracting significant additional investment from outside Victoria;
- generating hundreds of research findings requiring IP protection;
- high levels of licensing and patenting of IP;
- generating high levels of research articles;
- securing research contracts with industry; and
- attracting new research staff to Victoria.

The conservative 'average performance' case assessment of the economic impacts of the STI Initiative conducted in this study forecasts that the initiative will generate by 2014 Gross State Product $385.1 million higher (2005 dollars) than would have been the case in the absence of the initiative.

For the STI Initiative to generate these returns, the investment in Victoria's research capability occurring as a result of the STI Initiative needs only to deliver the same rates of return as those associated with all public investment in research capability in Australia. Outcome indicators from STI Initiative funded projects, especially across the commercial and scientific research outcomes, strongly suggest that STI Initiative related investment will in fact generate outcomes at, or far more likely significantly above, the average for scientific research investment in Australia.

The 'premium performance' case assessment (which assumes that the STI Initiative funded projects generate impacts double the average for public funding of research in Australia) of the economic impacts of the STI Initiative conducted in this study forecasts that the initiative will generate by 2014 Gross State Product $738 million higher (2005 dollars) than would have been the case in the absence of the initiative.

The economic 'pay-off' from the STI Initiative, forecast through the economic impact modelling undertaken in this report, will be generated as a result of the increased productive investment in the Victorian science, technology and innovation system that the STI Initiative has generated. This investment will generate returns largely via:

- new company, and indeed potentially new industry, formation;
- the adoption of new products and processes by existing companies and industries; and
- the location of additional commercial activity in Victoria by interstate and overseas companies.

In addition to the benefits quantified in this study, potentially significant skills formation related economic benefits and human and environmental health benefits will also likely be generated as a result of the STI Initiative.

Given the results of the economic impact quantification undertaken in this study, we can reiterate the conclusion of the 2003 that it is highly likely that in the future, when the full benefits of the STI Initiative can be observed, the STI Initiative will be viewed as a very successful long term Government investment that has achieved higher living standards for Victoria.

The Allen Consulting Group[34] advises that assessing the outcomes of the STI Initiative is a challenging task for a number of reasons, including:

- the benefits generated by STI funding are diverse – including economic, health, environmental and social benefits;

[34] **Allen Consulting Group 2003, *Review of the Economic Impact of the STI Initiative***

- often long lead times are involved between the conduct of research and the capture of benefits from this research – for instance a 2000 CHI Research study into Australian patenting found that the average lag time between publishing a research paper and its subsequent use in a patent is around 10 years;[35]
- in the process of going from knowledge generation to markets or use, other complementary investment will generally have been made from multiple sources – raising the issue of what benefits should be attributed to what funding sources; and
- quantitative outcomes data is in some cases not comprehensively reported. However, as a result of the outcome monitoring performed by the STI Initiative administration team, outcomes data for the STI Initiative, while not optimal, is actually significantly more comprehensive than that generally found in relation to public investments in science, technology and innovation.

In order to deal with these challenges, a number of analytical approaches have been adopted in assessing the outcomes of the STI Initiative. Three core analytical stages are:

- review of all available outcomes documentation and data relating to each of the elements funded through the STI Initiative. Material reviewed included;
  - project business plans submitted by grant recipients,
  - project interim and final outcome reports submitted by grant recipients,
  - responses to a comprehensive outcome monitoring survey distributed to competitive grants recipients,
  - a previous preliminary review of Government Agency projects conducted by The Allen Consulting Group in 2001; and
  - a previous review of the outputs and outcomes of the STI Initiative conducted by the SA Centre for Economic Studies in 2002.
- development of detailed case studies of projects funded through the STI infrastructure grants project. Preparation of these case studies involved;
  - review of business plans and quarterly progress reports submitted by the case study projects,
  - interviews with key stakeholders in the projects,
  - interviews with Department of Innovation, Industry and Regional Development project managers attached to the case study projects, and
  - interviews with external referees with expert knowledge in the areas of relevance to the case study projects.
- the development of economic modelling scenarios designed to model the economic impacts of the STI Initiative on the Victorian economy over a fifteen year period. The modelling scenarios are based on data gathered through the above two analytical stages of the project. The Centre of Policy Studies conducted the economic modelling using their MMRF-Green general equilibrium model of the Victorian economy.

Technology Commercialisation

Funded through the STI Initiative Generation I and II the Department has been responsible for the management of the $20 million Technology Commercialisation Program and its successor initiative the $25 million VicStart program.

Both initiatives were designed to complement Commonwealth initiatives and address market failures and gaps in program support. They primarily focused on capability

[35] Narin, F., et al. (2000), *Inventing our future: The link between Australian patenting and basic science*, CHI Research Inc.

building: skills and networks to develop opportunities and convert R&D into marketable products and services. See Technology Commercialisation in Victoria - Information Paper at Appendix 2 to the Submission.

Box 2 provides a summary of some of the DIIRD projects that support technology commercialisation.

Box 2. Addressing Impediments to Commercialisation - Case Studies

- The Victorian-Israeli Science and Technology R&D fund (VISTECH) was established to promote, facilitate and support jointly approved, market oriented, science and technology R&D projects between Victorian and Israeli companies. The objective of VISTECH is to strengthen Victoria-Israel cooperation and ultimately the overall economic activity for the mutual benefit of both states. Since its launch in December 2005, six joint-project applications for US$3 million (representing 12 companies) have been submitted for the first round of funding.

- The Australian Textile Clothing Footwear Technology Network is rune by the Council of Textiles and Fashion Industries of Australia. The Network aims to help companies find technologies that can potentially create new product lines or develop better processes. The Network is a good example of how the contracting of membership organisations to deliver services allows for access to strong networks and facilitates 'market pull' technology transfers through relationships with organisations such as Nanotechnology Victoria and CSIRO.

- Australian Aerospace and Defence Innovations Limited (AADI) is a not-for-profit entity established to identify market demand for defence technology and innovation, to broker interactions between technology suppliers and end-users, and facilitate partnering in the sector. AADI works with small and large defence companies, focusing on collaboration to promote local and export opportunities. The support of the Commonwealth and State Government has been critical to the success of this model.

- The Regional Technology Commercialisation Program, delivered by Pyksis, assists regional companies who are developing products and processes based on their innovations. Candidate companies may range from start-ups to long established regional businesses. Participants undertake one-day diagnostic workshops to establish where they are in commercialising their products. A number of these progress to an 11-week business case building program. Key commercialisation tools and concepts are delivered through workshops; business case development is undertaken by 1:1 mentoring; business cases are then presented and tested at a Graduation Showcase. Participating companies emerge with tested business cases and enhanced opportunities to obtain funding and reduce risk.

Operational Infrastructure Support for Medical Research Institutes

The Victorian Government's annual Operational Infrastructure Support for Medical Research Institutes (OIS) provides essential infrastructure underpinning research that is not provided for within competitive, peer-reviewed research grants.

Most Australian competitive research grants provide only for the marginal (direct) cost of research and do not cover operational and overhead costs. Unlike universities, Independent Medical Research Institutes are ineligible for infrastructure support from the Federal Government Department of Education Science and Training. The OIS program was instigated to fill this gap and provide for the operational and overhead costs of Institutes. It enables institutes to realise maximum outcomes from their competitive research grants, rather than use these valuable grants to cover infrastructure costs.

Prior to July 2003 the program was administered by the Department of Human Services. In its current form (introduced in 2002-03) the OIS funding managed by DIIRD has two complementary components:

- *Medical Research Growth funding*: This provides an additional 20 per cent of recognised peer-reviewed grant income received directly by Institutes and 10 per cent if received indirectly (i.e. – from a University affiliated with the Institute).
- *Medical Research Innovation funding:* This is linked to a higher level of research performance, clinical impact and/or commercial activity and is designed to stimulate and sustain the competitiveness of Victoria's Institutes. This assessment process is guided by the extent to which Institutes contribute to the strategic aims of the State as detailed in Growing Victoria Together and the Innovation Statement.

Funding through the program has grown from $11.3 million in 2000-01 to $22.3 million in 2004/05. It increased further to $25.5 million in 2005/06.

A review by the Allen Consulting Group in 2005 (copy at Appendix 3) found that the OIS funding, as perhaps the largest source of 'untied' funding, has played a key role in the ability of the Institutes to seek, secure and support additional competitive grants funding. It has allowed the Institutes to provide technical and core services to underpin research activities and support their researchers and has contributed to improved research productivity.

The key measurable effects of the OIS program can be categorised as:

- a scale effect – whereby the OIS program has allowed the Institutes to secure *and* support more competitive grants funding from the Commonwealth and International sources than they would have in the absence of OIS funding; and
- a productivity effect – whereby the enhanced support services now in place (due to OIS funds) within Victorian Institutes has improved the productivity of their research efforts.

By enhancing the ability of Victorian Institutes to undertake higher levels of research activity and, crucially, to do better research, the review found that the OIS program supports both the overarching objective of the Victorian Government's Biotechnology Strategic Plan[36] and the achievement of specific targets within it, such as the generation of high quality US patents.

Modelling of the direct economic impacts associated with allocation of Victorian Government funding to the OIS program (and also the effects of *not* allocating that money elsewhere) and the scale and productivity effects suggests that the OIS program has had a strongly positive impact on Victorian economic performance when compared to the counterfactual that the OIS program had not been funded over the past five years.

The key economic impacts in Net Present Value terms of the OIS program in Victoria over the 2000 to 2007 period are:

- Real Gross State Product has been cumulatively $274 million higher than it would have been in the absence of the program;

[36] Copies available www.biotechnology.vic.gov.au

- Real Investment has been cumulatively $99 million higher than it would have been in the absence of the program;
- Real Consumption (perhaps the best measure of overall economic welfare) has been cumulatively $85 million higher than it would have been in the absence of the program; and
- Employment is currently slightly higher (200-300 jobs) than it otherwise would have been.

The review commented that while it is difficult to directly compare results from the OIS program to other research funding initiatives – due to the fact that each initiative differs in its goals, functions and timelines to generating impacts – the above results do suggest that the OIS program is delivering impacts above the 'norm'. This is due to the particular role that OIS funding plays in allowing Institutes to both secure and support additional project grant funding *and* to improve their overall research productivity.

The Australian Synchrotron

The Australian Synchrotron, to be opened in April 2007, is a state-of-the-art light source that generates very intense light over a broad range of the electromagnetic spectrum. This synchrotron light can be used to measure structure and composition across scales, from atomic and molecular through to macroscopic, with extremely high resolution and sensitivity. Such characterisation capabilities allow users to understand systems' function and properties in terms of composition and structure, so enabling development of new and improved products and processes.

The Australian Synchrotron will be the pre-eminent national facility in terms of user numbers, with 1200 expected. The users will mainly come from Australia and New Zealand. The facility will enable these national users to participate effectively in international collaborations. Memorandums of Understanding have been signed with the world's largest synchrotrons, and relationships with synchrotron facilities in South East Asia and China are developing.

The Australian Synchrotron is a good example of public investment in innovation infrastructure. As such, it provides a model for future investments in platform capabilities for high end research and development. The Victorian Government has contributed $157 million, the funding partnership for the initial suite of beamlines totals $50 million from around Australia and NZ, and support from the Commonwealth is now being sought. The investment in beamlines by a broad range of organisations highlights the collaborative nature of the Australian Synchrotron.

The Victorian Government used a series of economic studies to inform its decision to invest in the Australian Synchrotron. These studies are briefly discussed in the National Science Case for the Initial Suite of Beamlines.[37]

In order to maximise local content and economic benefits during the construction phase of the project, the Project Delivery Team in Major Projects Victoria has worked with the Industry Capability Network (ICN), implementing practices consistent with the Victorian Industrial Participation Policy.

[37] available at http://www.synchrotron.vic.gov.au/content.asp?Document_ID=1265 .

Collaboration with and extension to industry users (rather than suppliers) is also an important element of the Australian Synchrotron project. The National Industry Advisory Committee (NIAC) has provided input to the Australian Synchrotron Project on issues related to industry use of the facility. NIAC has identified several key areas, and has suggested several key principles in relation to these areas, where appropriate "industry friendly" policies will need to be implemented. These areas include access, intellectual property, pricing and user support. Under the auspices of NIAC, a pro-active industry engagement program is being rolled out in several phases: awareness raising, consortia development, marketing and value capture.

The Australian Synchrotron will also be an important training facility. Many of the users will be post-graduate student, post-doctoral fellows and early career researchers, and the facility becomes a training ground for science. Synchrotron science is now being taught at VCE level physics and other subjects, the Monash Science Centre has a permanent synchrotron display, and an active speaker program is being run at primary and secondary schools. The Australian Synchrotron clearly has an active role to play in science and technology education, and can act as a focal point for encouraging interest in science.

The Australian Synchrotron is a place where connections, collaborations and linkages will occur, linking the disciplines of physics, chemistry, biology, engineering and information technology. These linkages occur because the facility in its nature is cross-disciplinary, where users from across conventional disciplines meet and work together. It is generally recognised that new science will result from the convergence of conventional disciplines, resulting in innovation from the new interfaces that develop.

Innovation and the Agenda for New Manufacturing

The Agenda for New Manufacturing was released in 2002 as part of the Victorian Government Business Statement. Some $27 million was allocated over four years to implement a series of initiatives aimed at supporting the Victorian Government's commitment to make Victoria a centre for manufacturing excellence in the Asia-Pacific region.

Accelerating innovation is one of the seven objectives of the Agenda. There are six key programs which supported this objective:

- *Innovation Insights Visits Program* to provide businesses with the opportunity to visit 'best practice' firms and gain first hand experience and advice on how to adopt new and innovative practices.
- *Keynote Conference and Seminars* which aims to keep companies up to date on emerging technologies and market developments.
- *New Technology Demonstrations* which aims to highlight successful application of new technologies that develop high value-added products for export or enhance manufacturing productivity.
- *Technology Evaluation Projects* which aims to encourage companies to evaluate new technologies and provide case study materials for their industries.
- *Technology Roadmap and Skills Studies* which aims to identify future technology and skill needs for key manufacturing sectors.
- *Value Chain Workshops/Mapping* which aims to provide companies with an introduction to the benefits of managing business value chains.

These initiatives are currently being reviewed as part of the development of a new manufacturing strategy for Victoria. The programs have primarily addressed planning, information needs and firm based learning. While a number of these programs have been popular and successfully implemented, it is feasible that having demonstrated the benefit of the approach to industry, that the initiatives might continue in the future either without or with reduced Government support. Outcomes include:

- *Innovation Insights* - involved more than 3,000 people from over 450 Victorian manufacturing companies learning about innovation from other manufacturing businesses. Respondents to a participant survey indicated that 36 per cent had introduced changes following visits and 46 per cent planned to in the near future.
- *New Technology Demonstrations* - involved over 630 participants. In addition to helping to raise awareness of products amongst potential customers, the demonstrations provided useful feedback on customer mind sets and requirements.
- *Technology Roadmapping and Skills Studies* - The industries covered include Electronics and Telematics, Technical Textiles, Casting, Tooling, Automotive and Scientific Equipment. The program has contributed to the awareness and understanding of Technology Roadmapping across a broad range of industries. It has been particularly applicable to sectors involved in developing and delivering Federal Government Action Agendas and the road mapping activities are generating follow-on demonstration projects.

Conclusion

This section has presented information on a selection of science and innovation programs run by DIIRD. In particular it has considered issues of program design and measuring the benefits of science and innovation investment. DIIRD continues to develop its program offering in light of experience, program evaluation and ongoing assessment of emerging issues, gaps and opportunities that require attention.

2.2 DEPARTMENT OF PRIMARY INDUSTRIES

Introduction

This section provides information on the science and innovation activities of the Victorian Department of Primary Industries (DPI).

Globally, science and innovation is recognised as a key determinant of industry growth and development. In particular, innovation delivers improvements in productivity - the key driver of economic growth. The annual productivity growth rate for the food and agriculture sector is 2.6 per cent in Australia compared to 1.3 per cent for the whole economy, or an extra $250 million per annum[38]. The purpose of science is to deliver innovation. Whilst the success of Victoria's primary industries is the result of many factors, investment in science has underpinned significant improvements in productivity and subsequent economic growth.

Value of Primary Industries to Victoria and Australia

Agriculture Forestry and Fisheries

Even though agriculture's relative importance in the economy has declined, it still plays an important role due to its growth in output, especially in exports, productivity improvements and by still remaining a dominant employer in rural and regional Australia. The long term growth in output over the last 40 years has been 2.4 per cent. In the last 30 years, exports have also grown at 3.5 per cent. This has been achieved with the area under agricultural land declining by 9 per cent in the last 20 years and with a relatively stable labour input in absolute terms[39].

Agriculture, forestry and fishing make a substantial contribution to the Victorian economy, producing primary products valued at approximately $9 billion in 2004-05. A large proportion of the contribution is exported, with food and fibre exports valued at $6.8 billion in 2005. The major contributors were dairy (31 per cent), meat (20 per cent), wool (13 per cent), wine (9 per cent) grains (7 per cent) and horticulture (6 per cent). Food and fibre exports from Victoria have experienced an annual trend growth rate of 3.2 per cent from 1997[38]. In 2005, Victoria accounted for 27 per cent of Australia's total food and fibre exports from just 3 per cent of the nation's agricultural land[40]. Victoria is one of the most efficient states in terms of dollar return per natural unit of resource (i.e. land and water).

Direct exports of unprocessed commodities (e.g. grain, animals) were $1.82 billion in 2004-05, which is 9.8 per cent of Victorian total merchandise exports. A large proportion of overall agriculture, fisheries and forestry production (51 per cent) provides input to the manufacturing sector such as processed dairy products, wine and paper, which are in turn exported. Primary producers also supply raw materials to other sectors of the economy. For example, half of fisheries production goes to accommodation, cafes and restaurants[38]. Recreational fishing also has a significant value to the Victorian economy especially

[38] Victorian Agriculture Forestry and Fishing Industries: At a Glance, Department of Primary Industries (DPI) 2006

[39] Trends in Australian Agriculture, Productivity Commission Research Paper, July 2005

[40] Summary of Victorian Food and Fibre Export Performance, Department of Primary Industries (DPI) 2005

regional areas, with an estimated $500-600m spent annually on fishing related activities (including equipment, travel and accommodation).

The sector directly employs 74,600 persons or 3.0 per cent of the total Victorian workforce[38]. The majority of this workforce is in regional areas, accounting for a fifth of regional employment. The impact of changes in the value of primary products is felt more directly in the regions than by the economy as a whole. The 2002-03 droughts illustrate the inter-sectoral linkages, with the following estimated flow-on effects:

- Reduced regional income in the Mallee and Wimmera by 15.5 per cent and 11.1 per cent respectively;
- Reduced GSP by 1.2 per cent in Victoria (1.6 per cent nationally);
- Reduced investment by 0.5 per cent in Victoria (0.7 per cent nationally);
- Reduced employment by 0.6 per cent in Victoria and 0.4 per cent in Melbourne (0.8 per cent nationally); and
- Reduced export volume by 4.3 per cent in Victoria (5 per cent nationally).

In contrast with most developed economies, Australia does not routinely provide assistance to agricultural commodity producers through tariff protection, income transfers or other production subsidies. Effective rates of assistance for primary industries in Australia are now on par with, or below, the remainder of the economy. The effective rate of assistance for primary production is 4.1 per cent, with fisheries at 3.8 per cent and forestry 5.3 per cent [41]. Australia's and Victoria's success has been achieved without the high rates of Government assistance that its competitors receive in the United States (18 per cent), the European Union (33 per cent) and Japan (56 per cent).[42] The Victorian Government provides indirect assistance in the form of science capability and capacity to improve efficiency and protect industry against biological threats eg. biosecurity. Direct assistance is applied only in times of exceptional circumstances such as drought. To remain internationally competitive, Victoria's primary industries have needed to develop productivity, efficiency, quality and marketing advantages[38].

The emergence of an efficient, productive and lightly assisted primary industries sector in Victoria has been a key factor in the expansion of the economy in general. Continued strong growth in broadacre farm productivity, averaging 2.6 per cent per year, has reduced agriculture's call on the nation's resources allowing other sectors to expand rapidly. This is considerably higher than that achieved in Australia's market sector and is relatively strong compared to other OECD countries. In fact, Agriculture contributes around 16.4 per cent to market sector MFP growth[39]. At this rate of productivity growth it takes only 27 years for farmers to double the outputs produced from each unit of input. In the grains sector, where productivity has grown at a spectacular 3.3 per cent per year, it takes only 22 years to double outputs per unit of input[38]. Growth in labour and capital productivity is of similar amounts[27]. What this means is that less of our scarce resources such as land, labour and capital are needed to produce the essentials of life, leaving more resources to generate wealth/well-being in other activities. However market access on which these highly efficient industries depend is very vulnerable to biosecurity threats and breakdowns.

[41] Trade and Assistance Review 2003-04, Productivity Commission (PC)

[42] Agriculture Policies: At a Glance, Organisation for Economic Cooperation and Development (OECD) 2005

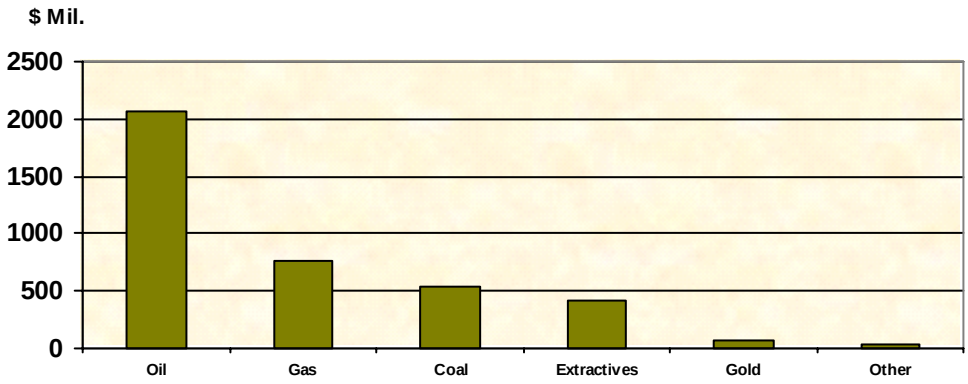
Minerals and Petroleum

The Victorian Government ministerial policy statement on energy and resources[43] identifies major extractive, mining and mineral and petroleum industries in Victoria and the benefits they bring to the State:

- The average value of minerals and petroleum production during the past three years has exceeded $4 billion per annum.
- The minerals and petroleum sector employs approximately 6000 people directly. Taking into account downstream processing activities linked to Victoria's Earth Resources employment numbers are in the order of 90,000.
- Investment in exploration for minerals and petroleum resources has averaged $14 million per year since 2001-02.
- Over the last four years, commitments for new capital investment on major minerals and petroleum projects have totalled in excess of $4 billion.
- Electricity derived from brown coal provides the majority of the energy necessary to support the State's manufacturing industry and household demand.

The value of production for the major mineral and petroleum commodities in Victoria is described in Figure 5[44].

Figure 5. Value of Mineral and Petroleum Production in Victoria in 2003/04



This important business sector is starting to accelerate. It has been recently estimated that the gold sector alone could create up to 2000 new jobs (four new gold mines in production) over the next five years, most in regional Victoria, with each one creating an additional 2 to 3 indirect jobs. Extractive industries, primarily sand, gravel and aggregates are important; as they generate approximately $500 million in revenues. But most importantly, total employment reliant on the extractive industry is estimated at over 8000 people. Extractive industries serve the construction industry, which is central to continuing economic development as well as underpinning the growth of the State's export base. In addition, the $270 million Douglas/Hamilton project located near Horsham in Western Victoria will commence operations in 2006 and result in Victoria becoming a major mineral sands producer to the world market.

[43] Promoting Victoria's Prospects, Department of Primary Industries (DPI) 2003

[44] Minerals and Petroleum Division Statistical Review 2002-03, Department of Primary Industries (DPI)

Measuring the Value of Science and Innovation in Primary Industries

Increased output of Agriculture in the last thirty years has been due to productivity improvements. For Victoria, it is estimated that the value of productivity improvement in 2004/05 solely for broadacre industries (i.e. excluding dairy, wine and horticultural) has been $119 million[45]. The key drivers of productivity improvement have been identified as: the development of more sophisticated farm machinery and equipment, development of improved herbicides, fertilisers and other chemical, plant and animal breeding, better use of new technologies and improved management practices[27].

Studies show that investment in agricultural R&D consistently delivers high returns. The Primary Industries Standing Committee review of agricultural research and development found there was evidence of a strong link (i.e. 80-85 per cent contribution) between R&D and productivity growth[46]. A study was conducted to measure the impact of research on broad acre agriculture in Australia in the period from 1953 to 1994[47]. Using a non-parametric method, the study estimated internal rates of return to be in the 12-20 per cent range. The USDA has also estimated the social rate of return from publicly funded agricultural research to be in the order of 35 per cent[48]. More recently, the Monash Model, a dynamic general equilibrium model of the Australian economy designed to estimate the impact of policy changes, has found benefit-cost ratios of such research in the order of 5:1 to 10:1 and higher[34]. They suggested this is usually where an innovation is widely adopted across a large industry.

The Rural Industries Research and Development Corporations (RDCs) are major funders of Agricultural R&D in Australia with States and Territories being substantial recipients. RDCs commission reviews on the returns from their investment in R&D and the key findings from recent reports in relation to the most important industries to Victoria are listed in Table 2[49]. These illustrate the economic benefits that science in the primary industries sector can deliver.

A major investment by the Victorian Government has been the Science, Technology and Innovation (STI) initiative managed by the Department of Innovation Industry and Regional Development (DIIRD). DPI has received a significant amount of funding through this initiative especially to support its strategic science. One of the areas where DPI has been a key player is the Victorian Micro-array Technology Consortium. The Consortium has brought together the agri-food and biomedical research sectors and has developed platform technologies to allow the analysis of genome wide patterns of gene expression across sample and species. Evaluation of the initiative indicates an estimated benefit of $50

[45] Investment Performance for the Agriculture and Food sector 2004-05, Department of Primary Industries (DPI) (In Preparation)

[46] Review of Agricultural Research and Development, Primary Industries Standing Committee, Department of Agriculture Fisheries and Forestry (DAFF) Commonwealth of Australia August 2004 (Internal Report)

[47] Cox, T., Mullen, J., and Hu, W. (1997) "Nonparametric measures of the impact of public research expenditures on Australian broadacre agriculture" Australian Journal of Agricultural and Resource Economics, Vol 41, page 333-360

[48] Fugile, F., N. Ballenger, K. Day, C. Klotz, M. Ollinger, J. Reilly, U. Vasavada, and L. Lee. (1996) Agricultural Research and Development: Public and Private Investments under Alternative Markets and Institutions, AER 735 USDA Economic Research Services, Washington DC

[49] Innovating Rural Australia: Research and Development Corporations Outcomes, Department of Agriculture, Fisheries and Forestry (DAFF) Commonwealth of Australia (2002, 2003, 2004)

to $300 million per annum to the Victorian dairy industry because of improved productivity and cost reduction due to properties of feed[50] .

Traditionally, the focus of measuring the value of science in many institutions, especially universities, has been on many so called "academic measures" of science quality such as number of publications, citations etc. The development of the proposed Research Quality Framework led by the Commonwealth Department of Education, Science and Training has highlighted that measuring the impacts of the science on industry is just as important. Science quality measures, while important (especially at the basic and strategic end of the science and innovation pipeline), often do not give a good indication on the return of investment and therefore impact on industry needs to be incorporated into a measurement system.

Table 2 Key findings from RDC reviews (2002-2004) of investment in Agricultural R&D for industries most relevant to Victoria[34].

Industry	Report	Return on Investment
Dairy	2002	The Dairy Research and Development Corporation's (DRDC) benefit-cost ratio for its portfolio of projects is estimated at 3.2:1.
	2003	During the past decade, the volume of milk produced per cow has increased by about 25%, while the volume of milk produced per dairy hectare has gone up by 60%. The production per week of farm labour has also risen by 60% over the same period.
Meat	2002	Analysis of 10 R&D projects undertaken by Meat & Livestock Australia (MLA) showed that the 10 projects were technically successful, six had environmental benefit, and five had social benefit to rural communities, with an average benefit-cost ratio of 8:1.
	2004	Predictive microbiology, developed and adopted in the meat and livestock industry, has assisted in securing market access and delivering $85 million a year in direct benefits to industry.
Wool	2002	An interim BCA report commissioned by the Australian Wool Innovation Limited (AWI) designed to evaluate investment in off-farm wool R&D revealed an expected return of $5 for every $1 invested.
	2004	The Bestwool 2010 state-based education program, a collaborative project supported by Australian Wool Innovation (AWI), the Victorian Department of Primary Industries, the Victorian Farmers Federation, GRDC and MLA, includes workshops, information sessions and courses. 69% of growers participating in the program have made major business changes as a result.
Wine	2002	The Grape and Wine Research and Development Corporation's (GWRDC) research portfolio is spread across developing superior techniques for growing and processing grapes in a variety of climates, and has estimated the overall expected economic return across the selected portfolio to be 9:1, with a large number of individual projects expected to return over 10:1.
Grains	2002	An analysis of the Grains Research and Development Corporation's (GRDC) investment portfolio indicates that the GRDC is delivering an overall benefit-cost ratio of 6.5%.
	2003	Grains R&D is delivering an overall benefit-cost ratio of 6.6. When account is taken of benefits flowing off-farm (to off-farm industry and consumers) the benefit-cost ratio rises to 7.8. This equates to a net present value of about $3 billion flowing to the wider community through grains R&D.
	2004	A GRDC survey in 2004 found that 51 per cent of farmers had adopted new or improved farming practices in the past two years.
Horticulture	2003	High rates of adoption also contribute to the positive results from ABARE's report evaluating the costs and benefits of horticulture research. ABARE examined a wide selection of horticultural projects and found research into the control of husk spot in the macadamia industry delivered a benefit to Australian macadamia growers of $35.8 million in present discounted value terms. The estimated benefit-cost ratio was 67.6.

[50] The Allen Consulting Group, Outcome Review of the STI Initiative, Report to the Department of Innovation Industry and Regional Development, November 2003

DPI has rigorous investment decision principles and processes that are built around development of strategies and priorities derived from government objectives, industry strategies and a role of government overlay[31]. The investment criteria are described in Box 3.

Box 3. DPI Investment Criteria for Agriculture R, D & E Programs

Principle 1. Contribution to achieving Government outcomes: DPI's primary role is to interpret the policies of the government of the day and to implement programs to deliver on these policies. The alignment of the department's current high level outcomes – strong economic growth, high quality natural resource base and resilient industries and communities - with government policy is clearly articulated in the DPI Corporate Plan 2004-2007.

Principle 2. Role of Government: While most outcomes in the economy are achieved efficiently through markets, where there is market failure, the government may have a role to intervene. A market failure test is used to help determine the role of government in future RD&E investment and the beneficiaries and funders test is applied to help determine who benefits and therefore who should be funding the work.

Principle 3. Alignment with strategic direction and investment priorities: DPI develops an Investment Strategy for Agriculture Programs 2006-07 that describes future direction and priorities for funding. Activities undertaken in developing the strategy include scanning the environment (external and internal) to identify the key drivers and emerging issues that might inform setting strategic direction as well as annual investment priorities. Project proposals need to align with the strategic direction and priorities to be considered for funding.

Principle 4. Equity in funding: Where an agriculture industry or sector is likely to be a significant beneficiary of government investment, it is expected that they should also be a major funder of those activities. Investors should make a quantum of investment proportionate to the benefit of the output to that investor using the market failure test. Some projects should be fully funded by industry, some fully funded by government, and others a mix of both government and industry.

Principle 5. Impact of investment and value for money: The success of government investment in RD&E through DPI will be underpinned by demonstrated achievements in relation to economic impacts for the agri-food sector and benefits to the natural resource base and regional communities. That is, the impact of the investment.

These principles are considered when allocating resources to investment programs/programs with the intent of ensuring:

- Portfolio balance - In a political context, it is important to understand that the 'balance' across the portfolio is important so that government is recognised for its broad role in 'governing for all'. This includes agriculture industries, cross-industry issues and place-based needs (both demographic and landscape).
- Development of strategic alliances & partnerships - Building long-term strategic alliances and partnerships with external co-investors can contribute to the achievement of government policy objectives.
- Consistency with developing DPI capability and accessing new capability - There is strategic investment in the longer term capability needed to deliver on the investment programs as well as ensuring suitable capability within service deliverer agencies. The national RD&E agenda will drive this process over the next 10 years.

DPI's Economics & Policy Research Branch has been involved in developing a project selection and evaluation system to assist resource allocation in DPI. The system involves the use of a market failure test to identify the role for public involvement, and the quantification of industry benefits using farm systems models[51]. Benefit-cost studies for large programs using these models have been completed for dairying[52], grains[53], and beef

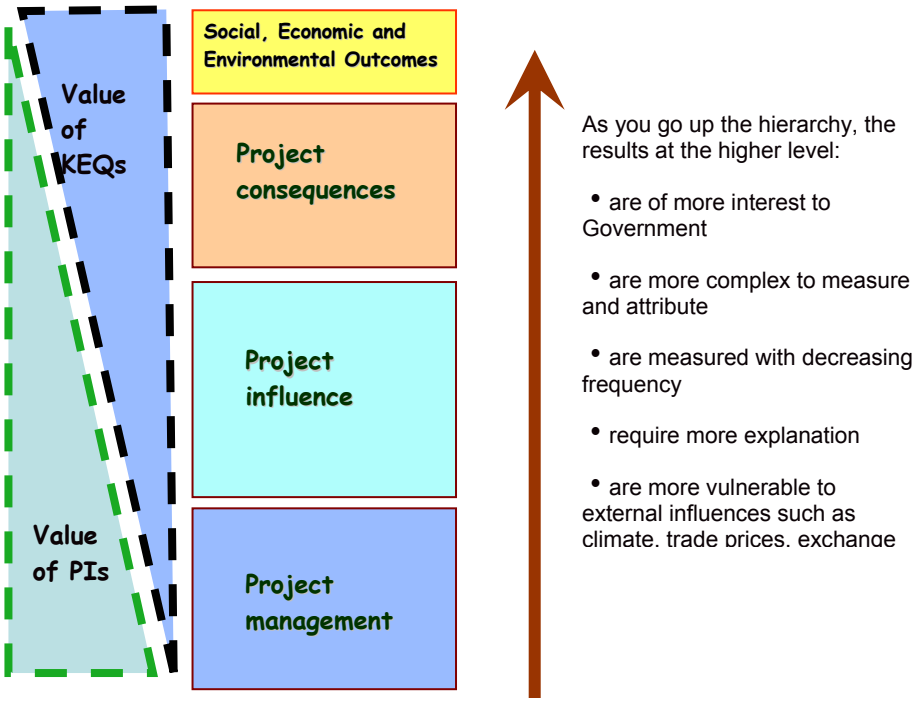
[51] Beneficiaries and Funders of Research and Development in Agriculture: Science Technology and Innovation Initiative, Evaluation Report 1, Department of Natural Resources and Environment, June 2000

[52] The Value of Prospective Improvements from Research and Development in the Victorian Dairy Industry, Evaluation Report 2, Department of Natural Resources and Environment, 2000

and lamb[54]. This work has led to the adoption of a market failure test and an assessment of benefits and costs in project selection in DPI.

In the past, valuing of the impact of science and innovation, particularly R&D, has focused on determining quantitative economic measures; benefit costs ratios and so forth. There are many challenges in measuring the impact of R&D in agriculture, especially attribution i.e. taking into account external factors such as Australian dollar fluctuations, weather, and trade policies of competing countries. Additionally, an inherent problem in measuring the value of R&D is the 10 to 30 year lag time for the full benefits to accrue[46]**.** Performance indicators at the program/project level may be useful but also may lead to goal displacement if considered in isolation**.** It is important to use a range of measures and qualitative measures can be just as important as quantitative ones. DPI uses evaluation methods such as case studies, surveys, interviews, focus groups and story technique to name a few. As illustrated in Figure 6, specific "key evaluation questions" for projects and programs are more important than broader performance indicators when holistic outcomes are desired.

Figure 6. Hierarchy of Key Evaluation Questions (KEQs) and Performance Indicators.



DPI employs program (project) evaluation as one of the most accurate and useful means to measure the impact of science and innovation and is an important tool for reporting and review. Program evaluation determines the impact of outputs from a particular program /project and minimises problems related to externalities and attribution to outcomes. Program evaluation also relies on establishing and testing a sound program/project theory

[53] Wimalasuriya, R., Grey, D., Fisher, W., Haines, P., and Eigenraam, M. "The Value of Prospective Improvements from Research and Development in the Victorian Grains Industry" Evaluation Report Series No: 3, Department of Natural Resources and Environment, 2001

[54] Wimalasuriya, R., Hamilton, J., and .Goldsworthy, D. The Value of Prospective Improvements from Research and Development in the Victorian Beef and Lamb Industries" Evaluation Report Series No: 5, Department of Natural Resources and Environment, 2002

of action in the project development and planning phase that will result in outputs contributing to outcomes (e.g Bennett's hierarchy). This provides clarity for scientists on what the project is expected to deliver and confidence that it is well targeted. The planning phase is then complemented by post program evaluation of "key evaluation questions". This usually requires collection of data on utilisation and benefits derived from end users of the products from the science. Program evaluation can be conducted either internally or externally depending on the size and nature of the program or project and on the purpose of the evaluation. DPI's project evaluation is integrated into its project management framework and DPI offers a graduate diploma in project management to its scientists and managers.

A specific example where DPI uses program evaluation is the $50 million "Our Rural Landscape" (ORL) initiative which is part of the second generation of STI funding from 2003-2007. ORL involves both evaluation of the development and delivery processes, as well as the outcomes. In 2004, an independent evaluation was commissioned to examine the developmental phase of ORL for use in future initiative development. A reference group has been used to provide insights into the implementation of the initiative. An annual outcome monitoring tool provides reports to DIIRD along with strategic reviews of projects throughout the life of the initiative including a stakeholder forum to test the satisfaction of stakeholders with the projects.

Overview of DPI Research and Development

Established in December 2002, DPI is the lead government agency in Victoria for the sustainable development of natural resource based industries – agriculture, forestry, fisheries, minerals and petroleum[55]. DPI continues to focus on economic development, but in an environmentally and socially sustainable manner so that the needs of future generations of Victorians are not compromised.

DPI, through its research capability and capacity in its Primary Industries Research Victoria (PIRVic) Division, is the largest science based organisation in Victoria[56]. PIRVic provides strategic and applied research for Government and the state's agriculture, fisheries and environmental resource management sectors. Its science and technology focuses on improving the productivity of major Australian industries including dairy, grains, horticulture, meat, wool, fisheries and the specialised rural industries sector and the sustainability of natural resources. It is designed to address five essential needs:

- Biosecurity and health – new technologies and tools to protect Victoria's primary industries against endemic and exotic disease incursions.
- Genetics and genomics – creating innovative and globally competitive high value products, working at the cutting edge of new science.
- Sustaining resources for the future – increasing our knowledge to continue to find better ways to sustain the natural resource base of our rural industries and the rural landscape.
- Production science – developing new management practices, increasing the production and quality value from rural industries, and solving farmers' and industries' immediate problems.

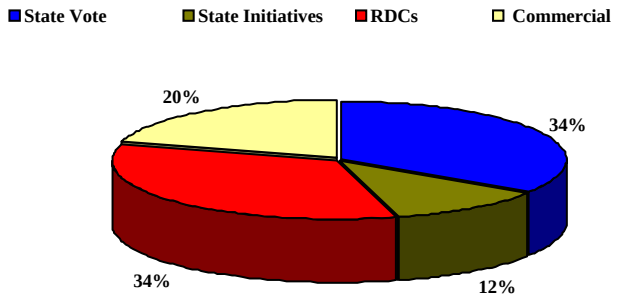
[55] The Thinking Behind our Everyday Essentials: Annual Report 2004-05, Department of Primary Industries (DPI)

[56] Achievement Report 2004-05, Primary Industries Research Victoria, Department of Primary Industries (DPI)

- Value from the rivers and sea – new knowledge and strategies to grow the opportunities for ongoing development of seafood industries, inland fishing and aquaculture, in a manner that will sustain the aquatic environment in the long term.

The research and development undertaken by PIRVic is funded through a range of sources, including State and Commonwealth Governments, Rural Industries Corporations, and a number of commercial customers. Where consistent with government policy, PIRVic provides R&D services to the commercial sector on a contractual and fee-for-service basis through its commercial agent, Agriculture Victoria Services (AVS). All services to the commercial sector recover full cost and comply with the National Competition Policy. Funding for PIRVic's output delivery for 2004/05 was $117.5 million, which included: $40 million from State Vote, $13.5 million for State Initiatives, $24m from commercial work (fee for service and contracts), and $40 million from Rural Industry Research Corporations (RDCs) and the Commonwealth (Figure 7).

Figure 7. PIRVic funding sources for 2004/05[42]



PIRVic provides a combined scientific strength of over 950 highly skilled scientific and technical staff located at 19 research centres throughout Victoria. In addition to our own staff, DPI supports over 120 postgraduate university students conducting research at our centres and co-supervised by PIRVic scientists Fifty four per cent of our scientific and technical staff are located in research centres in regional Victoria giving them first hand knowledge of the issues affecting regional communities. Recently, as part of its Growing Victoria Strategy, the Victorian Government completed its $50 million modernisation of major office and research facilities at Horsham, Mildura, Tatura, Rutherglen, Bendigo and Ellinbank. The investment also supported establishing new glasshouses with containment facilities, a world leading greenhouse research facility in the form of whole cow calorimeters and a "super computer" for bioinformatics and landscape modelling.

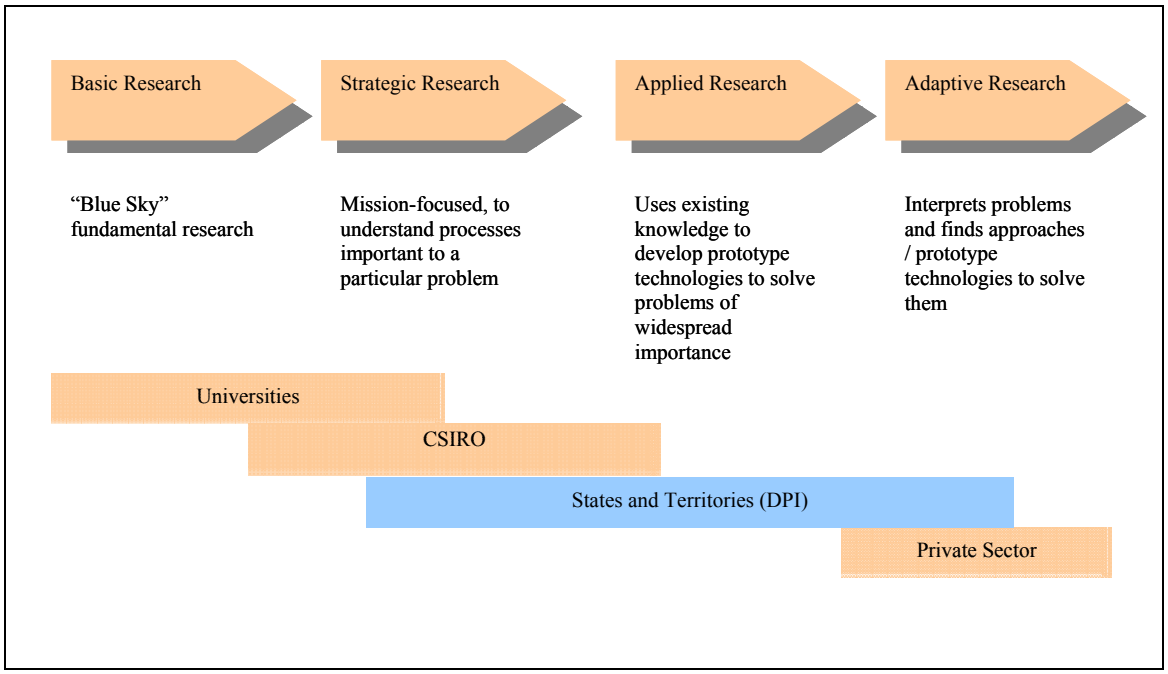
PIRVic operates 10 discrete research areas known as science capability platforms across the State:

- Plant Genetics and Genomics;
- Plant Production Sciences;
- Plant Health Sciences;
- Animal Production Sciences;
- Animal Health Sciences;
- Animal Genetics and Genomics;
- Soil and Water Sciences;
- Marine and Freshwater Systems;
- Environmental Health and Chemistry; and
- Landscape Systems

Overview of DPI in the Science and Innovation System

In Australia, the States and Territories undertake approximately 50 per cent of the research and development in Agriculture. The rest is undertaken by the Commonwealth (20 per cent), the higher education sector, predominantly universities (19 per cent), and private companies (9 per cent)[34]. However, only 2 per cent of the Australian Government total investment in R&D goes to the States and Territories[57]. A very simplified model of the research and development pipeline (Figure 8) describes generically where each of the research agencies is positioned in the system. The overlap illustrated in the system is intended to represent that the boundaries between the different types of research in reality are not strict, there is now greater collaboration between organisations through vehicles such as CRCs and Centres of Excellence, and organisations may extend their breadth across the pipeline in specific areas where they have a major focus.

Figure 8. Simplified representation of where DPI is positioned in the Australian Science and Innovation System

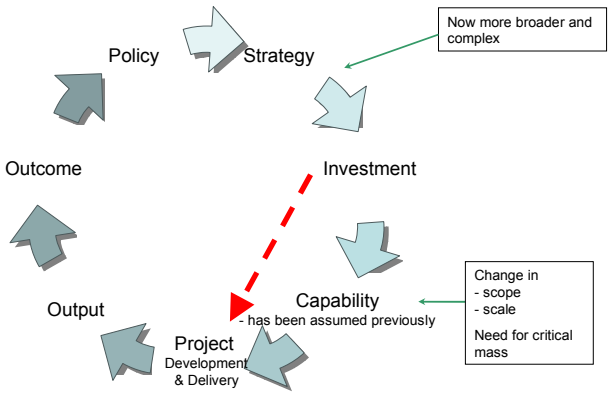


States and Territories agencies such as DPI are traditionally well known for applied research and extension activities, particularly in regional Australia where results are widely adopted by the farming and fishing industries. Farm businesses collectively invest directly in applied research through their industry levy contributions to RDCs, and direct contract research from agencies such as state government research organisations and CSIRO. DPI believes that the RDCs have been a critical component in the system supporting applied research to guide investment in science and innovation that delivers solutions that meet industries needs. However, the "spot" buying of projects by RDCs has presented challenges for State R&D providers in maintaining capability. There has been an assumption that this capability is always readily available. As illustrated in Figure 9, determining if there is the capability available or it needs to be developed to deliver on strategy is now a key step in

[57] Backing Australia's Ability – Building Our Future through Science and Innovation, Department of Education, Science and Training (DEST) 2001

the business model of agencies. Industry needs to recognise it also has a role in investing in capability.

Figure 9. Research, Development and Extension (RD&E) Strategic Development and Delivery Model



In recent times, as a result of greater adherence by agencies to the beneficiary pays principle and more players from the private sector able to fulfil the role, DPI has been undertaking less work in the adaptive research area. This is a deliberate strategy to avoid "crowding out" of prospective private sector participants in R,D&E. Companies in the private sector conduct some R&D, mainly adaptive research where the costs are lower and the pay-off is more immediate. Some applied research is also conducted where businesses see clear commercial benefit. In addition, governments are now stricter on requiring industry co-investment where R, D & E projects have strong industry benefits as well as public benefits, especially in the area of extension, which RDCs have traditionally seen as the governments' funding responsibility. Progress is being made in discussing appropriate funding arrangements with some of the RDCs. DPI employs a beneficiary-funder policy where it will:

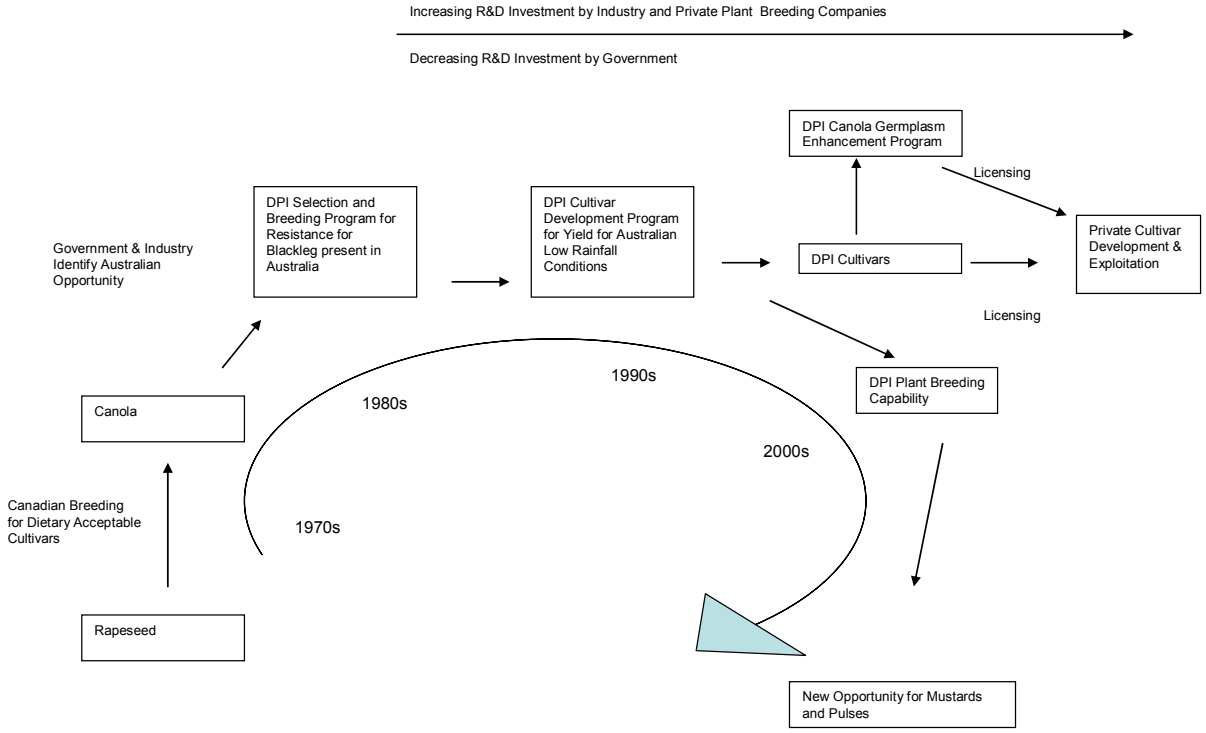
- Invest 100 per cent in projects if there is market failure and projects will have solely public benefit;
- Invest jointly with industry where there is partial market failure and both public and industry benefit; or
- Not invest if there is no market failure and the benefit is solely private.

A national agreement on a beneficiary and funding policy would reduce disputes between the parties that often result in projects being delayed or not going ahead.

A good example of adherence to this approach is the Department's policy and principles for investment in plant breeding programs. DPI uses a "market failure" framework to identify those situations where the private sector is unable or unwilling to invest. Generally, it has been determined there is a role of government in aspects of the early stages of the plant breeding continuum, namely technology discovery and development, and germplasm development. In the later stages of cultivar development and variety exploitation (i.e. marketing and grower adoption) there is less of a government role, unless there is no clear path to market. DPI will normally follow an open "expression of interest" process and licensing arrangements to establish the route to market of its investment[58]. Figure 10 shows a brief history of how the DPI breeding program for canola has evolved.

[58] Plant Breeding: Policies and Principles for Investment, Agriculture Division, Department of Primary Industries (DPI) February 2005

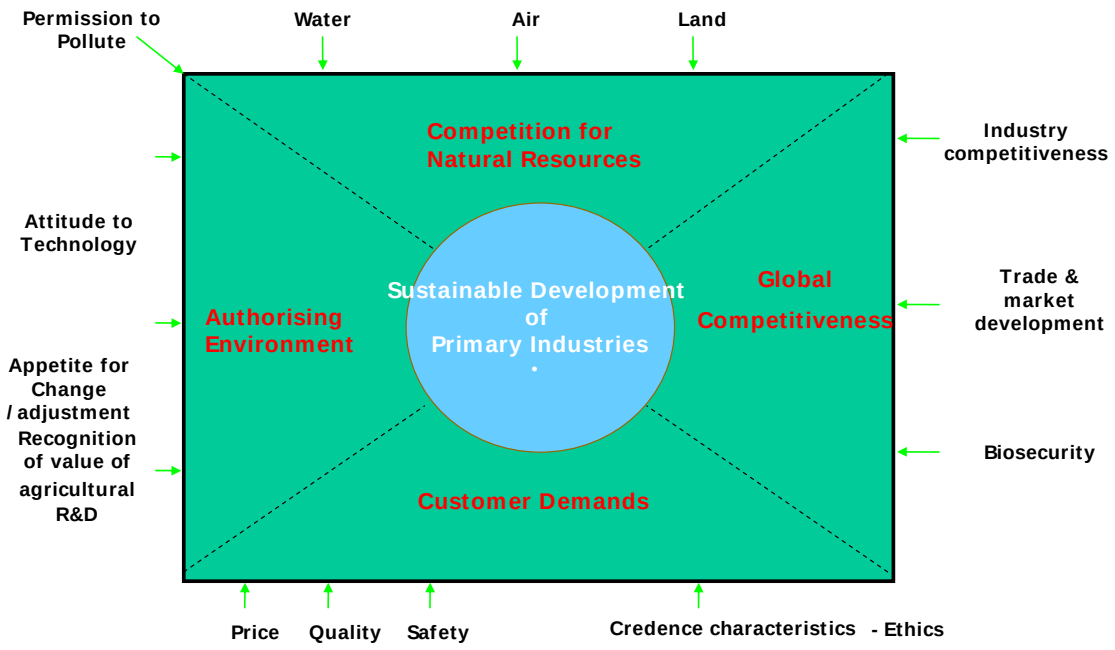
Figure 10. History of RD&E investment in DPI Canola Breeding Program



At the same time, DPI has also been gradually increasing the level of strategic research that it undertakes. The Victorian Government's Science Technology and Innovation initiative to support the competitiveness of the State's major and emerging industries has been a major driver of this. Biotechnology is seen as a one such key area of science which will generate economic and environmental benefits to future economies. Recent examples of DPI work in this area has been the use of biome sequencing for development of DNA tools for soil health, isolation of a freezing tolerance gene in Antarctic hairgrass and the discovery of an antimicrobial protein in Tammar wallaby milk.

In addition to supporting research to enhance productivity, state Government research organisations also increasingly need to undertake research into social issues, environment and natural research management issues such as salinity, nutrients, water and climate change related to primary industry research. Research on environment and social issues are often solely funded by Government. The key factors influencing sustainable development of primary industries are illustrated in Figure 11. For the majority of these factors there is a role for government and also a corresponding RD&E requirement.

Figure 11. Key factors affecting sustainable development of primary industries.



Science now needs to address the total value chain system, not just agricultural production systems and there is an increasing emphasis on food health and nutrition. For example, research has been initiated on increasing selenium in milk for Asian markets. Biosecurity has also emerged as a major role for government in protecting industries and also managing public health risks, with States and Territories having a major legislative responsibility. It is important to gain a better understanding and detection capability of animal and plant pest and disease that could threaten export market access.

Scientific organisations are therefore faced with the challenge of an expanded mission agenda for R&D as well as needing to have critical mass in capability to be competitive and relevant in the global scientific environment. In the past, the RDC funding decisions and the States and Territories have perpetuated a dilution of capability across Australia. The States and Territories have recognised that this is not sustainable and that they need greater coordination of capability to be more efficient and effective in their science and innovation. This is a strategy that needs to be undertaken in consultation with the RDCs. The Primary Industries Standing Committee of the Primary Industries Ministerial Council is driving a national consolidation of RD&E. A discussion paper on this issue was released for public consultation in June 2005, which lists some of the issues in the RD&E environment and outlines a concept of national research and regional development and extension. In this, States and Territories will jointly determine which jurisdictions will focus in which areas of strategic R&D, depending on existing scientific and industry strengths, while retaining some applied research capacity to test research under regional

conditions[59]. For example, Victoria is a leader in genetics and genomics for animals and temperate plants for the dairy industry.

This has precipitated closer working relationships between the States and Territories research agencies with their Commonwealth-funded counterparts, i.e. the CSIRO and the universities. The South Australia Waite Institute model, the recently established Tasmania Institute of Agricultural Research and the emerging collaborative models in Western Australia and Queensland linking states research agencies with universities typify this direction.

DPI already has strong links with universities, for example the Victoria AgriBioSciences Centre at La Trobe University and CSIRO through the Food Science Australia collaboration. DPI is moving even further in this direction with the planned consolidation of its metropolitan research capacity in the proposed National Biosecurity Centre at La Trobe University and its intention is to work more closely with CSIRO's Australian Animal Health Laboratory and AQIS. One barrier to a strategic approach of closer collaboration is the different approaches to costing by different organisations and the degree of compliance to national competition policy. An agreed national costing model would reduce the amount of "gaming" that occurs and the resulting inefficiencies.

The Department applauds the attempts by the Commonwealth Government for better national coordination of the science effort through the National Research Priorities and programs such as the National Collaborative Research Infrastructure Strategy (NCRIS). For these programs to be truly national and successfully implemented, the State and Territories need to be engaged in real consultation, have influence in setting the agenda and be supported by access to funding. The National Research Priorities also need to have second order objectives established for them to become more relevant to the States and Territories[46.] It could be beneficial to have a single strategy for the primary industries sector that feeds into the National Research Priorities. The states and territories have also been excluded from access to many of the other "Backing Australia's Ability" (BAA) programs thus impeding a truly national science agenda. Although in its early stages, the NCRIS process has a great opportunity to drive further coordination of research both across and within Commonwealth and State/Territory agencies and could represent the typical approach in the future.

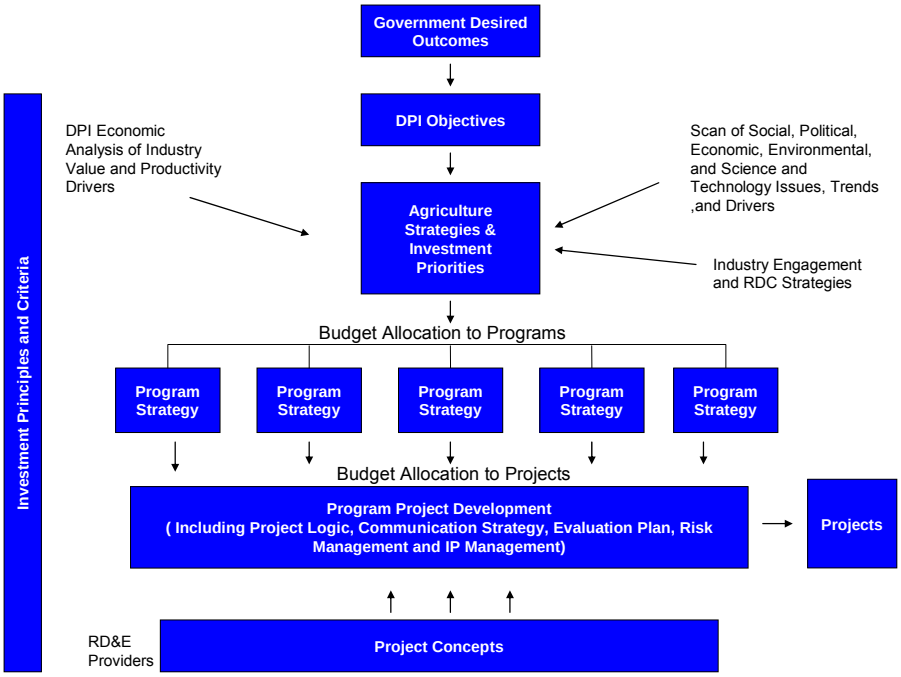
The Value of DPI Science and Innovation

Agriculture, Forestry and Fisheries

The value of DPI science and innovation is underpinned by informed investment decisions based on sound strategy development and rigorous program and project development, planning, management, reporting and evaluation processes. A simplified diagram of the investment framework is provided (Figure 12). DPI operates a purchaser-provider model for its Agriculture program which utilises a "top down" program development and "bottom up" project development approach.

[59] Securing the Future for Australia's Primary Industries: Development of a National Research, Development and Extension (RD&E) Framework, Discussion Paper, Department of Agriculture Fisheries and Forestry (DAFF) June 2005

Figure 12. DPI Investment Framework



The Victorian Government desired policies and desired outcomes and in turn DPI objectives are the overarching basis of the development of the Agriculture strategies, investment priorities and programs strategies. The priorities and program development of funding to programs are informed by a number of key factors. For example DPI conducts econometric analysis of the gross value of annual production of industries in the state, and the productivity drivers of those industries. Additionally, DPI conducts scans of the global, political, environmental and social issues, drivers and trends that are important in meeting triple bottom line outcomes required by Government. DPI also engages with industry in understanding how their and government priorities are aligned and the opportunities for joint investment. These factors also guide the allocation of funding between programs. Allocation between programs is a dynamic process which changes as new strategic initiatives are announced by government, programs and projects start and finish and are reviewed, and opportunities arise for joint investment with external funding /industry bodies.

Each of the programs develops projects jointly with the RD &E providers which captures innovative project concepts from the scientists, as well ensuring there is the capability and capacity to deliver the projects. An additional factor included in the investment decision on projects is the track record of the project RD&E group. The projects developed include an evaluation plan, communication strategy, risk management and route to market. The whole investment decision making process is overlaid by the investment principles and criteria.

The Department's Economics & Policy Research Branch has conducted research on the drivers of productivity (wool[60] and grains[61] industries) to ensure the science has greatest

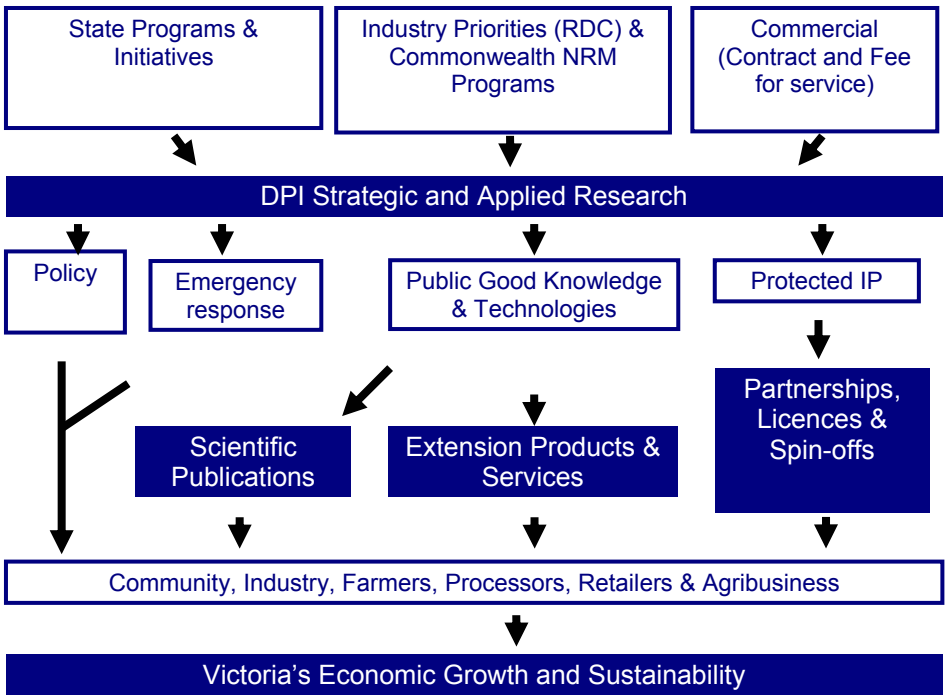
[60] Duke, C., Hanrahan, P., and O'Neill, T. (2002) "Technology Adoption and Victorian Wool Producers 1999/2000" Economics Branch Working Paper, Department of Primary Industries (DPI)

61 Pakula, B, Fisher, W. and O'Neill, T. (2004) "Management Practices and Productivity: Victorian Grain Growers 2000/01", Economics Branch Working Paper, Department of Primary Industries (DPI)

value and impact. Both the wool and grains studies involved the use of Supplementary Surveys as part of ABARE's annual farm surveys program. In the case of wool, the research found that participation in the extension program Triple P had the largest impact followed by stocking rate. Also, finance for changes on farm, information, and pasture establishment & maintenance are important for increasing stocking rate, which feeds into productivity. In the case of grains, it was found that agribusiness advisers (as a source of advice for new crops and weed control) had a positive association with productivity, as did farm size, and the storage of grain as part of a marketing strategy. The wool industry has continued this type of research since the initial work was completed. ABARE has undertaken similar work to that done by DPI with the Grains Research & Development Corporation.

One of the major competitive advantages of State and Territory agencies' Science and Innovation capability has been in the impact that their R&D delivers to the industry and community. They have R&D capability in both strategic and applied science and also are close to the market. They generally have strong links with industry through agribusinesses and processors, farmer peak bodies, direct access to farmers through the regional extension network, as well as community links through Catchment Management Authorities and local government. The rate and extent of adoption is a key determinant in the effectiveness of agricultural innovation[34] and the states and territories have the capacity to actively facilitate adoption. State and Territory RD&E has both a broader and shorter investment pipeline for science and innovation; broader with more outlets for uptake of research and shorter because products can be developed quickly for markets. Figure 13 shows a simplified diagram of the science and innovation system for DPI.

Figure 13. The DPI Science and Innovation Pipeline



In Victoria, DPI's extension arm "Catchment and Agricultural Services" (CAS) has the responsibility for delivering the outputs from R&D consistent with role of government principles. CAS provides a broad range of technical and support services to help Victoria's agricultural producers develop their businesses, along the whole marketing chain. CAS is responsible for delivering cost-effective, independent, and accessible advisory and regulatory services in sustainable land and water management, management of pest animals and pest plants, agricultural industry development and biosecurity and emergency management, including relevant compliance and enforcement activities. CAS has more than 700 staff across the state that live in the communities they service. This includes a strong science base of industry veterinarians, plant pathologists and agricultural scientists that underpins policy development and program implementation of Victoria's biosecurity program.

CAS delivers industry-wide projects such as Bestwool 2010, Topcrop, EDGEnetwork, Target 10, and the Victorian Agribusiness Networks (VAN) Program[62]. These programs often provide integrated productivity improvements as well as sustainability outcomes. Additionally, CAS has responsibility for delivering "FarmBis", a joint Commonwealth and Victorian Government initiative which enhances the business skills of farmers. In 2004 CAS delivered industry development programs to over 750 groups, many of which were customised to address the challenges of surviving and thriving during the drought. CAS also undertakes social research into rural and urban communities to understand drivers of change and barriers to adoption to accelerate uptake of improved technologies.

CAS delivers world class extension programs that provide training and skill development predominantly through a programmed learning approach to encourage farmers to use new technologies and to target specific practice change. The group facilitation/empowerment model is used to help industry and farmers understand, anticipate and respond to changing market signals and risks. Group based delivery is still the main method of delivery, although the personalised consultant model is used in emergency responses. Regulation and incentives are increasingly being used in natural resource management issues. The on-ground extension activities are supported by networks established with industry and community groups, newsletters and development of technical information packages.

Some industry benefit R&D and other commercially valuable intellectual property (IP) is most effectively utilised by arrangements with commercial entities (eg a licence to a seed company) who provide the route to market. Agriculture Victoria Services Pty Ltd (AVS) is the legal entity acting as agent for DPI, through which IP is protected and commercialised. AVS also acts for DPI by entering into contracts with collaborative partners and commercial customers where there is no state investment. Such work includes contract research, fee-for-service, product commercialisation, and occasionally outright sale of technology or the formation of a spin-off company[56].

AVS maintains a portfolio of IP including patents, trade marks and plant breeder's rights and remains one of the top Australian-owned companies for patent applications. In the past year, nine patents, three trade marks and eight plant breeder's rights have been filed. Patent applications cover various technologies including enhancement of the performance of perennial grasses, methods of producing value added colostrum, apparatus for measuring

62 Catchment and Agriculture Services: Victoria's Leading Rural Service Provider, Services Brochure, Department of Primary Industries (DPI)

plant material and the development of specific plant proteins. New animal patents have been in the areas of milk composition bioactives and pasture management[56].

As well as the delivering outputs to industry and the community, DPI believes in publicising findings from programs in the scientific community through journal papers, conference papers etc. PIRVic produces over 300 scientific papers per year in peer reviewed journals and technical publications. The provision of this freely available knowledge in a range of forums improves the knowledge foundation for future productivity improvements.

The R&D capability and capacity is also important in providing science to underpin evidence based policy in specific issues. For example, science has been important in gaining an understanding of agriculture's greenhouse gas emissions which will inform abatement strategies. Additionally, the R&D resources can be mobilised to provide capacity to address serious climatic and biosecurity emergency responses that threaten industries and markets.

Concrete examples where DPI's research, development and extension capacity and capability have clearly demonstrated impact on economic productivity as well as the sustainability of agriculture industries are provided in the following case studies.

Growth in the canola industry through new disease resistant varieties

Australia's thriving canola industry owes much of its success to DPI scientists. The potential for Australia to produce and export canola was originally recognised in the 1970s and DPI established the first public R&D breeding program at Horsham. However, initial attempts were thwarted until DPI scientists developed high-yielding varieties resistant to a serious fungal disease called 'blackleg'. In just 10 years, the industry grew from almost nothing to one producing 2.36 million tonnes, with exports worth more than $700 million pa. The development of newer forms of herbicide tolerant varieties and specialty oil types could lead to further increases in area sown.

Reducing the cost of disease incursions

DPI is applying its molecular science capability to more accurately and quickly diagnose a range of important crop and livestock diseases. DPI developed a new molecular diagnostic test for Newcastle Disease of Poultry which was applied at the onset of an outbreak in Meredith, Victoria in 2002. The new test reduced the time for an accurate identification of the disease from 2 weeks to 2 days. This rapid identification allowed eradication procedures to commence quickly limiting the spread of the disease and reducing the duration of trade barriers. The cost of eradication of the Meredith outbreak was $2 million. A similar outbreak the year before in NSW, where diagnosis of virulence had taken several weeks, resulted in an eradication cost of almost $30 million

Improved grazing practices on dairy farms improves productivity

DPI research has resulted in the development of improved grazing management practices that significantly improve productivity in the dairy industry. Coupled to the dairy extension program, Target 10, these practices have resulted in an average 11 % improvement in productivity or an extra $20,000 in income each year for an average dairy farmer. Economic modelling of the impact of these improvements has estimated industry benefits of $85 million a year – a significant contribution to Victoria's largest export earner.

Growing larger, healthy lambs

DPI & MLA investment in R, D & E has underpinned a 4 % productivity gain per year since 1985 in Victoria's lamb industry, while at the same time meeting consumer demands for larger, leaner lamb. DPI has enabled lamb producers to achieve genetic gains in their flocks, to improve pasture production, flock health and management, and to meet export market requirements for heavier, leaner lambs. As a result, since 1990, Victorian lamb exports have doubled in quantity and quadrupled in value (from $60 million in 1990 to $227 million in 2002/03).

New techniques to improve water use efficiency on vineyards

DPI research has shown wine grape growers how to improve the quality of their wine using half the amount of water through innovative irrigation techniques such as Partial Rootzone Drying and Regulated Deficit Irrigation. For example, the value of red wine produced under Partial Rootzone Drying has been shown to increase by up to 90%. Furthermore, the introduction of such techniques can halve water use without affecting the quantity of grapes harvested. The adoption of such techniques will also decrease the environmental impacts of irrigation such as salinity and nutrient run-off.

Exporting Pork to Singapore

The Singapore Government had banned the import of chilled Australian pork as a result of poor shelf life in shipments. DPI applied predictive microbiology techniques to perform risk analysis of the cold chain and to identify the opportunities to double the shelf life. This enabled Australia to establish exports of 85 tonnes of pork per day to Singapore. This translated to an annual value of approximately $100 million per year from of an R&D investment of less than $400,000 by DPI & PRDC. This transformed the Australia pig industry to a viable and vigorously growing export market. It has also produced spill over benefits through export opportunities for chicken and other products.

Minerals and Petroleum

A window of opportunity now exists to significantly encourage and expand the minerals and petroleum industries to a new and greater level. For example, Victoria is capturing the attention of investors through a range of new major project announcements across the gold, mineral sands, coal, oil and gas sectors. Some $4 billion of capital investment on new developments has been committed during the period 2002-2006. In addition, the interest for new investment in this sector has been strengthened by improving commodity prices and international economic growth, particularly from China.

Victoria has a significant R&D capacity in the earth resource sector. In many areas, it is world class and can provide technology solutions to industry around the world. In some cases, significant service industry spin off has been achieved through this capability.

The types of benefits that would be expected from the public investment in R&D for the minerals and petroleum industries are:

- Highlight the potential areas where innovation and technology R&D can be applied to generate increases in productivity, improved safety, processing and export performance; and therefore increase the contribution to the economy from earth resources.
- Government leadership in promoting greater collaboration between industry, research providers and Government will lead to improved technology outcomes.
- Developing and applying new technologies can lead to the commercial development of mineral and petroleum deposits which are currently considered uneconomic. This will attract new capital investment and jobs. Greater revenue will flow to State and Territory economies and economic growth will be further improved.
- In recent years, the resources sector has made great advances in its relationships with local communities. Assessing the social impact of resource extraction near urban areas and gaining community acceptance and engagement covers common ground. These issues will continue to be most significant in the near to medium future as industry expands its activities.
- Improved environmental outcomes are likely to result, as innovation is brought to bear on the operation of mines and the rehabilitation of sites post-mineral extraction. This will assist in balancing the expansion of resource development with the need to ensure long term sustainability and environment stewardship.

Key Challenges for DPI Science and Innovation

DPI faces many challenges, common to other scientific organisations, in how it conducts its science to ensure it produces outcomes to increasingly complex economic, environmental and social issues. The science environment itself is now global, more complex and dynamic which makes science inherently more costly. Organisations need to be very strategic in their decisions and think differently about how they have traditionally operated to meet the many new challenges. DPI has identified seven key challenges for its science in the future.

Scientific Reputation

For state and territory agencies to be relevant in the future, they need to have a critical mass and capability in scientific disciplines that are most important to their industry and scientific strengths. The national consolidation of R&D will accelerate what, up to now, has been evolving very slowly. In these key areas, the depth of scientific capacity needs to be at a standard that is nationally and also internationally recognised. As discussed previously, traditionally the States' and Territories' scientific focus has been in the applied/adaptive research sphere, however, with States' and Territories' investment in science, technology and innovation initiatives they have now established expertise and reputation in leading areas of strategic research. For DPI, in the areas of plant, animal and soil genomics, the science is internationally recognised, as is evident from involvement in collaborations with highly respected overseas institutions. However, there are other key areas where the depth of scientific capacity and reputation could be raised and requires scientists from around the world to be attracted to work in Australia. This requires continued investment in core science and infrastructure to enhance our scientific reputation internationally.

Scientific Capability

Attracting and retaining highly respected senior scientists and young promising scientists, especially to regional locations, is still a major issue for States and Territories. To address this, scientists must be offered[63]:

- Competitive salary packages, including opportunities to move in and out of ventures which commercialise their research outcomes
- Career opportunities and promotion while staying in active scientific research
- Lifestyle attractions including assistance with quality housing
- Employment opportunities for partners
- Scope for travel to visit international and trans-national research networks
- Short to medium term opportunities for regular training and upskilling in other internationally recognised research institutes.

This has to be undertaken whilst minimising the rate of loss of scientists to competitors, even though it is recognised that first class research facilities serve as an ideal training environment for young scientists and a springboard for career changes and hence some scientists will inevitably leave. This works best for the State when they return some years later with new skills and experience unobtainable here.

DPI has made progress in some of these areas for senior scientists through the reorganisation of our science into ten state wide research platforms and the appointment of research directors and sub discipline leaders. DPI has also used joint appointments with universities of high quality experienced researchers to gain access to capability in key areas. However, there still needs to be investigation into the possibility of more flexible institutional arrangements for career development.

DPI has placed a strong emphasis in trying to attract young scientists through its graduate and PhD program. The graduate program involves a two year tailored training and development program exposing graduates to range of areas of the Department by rotation through selected metropolitan and regional locations. The PhD program involves either existing employees or external students undertaking PhDs jointly between DPI and their university. This has the benefit of increasing the research capacity of staff, ensuring students are exposed to industry and improving the chance of the research having a route to market. These programs however, often suffer from coming under budget scrutiny and are not adequately resourced to exploit their full benefit.

One of the other major issues in retaining scientists that has been repeatedly identified through staff employee surveys is of them being valued. This is to some degree related to job security due to the one to three year funding cycles where most scientists are responsible for securing their own funding. While this has always been a feature in the research environment, which has benefits in making sure the science is of relevance, it is perceived that it has become more time consuming and complicated. It seems a more healthy balance needs to be achieved in governance in investment of funds and security of funding. While recognising that contestability is critical in the funding system, there is need for some long-term funding to maintain core capability. This needs to be complemented with funding of larger and longer term projects to reduce inefficiencies due to bureaucratic processes and to allow scientists more time to undertake their research.

[63] Future Science Forum Discussion Paper: Looking Forward 2003, Department of Primary Industries (DPI)

Future Scientific Skills

DPI and other research organisations face the difficulty of attracting scientists in highly competitive areas related to emerging technologies and also areas of traditional and less fashionable scientific disciplines where supply is rapidly declining as senior scientists retire. The declining science education base has been well documented and is not further discussed here. Specific areas of need for DPI are highlighted below[64]:

- cell biology (including immunology), veterinary microbiology and pathology, plant disease (epidemiology, taxonomy, bacteriology virology, entomology) for biosecurity research;
- general biometrics and bioinformatics, quantitative genetics, e-science and metabolomics for molecular sciences research;
- water sciences, climate variability, environmental indicator sciences and soil microbiology for environmental sciences research;
- enabling technologies: systems modelling, spatial sciences and visualisation, synchrotron sciences, and small scale technologies (micro-technology and remote sensing);
- 3 / 4 D modelling, fluid flow modelling and general GIS in earth sciences; and
- mining and petroleum engineers and geologists and econometric geologists.

Scientists now are not only requiring the in-depth technical knowledge in particular disciplines, but also needing generalist knowledge in related scientific disciplines. In addition, scientists of the future will require competency in "soft skills" in the following areas:

- the ability to work in a multi-disciplinary science team;
- problem solving and project management skills;
- science communication skills;
- enterprise and business awareness; and
- industry and policy awareness.

Future Technologies

Many of the skill requirements in the future will relate to the new technologies and science fields which are emerging world-wide. However, such skills are not being developed initially or primarily for R&D outcomes in the primary industries sector, although many of these will have important applications in this sector. Early generation applications are generally first servicing the medical and pharmaceutical, defence and manufacturing sectors however, once applications of these technologies are introduced, there is often a rapid spilling of knowledge through other industry sectors. The challenge for primary industries and DPI is to have the technical ability and resources to identify and develop the opportunities and access intellectual property to exploit the benefits. DPI has identified the following seven key emerging technologies that could present opportunities for primary industries and DPI science[65]:

- Synchrotron sciences for: protein/structural proteomics/metabolomics, process optimisation, animal and plant imaging and determination of soil and mineral composition;

[64] Response to Case Study of Industry Demand for Science Engineering and Technology Research Skills, Department of Primary Industries (DPI), September 2005

[65] Future Science Forum Proceedings 2004, Department of Primary Industries (DPI)

- Microtechnology for: environmental sensing, animal production, health and welfare monitoring, plant health monitoring, quality control assurance and bio-security, precision farming and safe and efficient mining operations;
- Nanotechnology for: biodegradation of environmental contaminants, bio-reactive surfaces for plant and animal disease diagnostics, bio-sensors for health and productivity and production of new fibres and materials;
- Biotechnology for: animal, fish and plant production, food for health and lifestyle outcomes, enhancing bio-diversity, bio-remediation and utilisation of wastes and energy and fuels harvesting/production;
- Information and Communication technologies including e-science to improve utilisation and exchange of data, information and knowledge;
- Natural resource base /system modelling and management for understanding landscape processes and ecosystem function to better utilise resources and minimise degradation; and
- Airborne gravity geophysics, hyper-spectral logging of cores, electromagnetic geophysics and fluid flow modelling software for development of minerals and petroleum industries.

Building Trans-national and International Partnerships

In addition to building its own science capabilities, Victoria and DPI have recognised the need to establish strategic partnerships with public and private sector bodies not only in Australia but overseas so that critical mass is achieved in priority areas. This provides access to key technologies and techniques (not currently available or accessible here) and critically to access the 98 per cent of knowledge that is generated outside Australia. Collaborations also often will produce multidisciplinary and interdisciplinary science which will produce holistic solutions to increasing complex issues.

The importance of collaboration is well recognised but there are several challenges that have emerged. Collaborations involve significant development and on-going management and operating costs. There are a plethora of potential opportunities, especially at the international level, so strategic decisions need to be made on which ones to enter. The difficulty lies in identifying these opportunities, evaluating where the greatest alignment is, and then realising the benefit. Attendance at international conferences and international exchange of scientists is still one the best ways to establish relationships in specific areas of science. However, breaking into major international collaborative arrangements such as the European Framework[51] is often difficult for single organisations in Australia because of the size of effort and co-funding contribution required. There could be an opportunity for a more coordinated approach at the national level in accessing these networks in specific areas of strength.

From a more local perspective, where partnerships involve co-location, this can provide efficiencies in sharing laboratories, equipment and supporting technology and infrastructure. Where the greatest potential benefit could lie at inter-disciplinary research sites is in collaboration, but co-location does not guarantee that scientists will actually interact and share data. There are often cultural barriers that have to be overcome by organisations which require a joint commitment to recognising and addressing. The issues often revolve around clearly defining domains of research, intellectual property, differing employment condition, access to laboratories and equipment and attribution and recognition of scientific outputs.

Intellectual Property (IP), in particular, is emerging as a key issue as collaboration becomes important. While protecting IP has resulted in significant examples of commercialisation of R&D through partnerships with the private sector, there is concern that it is a barrier to collaboration and therefore more broadly having an impact on innovation. This is especially the case in dealing with IP rigid organisations which can result in delays in joint research projects and sometimes prevents collaborative research. There may need to be a more liberal and standardised approach to intellectual property management.

Commercialisation of Research

In recent years, major advancements have been made in identifying and protecting intellectual property. While there have been a number of success stories in exploitation, there is still room for improvement in this area. There have been a plethora of spin off and start-up companies established, but they often struggle due to the high proportion of management costs incurred and difficulty of attracting venture capital[53], especially when public support ceases. There exist opportunities to source funds from the "superannuation industry", which is expanding under the current favourable taxation conditions. Another opportunity for enhancing commercialisation rate could exist where researchers have a continued involvement and stake in the exploitation phase. This requires exploration of the possibility of more flexible employment conditions and arrangements for scientists while being mindful of conflict of interest considerations.

Communication of the Value of Science

One of the other major challenges is communication of the benefits of science to the community. Large sections of the community are more circumspect about science and scientific organisations due to recent controversial technologies. It is often difficult for the community to understand complex technologies and there are concerns that they may be misused. It is now recognised that science will need to better engage with the community and listen to, respect and respond to their concerns so we are authorised to explore and develop the opportunities from these technologies. There are opportunities to relate the benefits of science to the day to day aspects of people's lives and for individual scientists to be publicised and given more opportunities to interact directly with community groups[53].

DPI promotes the value of its science by building communication and evaluation strategies into their projects and programs. These are often targeted to industry and direct end users of the science and the broader community is of less focus unless there is a major breakthrough. There is an opportunity for the whole scientific community to better promote the generic value of science and the rewards of a career in science. We need a more coordinated national effort in making sure society values science and that the next generation of scientists are nurtured.

Conclusion

Primary industries make a significant contribution to the Australian and Victorian economies in terms of exports, providing input into the manufacturing sector, employment in regional areas, clean green food for consumers and sustainable natural resource management. The primary industries sector is innovative with productivity growth achieved of 2.6 per cent per year, approximately twice the national average.

Application of innovation has been the major contributor to enabling primary industries to achieve productivity increases at rates above other sectors in the Australian economy and delivering a good return on investment. Government investment in research, development and extension (R,D&E) delivers triple bottom line benefits to the community and industry benefits where there is market failure.

Additionally, biosecurity threats through greater global trade and travel between countries means we need better knowledge of, and detection capabilities for, animal and plant pests and diseases to protect these export dependant industries. Increasingly, "proof of freedom" from pest and disease is becoming a requirement to maintain access to markets.

Key Point 1
Retain and increase public investment in science and innovation in primary industries for long term growth of the agriculture and food sector through the development of new technologies and farming systems that will enable more efficient and sustainable use of resources for the benefit of all Australians, especially regional communities.

The State and Territory government departments carry out approximately half the research and development for the primary industries sector in Australia. They also have extension capability to ensure that the public knowledge and technologies generated are adopted by industry and the community. States and Territories undertake a large proportion of their R&D through joint investment with Rural Industries Research and Development Corporations (RDCs). Evaluation of RDCs research and development have shown benefit costs ratios of 5 to 10 in many programs, and even much higher in specific projects. States and Territories' closeness to market has enabled the research and development funded by RDCs to be adopted, which is critical in delivering impact.

In recent times, the States and Territories have been undertaking a greater proportion of strategic research and less applied or adaptive research. There has been a deliberate strategy driven by tighter "role of government" investment criteria in areas of R&D that have a commercial value in the market place. These areas of adaptive and applied research are being transferred to the private sector where they have been willing and able to progress the research through to the market. Additionally, State and Territory governments have recognised the importance of science and innovation, especially the enabling technologies in strategic research areas, in improving the productivity of their economies. It is now recognised that research providers need strategic and applied capability as well as the ability to commercialise.

The States and Territories have also recognised the need to take a collaborative approach with universities and the CSIRO rather than to compete with them, and therefore duplicate resources and capabilities. Many of the States and Territories have, or are in the process of, co-locating research facilities, primarily with universities, or developing joint ventures. This is an evolving process with institutional and cultural barriers progressively being overcome.

The current R&D funding model of a competitive, market based system has led to a distributed capability across Australia. This, combined with the broadening mission agenda has diluted capability so much that a more strategic approach is required. Through the Primary Industries Standing Committee, States and Territories are progressing national consolidation of strategic R&D capabilities while still retaining regional applied research

capabilities. Building critical mass in capability is critical for a more efficient and effective innovation system. This means agencies will need to focus effort into their core capability and relinquish periphery areas to their counterparts.

The "spot" buying of projects by RDCs has presented challenges for State R&D providers in maintaining this core capability. Industry is coming to recognise the benefits of R, D & E. Both government and industry should have a joint role in funding R, D & E capability. Identifying capability, as well as developing the underlying funding arrangements (eg national costing model and national funder-beneficiary policy) will require cooperation between the parties. The National Collaborative Research Infrastructure Strategy (NCRIS) provides a recent example that has involved consultation between the States and Territories and the Commonwealth on capability requirements. It provides an opportunity to drive further coordination of research both across and within Commonwealth and State and Territory agencies and could represent the typical approach in the future.

Key Point 2
A 'national strategic model' for primary industries is required to identify the broad strategic areas for investment, to evaluate current and future national capability requirements, establish a nationally agreed project costing model and an agreed national beneficiaries – funders policy

Key Point 3
That industry, jointly with government has a role in assessing and supporting modern and future R, D & E capability needs.

Key Point 4
A strategic approach, such as the NCRIS consultative process, is used to engage the States and Territories in implementation of Commonwealth initiatives to facilitate greater collaboration between the Commonwealth and State and Territory agencies

The National Research Priorities have provided a focus at the Commonwealth level for science and innovation but the extent of recognition of these at the State and Territory level in the past is suspected to be minimal. For there to be truly national and not just Commonwealth priorities, there needs to be "lower level" sub priorities developed in greater consultation with the States and Territories. This needs to be supported with access to funding streams that facilitate adoption of these priorities. For there to be a truly national science agenda, States and Territories need to be included in Commonwealth science and innovation programs such as the "Backing Australia's Ability" programs. While recognising organisations need some funding security for maintaining core capability, restricting States and Territories from contesting Commonwealth "initiative funding" will reduce competition and create inefficiencies in Australia's innovation system.

Key Point 5
That the States and Territories are included in the further development of the National Research Priorities and that States and Territories have access to Commonwealth science and innovation initiative funding initiatives to increase competitiveness in the science and innovation system.

From a mineral and petroleum perspective, there is window of opportunity now to significantly encourage and expand the minerals and petroleum industries to a new and greater level. For example, Victoria is capturing the attention of investors through a range of new major project announcements across the gold, mineral sands, coal, oil and gas sectors. Some $4 billion of capital investment on new developments has now been committed during the period 2002-2006. In addition, the interest for new investment in this sector has been strengthened by improving commodity prices and international economic growth, particularly from China. Historically there has been a lack of confidence by both industry and Government in allocating targeted funding to research and development in this sector, possibly due to the lack of sufficient knowledge of innovation potential within the State.

Key Point 6
That opportunities for public investment in science and innovation in the petroleum and minerals sector are explored.

The States and Territories agencies face the challenge of a broadening mission to meet the "triple bottom line' objectives of government and having national and world class capability in core areas. Like other agencies in Australia there are issues surrounding recruitment and retainment of this capability. Australia needs to provide the facilities, financial security and incentives, and working environment to make it attractive to overseas scientists, our own scientists and our future potential scientists. This includes scientists having the opportunity to build national and trans-national collaborations to access the knowledge, skills, facilities and expertise, especially in areas of emerging technologies.

Key Point 7
That there is a coordinated approach to identifying future human capability requirements and an environment is provided to attract, retain and develop the capability.

Efficiency and effectiveness of R,D&E is a function of good investment, project development and management, and evaluation processes. These help ensure the science is targeted at policy priorities, roles of government and industry are assessed, and an effective theory of action is developed, which improves the chance of success and addresses controllable risks. The products of evaluation provide quantitative and qualitative assessments that describe the return on investment. A range of performance indicators are necessary, not just benefit-cost ratios, particularly to measure the "triple bottom line" outcomes desired by government and the community.

Key Point 8
A national approach is needed to "process improvement" in the R, D&E system and a more holistic approach is required to measure the economic, environmental and social benefits of R,D&E.

2.3 DEPARTMENT OF HUMAN SERVICES

The Department Human Services undertakes a wide range of activities with links to science and innovation, most of these are embedded in service delivery or other operational programs and are not identifiable as discrete programs that directly support science and innovation. However, five key areas of support for science and innovation within the Department can be highlighted.

1. Victorian Cancer Agency

The Victorian Government has committed $15 million over two years for the establishment of a new Victorian Cancer Agency (VCA), as part of the *Healthy Futures: Life Sciences Statement* (announced by the Victorian Government in April 2006).

The VCA is a core component of the Ministerial Taskforce for Cancer's vision to align and connect cancer research and treatment through building collaborative research networks, increasing capacity for translational research and clinical trials, coordinating the cancer research effort and supporting shared platform technologies such as the Victorian Cancer Research Tissue Bank and the new Australian Cancer Grid (also announced in *Healthy Futures*).

The objectives of the VCA are to:

- Determine strategic direction and priorities for cancer research;
- Strengthen the links between cancer research and clinical service delivery by developing partnerships between cancer research organisations, academic institutions and cancer services to form collaborative research networks;
- Build research capacity and capability through joint clinician/research positions and cancer research scholarships and fellowship; and
- Support clinical trials including building capacity for trials in metropolitan and regional Victoria.

2. Victorian Breast Cancer Research Consortium

Commencing in 1997, funding of $3 million per annum over a ten year timeframe has been provided for breast cancer research through the Victorian Breast Cancer Research Consortium.

3. Public Health Research

The Public Health Branch within the Rural & Regional Health & Aged Care Division of the Department plays a significant role in supporting public health research in Victoria. As well as commissioning and using research, it has a leadership role in monitoring ethical standards for research, securing and allocating research funds and ensuring human and physical research capacity exists in the State. The Public Health research program is a priority driven program of strategic research that contributes directly to population health

policy and evidence-based health care within an equity framework and seeks to address new and emerging risks. Over $2 million is provided annually for public health research.

Key programs include:

- Funding of a broad range of public health research projects in State health priority areas. For example, projects funded in 2005-06 have addressed diverse issues such as:
  - Assessing the prevalence of type 2 diabetes and depression in Victoria and identifying effective public health interventions;
  - Disclosure of genetic information to those at risk of familial cancer – a randomised controlled trial and evaluation of two methods of assisting families;
  - Improving access to Hepatitis C treatment services for disadvantaged groups;
  - The effectiveness of biocides in the control of amoebae in cooling towers.
- Capacity building support for public health research within Victoria
- Funding Masters/Doctoral Scholarships in Public Health to assist Indigenous Australians to undertake coursework/research studies that have a major public health focus;
- Support for the establishment of health-related Cooperative Research Centres (CRCs) in Victoria; and
- Support for the ethical review of research involving humans by providing the Secretariat to the DHS Human Research Ethics Committee.

Following a review of the Public Health research program in 2005, the new Public Health Research Policy Statement – 'New knowledge for improved health' was announced by the Minister for Health in November 2005. A copy of the policy document is at Appendix 4. outlines the applied nature of the research support for 2005–2009.

4. Streamlining Multi-Site Clinical Trials

At present, research studies conducted jointly by more than one organisation (known as 'multi-site trials' face a slow and complex ethical review and approval process, involving several Human Research Ethics Committees (HRECs). As part of the Victorian Government's Life Sciences Statement, $250,000 has been provided to streamline ethical review processes in 2006-07 through the establishment of central HRECs that will review multi-site clinical trials on behalf of organisations intending to participate in these trials.

The implementation of the new system will make Victoria a more attractive location for clinical trials and assist earlier access to new and experimental treatments for Victorians. The aim is for the practical benefits of medical research to make their way into the community more quickly, while still ensuring a high standard of safety, ethics and consumer protection.

5. *Hospital Admission Risk Program – Chronic Disease Management (HARP-CDM)*

Since 2001, the Victorian Government has invested over $200 million in the Hospital Admission Risk Program (HARP). From November 2001 to June 2005, HARP projects proposing innovative models were implemented throughout major metropolitan and regional health services. This was part of the Hospital Demand Management Strategy (HDMS), which aimed to reduce avoidable hospital utilisation.

An independent evaluation of HARP aimed to determine whether avoidable hospital utilisation had been reduced and to identify models of care and interventions that contributed to such reductions. In general, the evaluation has found that HARP patients experienced:

- Up to 46 per cent fewer emergency department attendances;
- Up to 59 per cent fewer emergency admissions; and
- Up to 50 per cent fewer days in hospital.

In summary, HARP had a positive overall impact upon the level of hospital utilisation in Victoria. The reduced need for hospital services was equivalent to approximately one emergency department attendance, two emergency admissions, and six days spent in hospital each year for every HARP patient.

As a consequence of the successful outcomes of this program, the Department has commenced the process of mainstreaming chronic disease management initiatives developed through HARP across the Victorian health service system over the 2005-06 financial year.

HARP-CDM services are being implemented at 21 Health Services across Victoria. In 2005-06 the Victorian Government has invested $47 million in HARP-CDM, which includes $11 million growth.

In 2006-07, the Victorian Government will provide an additional $2.5 million in funding to expand the six new services established during 2005-06 and to broaden the focus of HARP-CDM services to include the management of people with diabetes.

A case study follows as an example:

We've spent billions training our doctors and nurses. Now we're training our patients.

Victoria has one of the best health systems in the world.

But it's complex. Thousands of doctors, nurses, care givers and administrators keep an intricate network of hospitals, medical centres and emergency departments running at the highest possible level.

Our health system is highly efficient. It's also complex, and can be confusing.

For patients, it can sometimes seem daunting. Where do you start? What's the best way to use the system?

In some cases, of course, decisions are made for you. Naturally, if you're unconscious and require immediate medical attention, you'll get it as fast as possible.

Here are some ways you can contribute to your health.

But in other circumstances you can make decisions which will greatly benefit not only your health, but also the well-being of the health system itself. How do you use an Emergency Department? How can you reduce the time you have to wait for elective surgery?

The evidence is now clear: less time in hospital means a better outcome. Programs like Restoring Health and Melbourne Easy Breathers can keep you out of hospital and improve your health.

There are alternatives to the Emergency Department. If it's painful, but not life threatening, you can save hours of waiting by visiting your GP.

Different hospitals have different waiting times for elective surgery. You can shop around for a shorter wait. Just visit www.health.vic.gov.au/your hospitals

Take responsibility for your health.

Our health system is a valuable resource. But, like our water, it's a limited resource. Use it wisely. It looks after us, and we should look after it.

Stay healthy, and help the health system that's kept you healthy. Visit www.health.vic.gov.au call 130 000 or talk to your GP.

Victoria
The Place To Be

After 7 admissions to St Vincent's in one year, an innovative Victorian program, Restoring Health, taught Laurie Dobson how to stay out of hospital, and get on with his life.

Restoring Health has improved health outcomes for patients like Laurie. With chronic lung disease, diabetes, heart failure and depression he was not in good shape.

A tailored care plan was developed between his GP, health staff at St Vincent's and in the community.

Laurie participated in rehabilitation programs, and community supports such as exercise classes, support groups and better health self-management courses.

He had flexible access to medical staff via rapid access outpatient clinics. Or they'd come to him (his dietician would even check the contents of his fridge).

Laurie has been out of hospital now for two years. He's learned how to improved his quality of life.

2.4 THE DEPARTMENT OF EDUCATION AND TRAINING

The Department of Education and Training provides the following information on policies and programs which support science, technology and innovation skills development.

Ministerial Statements

The Ministerial Statement Knowledge and Skills for the Innovation Economy (2002) announced that the Victorian Learning and Employment Skills Commission (VLESC) would develop a planning framework for establishing strategic directions and priorities for publicly funded Vocational Education and Training (VET) in Victoria. Specifically, the VLESC provides detailed advice on industry training priorities and skills development needs for public expenditure on VET in an innovation economy.

The "Maintaining the Advantage. Skilled Victorians" Statement (2006) details the Government's strategy, including specific funding initiatives, for achieving a highly qualified and skilled workforce.

Further information about the Skills Statement can be found at: http://www. deet.vic. gov.au/det/resources/policies.htm

Specialist Centres

With regard to the issues relating to public support for infrastructure development and skills training, the Victorian Government has established 20 Specialist Centres over the period 2002-2006 to deliver specialist training in priority industries and around the technological capabilities needed to drive effective competition in the innovation economy. A further three are to be set up in 2006-07.

The role of the centres is to work closely with individual enterprises and sectors to identify and deliver specific training that addresses current and emerging technological capabilities and business development requirements.

A key objective in the development of the Specialist Centres was to leverage private sector investment in training, particularly in new and emerging areas of skill.

Those Centres with direct relevance to the Productivity Commission's study are:

- The National Centre for Sustainability;
- Environmental Technologies;
- Innoven Food Processing;
- ICT;
- Centre for New Manufacturing;
- Automotive Design;
- BioSkills Specialist Centre; and
- Integrated Engineering and Science.

Melbourne Australia International Scholarships

The Melbourne Australia International Scholarships introduced in August 2005 are aimed at supporting international students whose studies address an area of the State's skills shortages. In 2006 30 scholarships were offered. The scholarships for 2007 will include:

- Teacher Education — Secondary Teachers in Mathematics, Manual Arts/Technical Studies, General Science, Physics and Languages Other Than English (LOTE) (specifically Indonesian, Italian, Japanese and German);
- Nursing;
- Pharmacy (hospitals and retail);
- Accounting (internal, corporate compliance and specialist taxation roles);
- Engineering (civil engineer and electrical engineer working with high voltage);
- Medical Studies (dentistry, occupational therapist, physiotherapist, speech pathologist, podiatrist, radiation therapist, audiologist); and
- Urban and Regional Planning.

Molecular Biology Cooperative Training Course

The Department of Education and Training has jointly funded a molecular biology training course delivered by the Biotechnology Centre of Ho Chi Minh City in cooperation with RMIT University.

2.5 THE DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT

The Department of Sustainability and Environment has a number of policies and programs that support science, technology and innovation skills development.

School of Forest and Ecosystem Science

The School of Forest and Ecosystem Science (SFES) is a joint initiative between the Department of Sustainability and Environment (DSE) and The University of Melbourne. This collaboration has produced a world-class facility where students and researchers can focus on the study of forests and their important ecosystems. In 2005-06, DSE provided $4 million for SFES to conduct rigorous scientific research on a range of topics related to sustainability and the environment. This DSE funding leveraged a further $2.3 million in research support from other agencies, bringing the total contribution to approximately $6.3 million. Specific research areas are outlined below.

Fire management and knowledge transfer

With 'inappropriate fire regimes' listed as a threatening process under the *Flora and Fauna Guarantee Act 1988*, land managers are committed to develop science-based ecological burning strategies which achieve both biodiversity and asset protection objectives, and operate at a landscape scale across all land tenures. Knowledge of vital attributes of species, key fire-response species and their relationship to fire cycles underpins this strategy, but such data are lacking for the heathy woodlands of southwest Victoria. Building on an existing research design, this project will survey groups for which fire-responses are poorly known; principally the invertebrates and non-vascular plants; organisms that constitute the bulk of the biodiversity and contribute significantly to ecosystem function. This approach addresses biodiversity issues as well as providing key data on food resources for a variety of insectivorous animals, a number of which are listed as 'Threatened' at State and National levels.

This project also provides advice to the Department and facilitates the transfer of expert knowledge from fire researchers to management and operational staff.

Forests and water: Yield security and stream health

The magnitude of the economic, environmental, and social value of water in Victoria has been most recently acknowledged in the white paper *Our Water Our Future*. Most of our water is sourced from forests, and our most pristine aquatic habitats are located in forests. However, state-wide water yield planning is constrained by forest hydrology knowledge gaps, particularly in relation to the effects of forest thinning and wildfire on water yields from forests. The management of risks to stream health in forests is also constrained by poor conceptual models of how pollutant sources (eg. burnt areas, compacted areas, roads) link to the stream network. The objective of this project is to provide improved security in the supply and quality of water from Victoria's forested catchments under the most likely disturbance scenarios and management options. Project components are:

- Yield responses to management.
- Hydrologic impact of wildfire and control burning.
- Improvement estimating water pollution risk in forest.

Advanced indicators of ecosystem health and vitality

Maintenance of Victoria's natural ecosystems requires clear understanding of the range of conditions between 'healthy' and 'degraded', and its relationship to abiotic and biotic threats. This project aims to develop plant and soil indicators of ecosystem function and condition and monitoring systems to identify threats by pests and pathogens. The outcomes will be potentially useful in defining sustainable limits of healthy ecosystems as ideal 'benchmarks'; meeting reporting obligations (e.g. State of the Environment) and setting environmental targets; identifying deleterious land management practices; measuring recovery success of degraded land; identify pest and pathogen threats to native ecosystems; scientific underpinning of economic value (e.g. ecosystem services) of natural assets. Project components are:

- Novel plant based indicators for early detection of stress and risk.
- Indicators for assessing soil health and function.
- Insect pest and pathogen risks to native ecosystems.

Climate change and greenhouse gas emissions

Concern about global change has focused most strongly on the deleterious effects of climate change. It is through the management of greenhouse gas emissions (GHG) that we have an opportunity to mitigate climate change. Controls on fossil fuel emissions and manipulation of the terrestrial biosphere are key areas that could be used to manage climate change. However, we currently have only a partial understanding of how GHG are cycled through the earth system, especially through terrestrial / biological processes. We need to know more about the processes influencing the source and sink mechanisms cycling GHG if we are to increase the probability that policy and management interventions will be successful. Australian based studies of the processes and mechanisms of GHG dynamics are, therefore, required to ensure appropriate mitigation strategies are developed to provide accurate emissions reporting. Project components are:

- Total greenhouse gas balance (CO2, N2O and CH4) in native and planted forests.
- Carbon balance and carbon sequestration potential of native and planted forests in Victoria.
- Impact of climate change on forest ecosystems.

Sustainable forest management

In the last ten years, a range of approaches have been developed to demonstrate to policy makers, to purchasers of wood and other forest products and to the broader community that forests are being managed on a sustainable basis. These approaches include criteria and indicators, certification, environmental management systems and codes of practice. Through the application of these different approaches, land management agencies, companies and private landowners aim to monitor and report on the effectiveness of management according to agreed standards. Many of the indicators used in these approaches are still in a developmental stage. This project aims to improve the application and integration of monitoring information and indicators into management decisions through active research with natural resource managers.

Landscape monitoring and reporting methodologies

DSE is embarking on a statewide project to enhance the application of remote sensing technology for monitoring and reporting on natural resource condition in Victoria. Satellite imaging will be used for a wide range of information products, including woody vegetation cover, biodiversity, ecosystem health and land cover change information for vegetation management planning and compliance, and for state government greenhouse gas inventory

purposes. SFES, in partnership with other project participants, will complete the field validation component of the project, concentrating on methodologies and procedures for ground truthing through fieldwork and LIDAR imaging. DSE expects this component of the project to result in a world-class field validation methodology for Victoria.

Arthur Rylah Institute for Environmental Research

Biodiversity Research

There is a clear recognition within government and the community of the need for a centre of excellence for environmental science. The Biodiversity Research Branch, located at the Arthur Rylah Institute for Environmental Research (ARI), is a leading centre for applied ecological research. Its emphasis is on providing strategic and applied research on biodiversity, to answer key questions affecting land, water and resource use, in support of the programs and strategies embodied in the Victorian Government initiative *Growing Victoria Together*.

Improving our knowledge and understanding of biodiversity is essential to good decision-making and effective management of natural resources. Due to the inherent complexity of the natural environment, there are significant gaps in our knowledge of biodiversity, and of the effects of human use. A systematic program of research is required, including research into species' population viability, ecosystem function and structure, and threatening processes, to generate knowledge that can be applied to conservation actions and lead to improved policy formation and ultimately on-ground outcomes. A greater understanding of the social, cultural and economic values of biodiversity is also required, including the specific interactions between societal values and wildlife.

The Biodiversity Research Branch works in partnership with a wide range of industry groups, research organisations and management authorities both at the enterprise and individual level to enhance biodiversity outcomes.

The Arthur Rylah Institute for Environmental Research (ARI) was established in 1970 by the Victorian Government as a leading centre for applied ecological research, with a focus on flora, fauna and biodiversity issues. The Institute provides services to state, federal and local government agencies, the private sector and the public. ARI works co-operatively with a wide range of clients and professional organisations and forms strong partnerships with universities, businesses and other agencies to expand the range of expertise and services available.

The ARI's 80 staff have an unusually broad range of skills in flora, fauna, freshwater ecology, land management, vegetation mapping and statistical modelling. They have worked in all Australian environments from deserts to the sea, including forests, grasslands, mountains, wetlands and the coast, in tropical, temperate and alpine climates. Many staff have international experience, collectively spanning all continents, with particular interests in Antarctica, the USA, South America and the tropics of Papua New Guinea, South-east Asia and the Pacific. The staff include acknowledged experts in flora and fauna surveys, management of threatening processes, recovery plans for threatened species, environmental flows, sustainable forest management and community participation. Their expertise includes often-neglected groups of flora and fauna such as mosses, liverworts, frogs, bats and freshwater fish and invertebrates. Most projects take a landscape approach,

recognising the interactions between people and ecosystems over broad spatial and temporal scales.

ARI's main focus is on providing strategic research and management advice to answer key questions affecting ecologically sustainable land management and resource-use policies. The Institute conducts a wide range of projects to help conserve biodiversity on public and private land. It specialises in providing information required for planning, and has the capacity to undertake large or small projects involving flora, fauna, resource use and land management, in Australia or overseas. It has a reputation for innovative work, and has helped develop novel solutions for many land and resource management issues such as recreational hunting, sustainable forest management, fire management and urban development.

ARI maintains close relationships with other research institutes. It forms partnerships and conducts joint projects with a range of universities, businesses, non-government organisations and land management agencies, such as Greening Australia and Birds Australia. These partnerships add to the range of skills that can be called upon, and the number of people that can be marshalled at short notice for major contracts. The partnerships with land management agencies ensure that research is focused on finding practical solutions, and that those solutions are implemented on the ground. The Institute has direct, on-site access to a large conservation library and substantial peripheral resources, including computing facilities, geographical information systems, mapping, publishing services, laboratories and specialised technical equipment.

The Biodiversity Research Branch contains two Sections:

- Freshwater Ecology; and
- Terrestrial Ecology.

Freshwater Ecology

The Freshwater Ecology Section provides technical advice, knowledge and expertise for research into the management of major ecological issues and processes in freshwater and estuarine environments. It aims to develop strategic and effective approaches to reducing the impact of threatening processes on biodiversity through research support for informed policy development, and through engagement with relevant agencies and managers of public and private land.

The Section also directly contributes to the protection of biodiversity in inland and estuarine ecosystems through implementation of research and monitoring actions for the protection of threatened aquatic species.

Substantial innovations have been made in areas such as:

- *Modelling of scenarios for threatened species and pest management.* ARI developed ESSENTIAL, a modelling tool for testing of scenarios for threatened species recovery such as re-stocking regimes for threatened fish, habitat and predator management for koalas, quolls and bandicoots and the spread of invasive aquatic weeds. This tool allows for current and future policy to be evaluated quantitatively and potential risks identified. It is conducted in collaboration with a range of national and international organisations and practitioners.

- *Innovative aquatic fauna monitoring techniques.* ARI staff have led the development of PIT (microchip) and radiotracking technology for long-term monitoring of important fish population dynamics, including migrations and the importance of river flows. These include the establishment of remote logging stations where fish can be monitored in real time from base. Otolith microchemistry allows for determination of fish movements across their entire life-cycle. ARI is a national leader in developing this technology.
- *Assessing and managing impacts of invasive species.* ARI developed carp separation technology for the selective removal of carp from waterways. This work has received a Eureka Prize for Innovation. ARI has developed procedures for identifying and managing the threats caused by other aquatic invasive species such as Gambusia, arrowhead, willows and weatherloach.
- *Contributions to restoration processes for aquatic ecosystems.* ARI staff have conducted a number of strategic research projects that have provided the evidence and techniques necessary to restore aquatic ecosystems. These include woody habitat reinstatement in the Murray River, flow management for fish recruitment, restoration of fish passage through innovative fishway design. This science has been recognised through awards such as the David Ashton and Gold Bansksia prizes.

Terrestrial Ecology

The Terrestrial Ecology Section facilitates and conducts research with an applied focus on a wide range of ecological issues and processes concerned with flora and fauna conservation across Victoria. This includes research across all the major biomes of the State, and across all land tenures. Major research themes are concentrated on threatened species and communities, land stewardship on public lands, ecologically functional relationships in agricultural systems, ecological sustainable forest management, ecological spatial analysis, and fire and grazing management research.

The Section aims to enhance effective policy development for biodiversity conservation, as well as scientific evidence for improved land stewardship.

Substantial innovations have been made in areas such as the following:

- *Modelling and mapping native vegetation.* DSE developed the vegetation typology of Ecological Vegetation Classes, and the new concept of Habitat Hectares as a measure of vegetation condition. Biologists at ARI have developed new tools for mapping and modelling EVCs and vegetation extent and condition, using remotely sensed data and strategic ground-truthing. This work has also provided new insights into the underlying factors that affect vegetation type and condition. It is conducted in collaboration with a range of planning agencies, as well as DSE regions.
- *Innovative fauna survey systems.* ARI staff have led or contributed to the development of several innovative fauna survey systems. These include harp traps for bats, timed area-searches for birds (now the most widely-used survey technique in Australia), playback surveys for nocturnal fauna, remotely triggered cameras and use of ultrasonic call detectors for bats. Recent work in collaboration with the University of Ballarat has developed the first automated system for identifying bat calls, greatly increasing the efficiency of studying these poorly-known mammals. The innovative nature of this work was recently given national recognition when it featured on the ABC program ‘Catalyst’.

- *Integrating systems for conservation and commercial production in agricultural and forest landscapes.* ARI has several innovative programs to help land managers and planners select suitable strategies for integrating or segregating conservation and production objectives. The programs relate to private farmland, public and private forests, plantations and wetlands. The work is conducted in collaboration with DPI, local land managers and Commonwealth organisations.
- *Assessing and managing impacts of over-abundant species.* These projects relate mainly to introduced fauna species, including foxes, dogs, deer, pigs and goats. Innovations include the use of adaptive management approaches, and productive collaborations with Landcare New Zealand, which has led the way in developing new management techniques.
- *Contributions to recovery processes for threatened flora and fauna species.* ARI staff conduct a number of strategic research projects on threatened flora and fauna species in Victoria, and contribute to similar programs elsewhere (e.g. Christmas Island). Current major projects include work on orchids throughout the state, and Spot-tailed Quolls and Long-footed Potoroos in the forests of eastern Victoria. DSE also participates in collaborative recovery programs for hundreds of flora and fauna species, with varying levels of research support from a range of institutions.
- *Monitoring effects of management and trends over time.* ARI staff have implemented a number of projects to monitor changes in biodiversity over time, often in response to management initiatives. Subjects include large forest owls, arboreal mammals, waterfowl and threatened flora and fauna species. Often the projects are conducted at multiple spatial scales: for example, the work on waterfowl includes a State-wide Summer Waterfowl Count, estimates of hunter success at selected wetlands and research on habitat use at a large Ramsar-listed wetland on the coast of Port Phillip Bay.

Sustainable Rural Landscapes

A large percentage of Victoria's natural assets exist on private rural land. The evolution to current land management practices, particularly in transitional and less profitable dryland areas in Victoria, has led to a significant decline in the condition of natural land assets. This key project aims at targeted intervention for protecting, enhancing and restoring land assets of greatest value to the Victorian community. Without this long-term public investment, there will be a continued decline in the condition of land assets and the services they provide to the broader community wellbeing now and in the future. A significant proportion of this program is invested in Research that help to build knowledge of landscapes systems and the processes that maintain and threaten them. The aim of this program is to enable land management in Victorian rural landscapes to contribute to healthy natural assets producing a range of services for broader community wellbeing. This will mean that key land assets are protected from established threats, such as salinity and soil degradation, particularly in areas where significant landscape change needs to be addressed.

Through this program along with DPI investment, Victoria is a major contributor to the CRC for Plant Based Management of Dryland Salinity (CRC PBMDS). The CRC PBMDS is a national program that conducts empirical research to develop landscape knowledge, investment tools and farming systems that can help combat the threat of dryland salinity to Australia's natural assets.

The following are innovation projects this program has direct investment in (including the CRC PBMDS):

- The salinity investment framework 3 - comprehensive analysis of dryland guide regional investment planning and national policy;
- Plant-based management of dryland salinity;
- Understanding the interactions between biodiversity and the management of native pastures in the Murray Darling Basin;
- Perennial and annual plants for managing salinity;
- Water use by plants in a landscape context;
- Environmental Management Systems - "connecting farms to catchments and land managers to ecosystems";
- Triple Bottom Line performance indicators for rural landscapes; and
- Understanding the social context for policy tool selection.

Weeds and Pest Management

This whole of government program focuses on the maintainance of land health through the protection from impact of pests. Victoria is using this investment in pest management on the greatest risks to natural assets, social values and the productive capacity of its land, water and biodiversity.

Pest plants and animals are a serious threat to Victoria's economic, environmental and social assets.
Research and development investment of the weed and pests program are directed to the following outcomes:

- Meeting State biodiversity objectives and enhancing private land productivity and profitability;
- Preventing new and emerging pests from having significant impact on natural and productive resources;
- Decreasing the impact of existing pests on natural and productive resources; and
- Increasing community capacity to successfully respond to new and existing pest problems

The following projects are directed toward these outcomes:

Weeds

- Aquatic and Riparian Weeds Research;
- Pest Plant Impact Assessment;
- Biological Control of Widespread Weeds;
- Integrated Control of Unpalatable Grasses; and
- Adapting willow management strategies to deal with spread of the willow sawfly.

Pest Animals

- Developing and effective and efficient aerial baiting;
- Developing a feral cat toxin; and
- Research into control of rabbits.

2.6 DEPARTMENT OF INFRASTRUCTURE

Introduction

The Department of Infrastructure (DOI) plays an important role in growing the information and communication technology (ICT) industry in Victoria. This includes supporting the establishment of new or expanded strategic ICT R&D infrastructure and investment in the State.

ICT remains one of the key enabling technologies for business. As the OECD has argued, investment in ICT capital by business provides a continuing means of innovation that is not delivered by any other form of capital.[66]

Deep usage of ICT across the whole economy continues to contribute to productivity growth. ICT was responsible for an estimated contribution of 0.1 to 0.2 per cent to the acceleration in the high multifactor productivity growth experienced in Australia through the 1990s and is expected to continue this role.[67]

In some industries, the role of ICT has been particularly significant with recent research indicating that between 60 and 80 per cent of productivity growth in the services sector over the past 20 years is attributable to ICT. ICT is also increasingly converging with other industries and other scientific disciplines to create completely new streams of opportunity such as bioinformatics and nanotechnology.

Victoria leads the nation in ICT skills development with nearly 40 per cent of university enrolments and a pool of high-quality ICT talent that is often cited by companies as the principal reason for locating business here.[68] Responsibility for maintaining this position in a global market where skills are developing rapidly must be shared collaboratively by the industry and education sectors, with Government playing a support and facilitative role.

National ICT Australia Victoria Research Laboratory

Investments in the National ICT Australia (NICTA) Victoria Research Laboratory (VRL) and the Australian Synchrotron in particular are intended to keep Victoria at the forefront of Australian ICT R&D. To this end, DOI works closely with the Victorian research community to ensure it is both enabled with, and adopts, leading edge e-research tools and methodologies.

NICTA VRL was established in June 2004 by NICTA, the University of Melbourne and the Victorian Government as part of a tripartite agreement to establish a Victorian base for world-leading, commercially focused, ICT research. VRL's principle purpose being to undertake ICT research as an enabling technology, focusing on end use commercialisation in telecommunications and information technology. The Victorian Government provided a

[66] OECD, *The Economic Impact of ICT, Measurement, Evidence and Implications*, p146, 2004

[67] Productivity Commission, *ICT Use and Productivity: A Synthesis from Studies of Australian Firms*, 2004

[68] Department of Education, Science and Technology, 2005

grant of $8 million over four years to assist with establishing the NICTA VRL facility on the University of Melbourne Parkville campus, creating up to 80 researcher positions.

In the 2006 Budget and through DOI, the Victorian Government has committed to provide NICTA VRL with $20 million of new funding to support the continued growth of NICTA VRL. This new funding has assisted VRL to secure a commitment to significantly expand its existing R&D activity and further funding by NICTA and University.

NICTA and VRL are committed to expand the existing VRL R&D activity from six to 12 research programs, as well as doubling the number of researcher positions from 80 to 160. A key aspect of VRL's expanded activity will be to expand the current level of ICT research, as well as undertake new research into "ICT as an enabling technology for Life Sciences".

R&D Resource Centre

In 2005 DOI established in the R&D Resource Centre website to make it easier for SMEs to locate important information related to sources of government and non-government R&D.[69]

[69] http://www.mmv.vic.gov.au/RandDCommercialisationResourceCentre