Tasmanian Biotechnology Sector Analysis

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DEPARTMENT *of*
STATE DEVELOPMENT

CENTRE *for* RESEARCH, INDUSTRY
and STRATEGIC PLANNING
Research Unit

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Preamble

It is the intention of the Premier's Office that this report, once finalised, be submitted for the consideration of Cabinet through the Premier as Minister for State Development. Accordingly staff should, at all times, be aware of the confidential nature of the material in this report.

Preface

The Biotechnology Sector Analysis has been produced at the request of the Department of State Development's Biotechnology Working Group. The working group was established to examine the potential of the sector to contribute to the State's economic development.

The objectives of this report are to examine the capabilities of the biotechnology sector in Tasmania and the constraints and opportunities impacting on its development. This report will also contribute to the State's policy position on biotechnology.

Methodology

This report is based on a survey of industry and research organisations that reported they undertook significant biotechnology activity. Submissions were also invited from organisations with an interest in biotechnology. Thirty-nine surveys were completed, most of which were conducted by way of face-to-face interview, and six submissions were received.

Advice was provided by the Biotechnology Reference Group comprised of Mr Buz Green, Chief Executive, Serve-Ag Pty Ltd, Prof. Andrew Glenn, Pro Vice-Chancellor Research, University of Tasmania and Prof. Terry Dwyer, Director, Menzies Centre for Population Health Research.

Extensive desktop research was also conducted covering international and domestic trends and issues in the biotechnology industry; State, national and international policy; as well as the identification of potential opportunities for Tasmania.

Appendix A provides a list of contributors to the report.

Glossary

ABA	Australian Biotechnology Association
AMC	Australian Maritime College
ANZFA	Australian and New Zealand Food Authority
BA	Biotechnology Australia
BIRD	Business Investment in Research and Development
BSE	Bovine Spongiform Encephalitis
COMET	Commercialisation of Emerging Technologies program
CRC	Cooperative Research Centre
DPIWE	Department of Primary Industries Water and Environment
DSD	Department of State Development
E&Y	Ernst and Young
FDA	Food and Drug Administration (US)
GMOs	Genetically Modified Organisms
GPD	Gross Domestic Product
IASOS	Institute of Antarctic and Southern Ocean Studies
IP	Intellectual Property
ISR	Department of Industry Science and Resources
IT&T	Information Technology and Telecommunications
PUFAs	Polyunsaturated Fatty Acids
SET	Science Engineering and Technology
SMEs	Small and Medium Enterprises
TAFI	Tasmanian Aquaculture and Fisheries Institute
TIAR	Tasmanian Institute of Agricultural Research
TMAG	Tasmania Museum and Art Gallery

Executive Summary

Biotechnology will be a key driving force of economic growth and employment in the coming decades. Annual global revenues from biotechnology are estimated at $20 billion and growth of between 12 and 20 per cent per year is expected in the medium term. The Australian industry is small in global terms with 120 dedicated biotechnology companies employing almost 4,000 people and generating revenues of $964m in 1998/99.

A survey conducted in June/July 2000 identified that 31 Tasmanian organisations were involved in providing research services on a contract basis or developing biotechnology for their own use or with the expectation of a market opportunity. Turnover of the sector is estimated to exceed $145 million per annum, however this includes revenues from products and services not related to biotechnology. The sector is outwardly focused, with 89 per cent of respondents accessing markets outside Tasmania. The sector is growing, from a relatively small base, with half of the respondents reporting 19 per cent annual growth in the most recent year for which figures were available.

Tasmania has clusters of biotechnology research and development in agriculture, aquaculture, environment and human health/genomics. The State has a strong biotechnology research and development base in the public sector, with 63 per cent of research activity focussed on developing commercial applications. Twenty-two businesses surveyed use biotechnology to enhance their product or core business and four organisations provide contract research services. One business committed more than 25 per cent of turnover on research and development.

The Biotechnology Sector Analysis has identified a range of opportunities that Tasmania can pursue in the field of biotechnology. Over sixty product opportunities were reported to be under development in agriculture, aquaculture and human health. These projects have the potential to return significant revenue to the State and generate high value employment, particularly in regional areas.

The most significant issues and constraints facing the development of the Tasmanian biotechnology sector were identified as:

- funding for basic and applied research within public research institutions;
- impediments to higher rates of commercialisation of research outcomes in public research institutions;
- access to finance at the seed and early development phase for smaller private enterprises and public research institutions;
- skill gaps in commercialisation and business management expertise in smaller enterprises and public research institutions;
- a low level of awareness of patents and issues relating to the protection of intellectual property across the sector;
- a shortage of specialist scientific and technical skills in some areas within biotechnology sector;

- inadequate telecommunications infrastructure, particularly phone services, was an issue for one in five respondents;
- inadequate water supplies and water quality was of concern to the aquaculture and agriculture sectors;
- maintaining the State's disease free and animal health status were important across the sector; and
- the potential impact of a moratorium to prevent the growing of GM plant and plant materials other than in authorised contained research until a State policy position is reached. This is anticipated to be finalised before 20 July 2001.

The University and State Government should work together to secure continuing and new funding for basic research in priority areas. Coordination between these parties and industry should be further exploited to strengthen proposals for funding collaborative and applied research in strategic areas. Financial returns from commercialisation of selected research will become an increasingly important source of funding for basic and applied research.

Strategies to better integrate research, development and commercialisation within public research institutions are being explored. The University is currently examining ways to fund early phase development of its research and provide greater incentives for researchers to be involved in commercialisation.

Public research institutions should underpin an increasing focus on commercialisation with the expertise to manage IP developments, identify potential markets/uses and partners and manage the legal and commercial negotiations with financiers and other development partners.

In the short term greater emphasis should be placed on the targeted dissemination of information within public research institutions on basic commercialisation issues, intellectual property, alternative sources of finance and commercialisation models such as incubators and various forms of alliances and joint ventures.

In the longer-term students in scientific disciplines should be exposed to basic and targeted business development and management principles.

Improved targeting of SMEs in this sector and better information on alternative seed and early development financing options will better equip SMEs to leverage later stage development capital. Programs and services that should form part of a communication strategy are detailed in Appendix C.

Australia's immigration policies provide flexibility to address demonstrated skill gaps in niche areas and Tasmania works with the Commonwealth to facilitate the approval process. This process must address visa and other requirements under Australia's bi-lateral arrangements with the country of origin. The application and approval process should be monitored to identify how timeframes might be reduced. A strategic assessment of ongoing specialised skill shortages in the medium term should guide strategies to attract enrolments and make changes to course content where there are significant and sustained skill gaps.

Concerns about the adequacy of telecommunications infrastructure will be addressed in a broader study into the alignment of the telecommunications infrastructure with industry development goals that is to be conducted as part of the Intelligent Island program.

There needs to be continued support for Tasmania's strict quarantine and animal health regulations.

The temporary moratorium on growing GM plant and plant materials other than in authorised contained research until a policy position is reached (anticipated before 20 July 2001) impacts on some areas of agriculture. The moratorium is not on biotechnology per se, but limited to plant and plant materials. Importantly, authorised contained research on GM plant and plant materials is permitted during the formulation of a policy position on the issue.

Tasmania needs to position itself to capitalise on Federal Government sources of funding for biotechnology through the National Biotechnology Strategy. This Strategy focuses on curriculum development in schools, community education and awareness and environmental risk assessment and the commercialisation gap, particularly in later stages of development or where a significant level of investment is involved.

Whilst Tasmania should not duplicate the national effort, some Commonwealth funding programs exclude many relatively small-scale projects that require seed and early stage development capital.

Introduction

There is no commonly recognised definition for the term biotechnology. The word was first used in 1917 to describe the mass production of materials from microbes. The term biotechnology has a much wider contemporary meaning. The definition used in the Australian Biotechnology Report (E&Y and ISR 1999) has been adopted for the purposes of this report:

"The application of science and engineering in the direct or indirect use of living organisms or parts of organisms in their natural or modified forms in an innovative manner in the production of goods and services or to improve existing processes".

This definition precludes traditional activities such as bread and cheese making unless they are elaborately transformed. This report is only concerned with modern forms of biotechnology.

The term biotechnology encompasses far more than genetically modified organisms (GMOs). It has applications in a wide range of areas including environmental and waste management, health and medicine, forestry, genomics, bioprospecting, mining and chemical synthesis.

Biotechnology can be an industry in its own right as well as a suite of enabling or value-adding technologies that are applied in many industries. The sector classification used in the Australian Biotechnology Report, Ernst & Young 1999 has been adopted for the purposes of this report. Biotechnology activity has been identified in the following sectors:

- human health-bio;
- genomics/informatics/bioprospecting;
- ag-bio;
- general biochemicals and fine chemical feed stocks;
- food production and processing;
- specialist service providers;
- aquaculture and marine biotechnology;
- mining, energy, petroleum and chemicals;
- forest products;
- environment;
- equipment, supplies and bioengineering; and
- other.

A more detailed breakdown of the sector classification used in the survey is provided in Appendix B.

International and National Trends

Global revenues for the biotechnology industry are estimated at around $20 billion annually. Biotechnology firms are receiving more than $1.5 billion in venture capital and $6 billion in overall equity finance annually. The global market for biotechnology is expected to grow by between 12 and 20 per cent per annum and employment in the industry is growing at a rate of 10 to 20 per cent. The industry is characterised by the need for patient capital as it may take several years before a return on investment is realised, particularly where regulatory approval is required. There is intense competition between countries to commercialise research breakthroughs.

United States

The US industry is large and includes more than 1,280 companies that employ 153,000 people. The industry has a market capitalisation of $US97 billion, sales of $US11 billion and in 1997 invested $US9 billion on research and development. Overall the US industry made a net loss of $US5.1 billion, which is indicative of the enormous investment in research and development with the view to creating long term benefits.

The US biotechnology industry is mature in comparison with the Australian biotechnology industry. Perhaps because of its maturity the public acceptance of the technology is very high, even for the agriculture sector. Consumer acceptance is also thought to be related to the high level of public confidence in the Food and Drug Administration (FDA).

Europe

More than 45,000 people are employed in 1,178 biotechnology companies in Europe. The industry is very diverse with companies engaged in platform technologies, contract research, development and manufacturing, therapeutics, diagnostics, biochemicals, agriculture, environment and food processing. The industry spends an average of 15 to 20 per cent of sales on research and development.

The European biotechnology industry is also large and well developed, however it faces far greater public scrutiny than in the US. Europe is at the heart of the GMO debate, particularly in relation to risks to the environment, food safety and labelling concerns. Public concern and protest has led to a barrage of legislation, especially in Western Europe, designed to put a check on genetically modified (GM) food appearing on the market - the most divisive issue being the labelling of GM food. For example, in Britain, thousands of customers of Sainsbury's supermarket have signed petitions against GM products and in Luxembourg, supermarket chains have urged food suppliers to refuse GM soya in their products. The aftermath of the mad cow disease (Bovine Spongiform Encephalopathy BSE) scare has also lowered public confidence in the regulatory system and is likely to be playing an important role in the high level of public concern over biotechnology in Europe.

Canada

The Canadian biotechnology industry bears the most similarity to the emerging biotechnology industry in Australia. There were approximately 224 biotechnology companies in Canada during 1997 with over 11,000 employees. In that year the industry invested $403 million on research and development and had sales of $979 million. Overall the industry incurred a net loss of $108 million.

The Canadian industry raised more capital in 1997 than it did during the previous five years, and products that were under development are now reaching the market place. The Canadian biotechnology industry is dominated by the health sector with strengths also in the environmental and agriculture sectors.

Australia

By international standards the Australian biotechnology industry is quite small, with approximately 120 companies employing almost 4,000 people. It generated revenues of approximately $964 million during 1998/99. There has been strong growth in the number of biotechnology start-ups during the last five years, with an accompanying high growth in the availability of venture capital, which should stimulate further growth.

The Australian Federal Government has recognised the importance of biotechnology by establishing a regulatory framework overseen by the Office of the Gene Technology Regulator and developing the National Biotechnology Strategy which was released in July 2000.

The Australia's expenditure on research and development was approximately $8.8 billion in 1998/99; this is only one thirtieth of the amount invested in the USA. The Federal Government invests an estimated $250 million per year on biotechnology research and development. Total research and development spending by core biotechnology companies in 1998/99 was estimated to be $234 million. The average research and development expenditure for private and unlisted biotechnology companies was $1.1 million.

Australian business expenditure on research and development (BERD) fell in 1998-99 for the third consecutive year. In 1998-99 BERD was estimated to be $3,992 million at current prices, a fall of 5% on 1997-98 and 9% lower than the recorded level for 1996-97. Australia's BERD as a percentage of GDP fell to 0.67% in 1998-99, following decreases in 1996-97 and 1997-98. The falls followed significant increases to a high of 0.86% in 1995-96. Australia's BERD/GDP ratio remains relatively low when compared with other OECD countries, ranking 12th among 24 OECD nations.(ABS Research and Experimental development 1998-99 8104.0).

The embryonic biotechnology industry in Australia is facing a number of challenges. The Australian Biotechnology Report identified the most important issues facing the industry as:

- access to capital;
- access to smart capital (money plus management expertise);

- capital gains tax;
- size of the domestic market; and
- the time required to gain regulatory approval.

There are also a number of cultural hurdles to overcome in order to promote growth in biotechnology. For instance, developing a culture that rewards entrepreneurship in universities and encouraging industry to invest more money in research and development would stimulate the growth of biotechnology. The National Biotechnology Strategy is addressing a number of these issues and is outlined in more detail in Appendix C.

Queensland and Victoria are moving quickly to position themselves as Australia's leaders in biotechnology, with a particular emphasis on medical applications of biotechnology. Queensland is investing $270 million over the next ten years, and Victoria is investing $310 million over the next five years to build their biotechnology capability through a range of programs and infrastructure development.

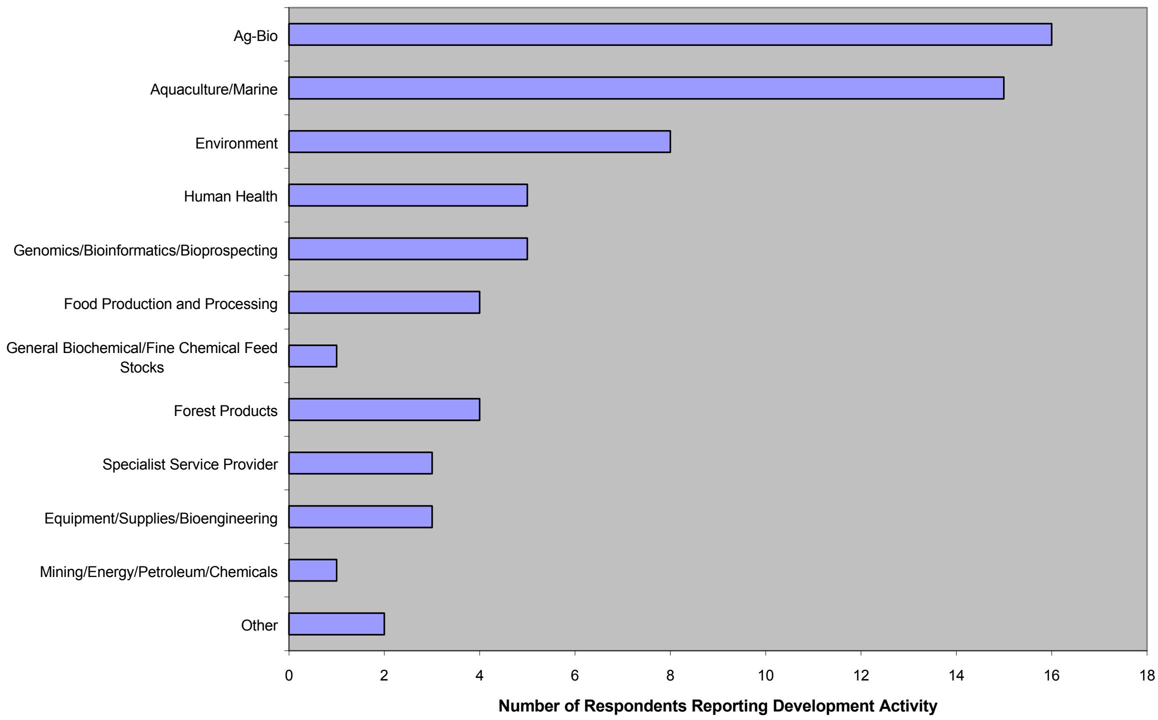
There has been some level of public concern in Australia over biotechnology. This is most evident in the area of food safety and labelling of genetically modified food. The Australian and New Zealand Food Authority (ANZFA) has adopted quite stringent labelling requirements for GM food. Labelling is required for all food and food ingredients with novel DNA and/or protein in the final food. The standard allows an ingredient to contain up to 1 per cent of unintended presence of genetically modified product. There are several exemptions to the proposed regulations including flavours which are present in a concentration less than or equal to 0.1 per cent in the final food and food prepared at the point of sale.

Biotechnology Sector Analysis

Profile of the Tasmanian Biotechnology Sector

In Tasmania biotechnology development is concentrated in agriculture, aquaculture/marine, environmental and human health including genomics/informatics/bioprospecting. This is demonstrated in Figure 1.

Figure 1 Biotechnology Development by Sector



Importance of Biotechnology to Respondents

Organisations were asked to rate the importance of biotechnology to their organisation. Table 1 shows that 41.7 per cent of organisations surveyed regard themselves as wholly dependent upon biotechnology, or see biotechnology as a significant factor for their organisation.

Table 1 Level of Importance Placed on Biotechnology

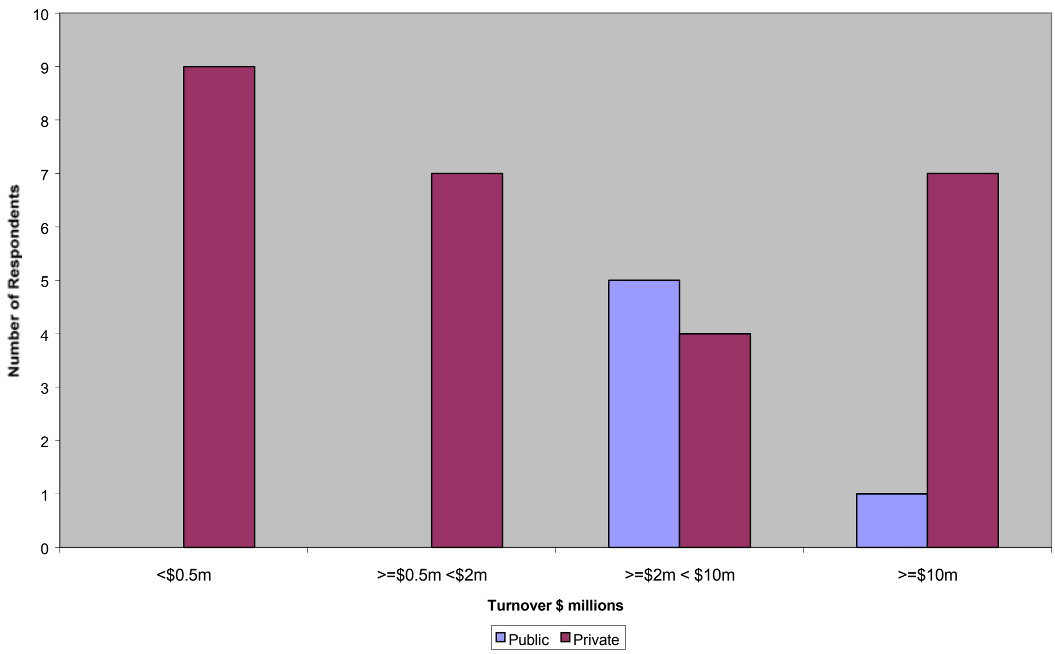
Importance of Biotechnology	No of Organisations	Percentage of Organisations
Wholly dependent	4	11.1
Significant factor	11	30.6
Use traditional biotechnologies	7	19.4
Minor role, one of many factors	9	25.0
Provision of products/services	5	13.9

Size of Biotechnology Organisations

The median turnover range for the biotechnology sector in Tasmania is between $2-10 million per annum. Public sector companies in Tasmania have turnovers exceeding $2 million per annum, whilst private companies exclusively made up those with turnovers of less than $2 million. Most private sector organisations with low turnovers were private companies, sole traders or partnerships. Private sector companies made up the majority of organisations with a turnover exceeding $10 million. Most of these were publicly listed companies. These results are depicted in Figure 2.

There was no significant difference in turnover between organisations that developed biotechnology and those that were predominantly users of biotechnology.

Figure 2 Turnover of Public and Private Organisations



Type of Organisation

A number of different types of organisations were involved in the use and/or development of biotechnology. These were private companies, sole traders and partnerships, listed and unlisted public companies, government institutions, universities and co-operative structures. More than 77 per cent of respondents were in the private sector.

Geographic Location of Biotechnology Organisations

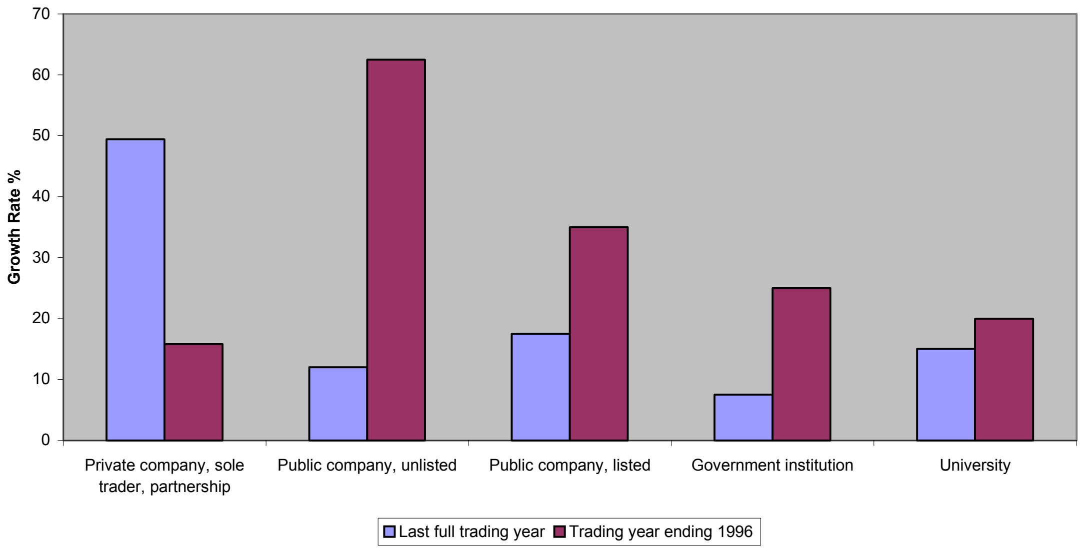
There was an even distribution of biotechnology organisations in the north and south of the State. There were a total of sixteen respondents in the north of the State at locations including Beaconsfield, Latrobe, Launceston, Ridgley and Devonport. There were seventeen respondents in the south, predominantly from Hobart, but also from Kingston, Glen Huon, Dunalley, New Town and Judbury.

Growth

The median increase in turnover over the past year was 19 per cent. Over the previous years to 1995/96 respondents experienced a median increase in turnover of 20 per cent.

All respondents reported strong growth rates since 1995/96. The rate of growth has slowed over the last full trading year for each type of organisation with the exception of private companies, sole traders and partnerships.

Figure 3 Growth Rate by Organisation Type

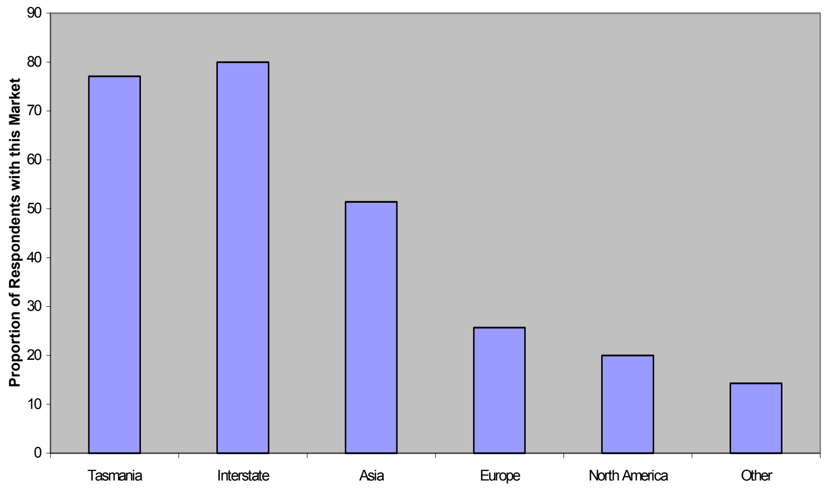


Export Focus

Figure 4 shows the proportion of respondents with markets in Tasmania, interstate, Asia, Europe and North America. Eighty-nine per cent of respondents have markets outside Tasmania and more than 57 per cent of respondents exported their products and services outside Australia. Over half of respondents exported goods and services to Asia.

Of those respondents who had production inputs that were sourced outside the State, 88 per cent reported that equivalent items were not available in Tasmania.

Figure 4 Location of Markets



Research and Development

More than 85 per cent of respondents undertook research and development, and of these almost 60 per cent had a dedicated research and development budget.

Six organisations did not undertake research and development in biotechnology within the State. One organisation conducted biotechnology research and development at a corporate level interstate, whilst other organisations undertook research and development in fields other than biotechnology. Organisations who did not develop biotechnology products and processes but used them in the running of their business made up only a small proportion of respondents.

The median level of investment in research and development was approximately 5 per cent of turnover. Investment in research and development exceeded 25 per cent of turnover in all six public sector research institutions and in one business.

The average investment in research and development for high R&D intensive industries in Australia is 4.5 per cent of turnover. This compares favourably with the average investment in research and development reported by private sector respondents.

Twenty-two businesses focused primarily on the development of biotechnology to apply within their own businesses to make them more competitive and four businesses supplied research services on a contract basis. Businesses that developed biotechnology applications for their own use generally applied incremental improvements rather than radical innovations.

Public sector organisations focus on the commercialisation of research that is anticipated to have a market or some commercial application. Sixty-three per cent of biotechnology-related research and development undertaken by public research organisations was reported to be commercial in nature.

Capabilities of the Tasmanian Biotechnology Sector

Key Sectors of Biotechnology Development Activity

Tasmania has very successful agriculture, aquaculture, food production, environmental, health and information technology industries. Biotechnology is building on these capabilities by developing new products, improving the quality and productivity of existing products and services and creating new synergies between industries. Biotechnology can be used to build on our existing capabilities to maintain and improve our competitive position.

Figure 1 highlighted ag-bio, aquaculture and marine biotechnology and environment as those sectors in which the most significant amount of biotechnology research and development is occurring. There is important biotechnology activity in human health/genomics, which is centred on the Menzies Centre for Population Health Research. There are also clusters of activity in bioprospecting, forestry, food production and processing. It is in these areas where biotechnology opportunities show the most potential within Tasmania.

Tasmania has a low level of research and development capability in equipment, supplies and bioengineering, specialist service providers and general biochemicals and fine chemical feed stocks. There is no biotechnology research and development reported in the areas of mining, energy, petroleum and chemicals.

Public Research Infrastructure

Tasmania has a strong public research base in science including biotechnology. The generation of intellectual property through public research is fundamental to the development of biotechnology and other knowledge-based industries in the State. Linkages between industry and research organisations are important to facilitate the commercialisation of this intellectual property. Some of these institutions, particularly Cooperative Research Centres (CRCs), have no guarantee of continued funding.

Public research institutions that reported biotechnology research and development included:

- University of Tasmania;
- Menzies Centre for Population Health Research;
- Tasmanian Institute of Agricultural Research;
- Tasmanian Aquaculture & Fisheries Institute;
- CRC for Antarctic and Southern Ocean Studies;
- CRC for Aquaculture;
- CRC for Sustainable Production Forestry;
- CSIRO Marine Research;
- DPIWE Research Laboratories;
- The Tasmanian Museum and Art Gallery; and
- Royal Hobart Hospital Molecular Medicine Unit;
- Australian Maritime College.

University of Tasmania

The University of Tasmania encourages and supports pure and applied research and research training, and has built a vibrant and productive research culture across a wide range of discipline areas including biotechnology. The University spent approximately $59 million on research and experimental development in 1998. This is made up of $25.5 million in applied research, $17 million in strategic basic research and $14.1 million in pure basic research.

The University has developed four theme areas of particular significance to Tasmania and in which it is placed to make excellent contributions to research. These are Antarctic and Southern Ocean Studies; National and State Development; Natural Environment and Wilderness; and Population and Community Studies.

In addition, the Centre for Law and Genetics, based at the Universities of Tasmania and Melbourne, researches the legal and ethical issues arising from the developments in genetic technology and proposes effective and equitable means for developing, applying and benefit-sharing of this technology.

The University of Tasmania is the central player in the development of biotechnology in Tasmania. It is responsible for a large proportion of the intellectual property generated in biotechnology within the State.

The University also has strategic links to industry with the potential to develop more of these linkages. The University is an important source of highly skilled graduates and a potential source of new high-growth biotechnology spin-off firms. It has an important role in the transfer of knowledge and technology to industry and the wider community.

Menzies Centre for Population Health Research

The Menzies Centre is a Department of the University of Tasmania. It has a Board of Management that reports directly to the University Council. Areas of research include environmental and genetic epidemiology, cardiovascular disease, cancer, adult onset glaucoma, multiple sclerosis, osteoarthritis, childhood asthma and diabetes. In only ten years of operation the Centre has established itself as internationally competitive in population health research. The Centre presently receives $1 million for its genetic epidemiology research and development from private sources.

Tasmanian Institute of Agricultural Research (TIAR)

TIAR is a joint venture between the University of Tasmania and the Department of Primary Industry Water and Environment. TIAR undertakes research and development in a number of programs including vegetables, perennial horticulture, cereal and grain legumes, dairy, wool, meat and grazing management. It is also developing the commercial applications of polyunsaturated fatty acids.

Tasmanian Aquaculture and Fisheries Institute (TAFI)

TAFI was formed through a partnership with the Department of Primary Industry Water and Environment and the University of Tasmania. The core participants include the Taroona Research Laboratory, Fish Health Laboratory at Mt Pleasant and the Schools of Aquaculture and Zoology at the University of Tasmania. TAFI is developing a variety of new aquaculture species, anti-fouling paints as well as other aquaculture products, which are at varying stages in the commercialisation process.

CRC for Antarctica and the Southern Ocean

The Antarctic CRC's areas of research expertise include oceanography, glaciology, polar atmospheric physics, paleo-reconstruction, microbiology, politics, law and international relations and remote sensing. The contributors to this CRC include the Australian Antarctic Division, Bureau of Meteorology, Australian Geological Organisation and the University of Tasmania's Institute of Antarctic and Southern Ocean Studies (IASOS). The CRC is undertaking biotechnology research and development into cold adapted enzymes, human pharmaceuticals and polyunsaturated fatty acids.

CRC for Aquaculture

The core participants include University of Tasmania, University of Technology, Sydney, James Cook University, CSIRO, Australian Institute of Marine Science, Queensland Department of Primary Industries, New South Wales Fisheries and the South Australian Research and Development Institute. The main areas of research expertise include nutrition, feed development, hatchery technology, genetics, reproduction, environmental management, vaccine development, immunology, fish physiology, disease diagnosis, health maintenance, food technology and grow-out technology.

The CRC for Aquaculture was not successful in applying for the latest round of CRC funding from the Federal Government. A new submission has been lodged to form a CRC for Sustainable Aquaculture and Finfish with some partners in common with the CRC for Aquaculture.

CRC for Sustainable Production Forestry

Core participants include North Forest Products, Australian Paper Plantations, Australian Newsprint Mills, Bunnings Treefarms, the University of Tasmania, Southern Cross University, Griffith University, CSIRO, Forestry Tasmania, and the Primary Industries Corporation (Qld). The core areas of research expertise include breeding strategies, quantitative genetics, tissue culture, molecular markers, breeding systems, modelling of tree growth, nutrition, tree pathology, yield prediction, resource protection, insect pathology, soil management, stand management and integrated pest management.

CSIRO Marine Research

The Marine Research Division includes staff with experience in fisheries biology, environmental researchers, oceanographers, marine engineers and computer modellers. The Division incorporates five research programs in aquaculture and biotechnology, oceans and climate, coastal waters, tropical and pelagic ecosystems, and multiple use management of the Exclusive Economic Zone.

Department of Primary Industry Water and Environment

The Department of Primary Industry Water and Environment has two major research partnerships with the University of Tasmania, the Tasmanian Institute of Agricultural Research (TIAR) and the Tasmanian Aquaculture and Fisheries Institute (TAFI). The agency also has research laboratories in Taroona, Mt Pleasant and New Town. For instance the Fish Health Unit at Kings Meadows is producing vaccines for use in aquaculture as well as developing diagnostic tools.

Tasmanian Museum and Art Gallery

The Tasmanian Museum and Art Gallery (TMAG) collects, houses and safeguards Tasmania's natural and cultural heritage. It offers an identification service for specimens, pictures and objects. TMAG has almost thirty-seven full time equivalent staff.

The Tasmanian Herbarium, located at the University of Tasmania's Hobart campus, is an important part of TMAG. Its role is to collect and identify Tasmanian plants, and to provide voucher information on plants. It has been engaged in a bioprospecting agreement with a national pharmaceutical company.

TMAG also has a significant role in scientific research. For instance it is currently examining the commercial potential of bumblebees as crop pollinators in the tomato industry using a Horticultural Research and Development Corporation grant. Plant biotechnology techniques are required in the development of this opportunity.

Molecular Medicine Unit, Royal Hobart Hospital

The Royal Hobart Hospital's Molecular Medicine Unit is the only molecular diagnostic laboratory in the State and is the Tasmanian reference lab for this form of testing. The core work of the Unit is the detection of infectious diseases, haematological disorders, malignancy and genetic disorders.

It also provides laboratory space for the Menzies Centre to undertake work for their genetic epidemiological studies as well as staff and students from the Clinical School of the University of Tasmania. They are also involved with a range of research in the medical and science fields at a local, national and international level.

The Australian Maritime College

The Australian Maritime College at Beauty Point is Australia's only higher education institution established to provide education and training services for maritime industries. It has two faculties, Fisheries and Marine Environment and Maritime Transport and Engineering. The Fisheries and Marine Environment faculty undertakes research and development in biotechnology. The core areas of research in biotechnology include disease vectors in seahorses, food safety and handling, and environmental remediation.

Existing Skills and Expertise

Respondents frequently reported that the skills, experience and expertise of staff were an important strength for their organisation. The range of biotechnology skills and expertise in the State includes, but is not limited to, the following:

- human health diagnostics;
- human health therapeutics;
- gene therapy;
- protein sequencing and molecular analysis;
- genomics;
- genetic epidemiology;
- environmental epidemiology;
- information technology;
- tissue culture;
- genetic engineering;
- plant breeding;
- animal breeding, diagnostics and therapeutics;
- biofertilisers;
- traditional biotechnologies in food production and processing;
- consulting, education and training in biotechnology;
- fish health and nutrition;
- brood stock genetics;
- silviculture;
- biofiltration;
- bioremediation;
- isolating and cloning DNA;
- identifying genes;
- forensic testing of human DNA; and
- forensic science skills residing in Forensic Science Services Tasmania.

Tasmania has a diversity of skills and expertise within the biotechnology sector. Many of these skills could be utilised in other areas. For instance the skills within Forensic Science Services Tasmania can potentially be applied to forensic testing of abalone, and the development of diagnostic tests to monitor the spread of introduced DNA from GM crops.

Networks and Alliances

Eighty-eight per cent of respondents participated in some form of business network or alliance and respondents saw strong industry linkages as a key strength. The most common forms of alliances were with local and national industry, State and Federal Government, the University of Tasmania, Cooperative Research Centres and Industry Research and Development Corporations.

The collaborative work occurring in the State is predominantly in the area of developmental research. Respondents indicated only a small proportion of funding for commercialisation is obtained from collaborative arrangements. The use of alliances, networks and other collaborative arrangements to secure seed, early and later stage development capital is an important financing strategy.

Tasmania's small size should make it easier for these alliances to develop as well as allowing Tasmania to be more flexible and responsive to change. This level of flexibility was seen by a number of respondents to be an important strength of the Tasmanian biotechnology sector.

Reputation and Image of Tasmania and Tasmanian Organisations

Tasmania's image and identity as a clean and green environment with a focus on the production of quality goods and services is an important strength recognised by the biotechnology sector.

Twenty-three per cent of respondents felt that their organisation's reputation was a key strength. Tasmania's reputation as a producer of clean and green produce, disease free status, as well as its excellent animal health status were regarded amongst Tasmania's core strengths.

Issues and Constraints

Public Research Funding

Public research institutions expressed serious concern over retaining their current level of funding. If investment in public research and development were to fall it would have significant consequences for the development of the biotechnology sector and the growth of innovative, knowledge-based industries more generally.

Finance

The lack of development finance was a strong theme emerging from respondents. This broad issue encompassed a number of more specific concerns.

A number of respondents reported that banks were unwilling to loan money on the basis on intangible assets such as the intellectual property within the organisation. These problems appeared to be confined to smaller organisations, with larger organisations reporting no difficulty obtaining bank finance.

Access to venture capital and development finance was reported to be a constraint to business development and the commercialisation of research. Public research organisations and smaller private sector biotechnology companies reported a lack of finance during all stages of development, but particularly at the seed and start-up phases.

Many Federal Government funding programs, venture capitalists and other financiers do not target companies that require a relatively small investment. As a consequence, many Tasmanian organisations are excluded from consideration because their required level of investment is too small. This may be compounded by the lack of management expertise in accessing venture capital finance in Tasmania.

Thirty seven per cent of respondents reported that they are likely to have difficulty accessing finance in the future. This group comprised public research institutions and small private companies with a turnover less than $2 million (with one exception).

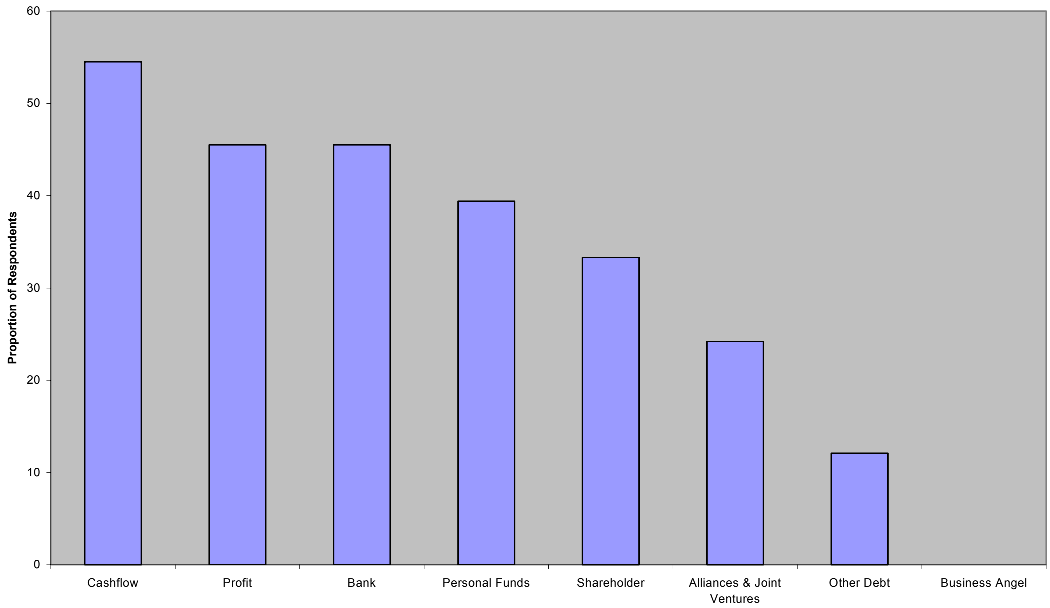
Several organisations reported difficulty in locating State and Federal Government sources of funding. These organsiations also found the application processes to be lengthy and arduous. They felt that greater support from Government could be provided for enterprises seeking this type of funding.

Figure 5 shows the principal sources of finance supporting the organisations in the biotechnology sector in the State. The most common forms of finance are from traditional sources including cashflow, profit, bank debt and personal funds. There was a low level of finance sourced from alliances and joint ventures, reflecting the emphasis of networks on research outcomes. There was no finance from business angels, which indicates one or a combination of a lack of venture and start up capital in the State and throughout Australia, inefficient matching services, or poor investment opportunities or high return and investment thresholds.

There is a range of funding opportunities emerging through the National Biotechnology Strategy that Tasmanian organisations conducting biotechnology research and development can potentially access. This Strategy and the programs grouped under the initiative are covered in more detail in Appendix C.

Other countries have addressed access to finance in a variety of ways. For instance a virtual matching service has been established in Scotland via the Internet to match investors with investment opportunities. The URL for this site is www.lincscot.co.uk. The US State of Maryland has addressed a lack of funding to biotechnology start-ups by developing an innovation fund dedicated to the biotechnology sector. The Maryland Government takes equity in the company as well as receiving royalties in return for providing government funds to biotechnology companies.

Figure 5 Principal Sources of Finance



Impact of Tasmania’s GM Food Policy

Respondents had a mixed view on the benefits of a moratorium to prevent the growing of GM plant and plant materials other than in authorised contained research until a State policy position is reached (anticipated before 20 July 2001).

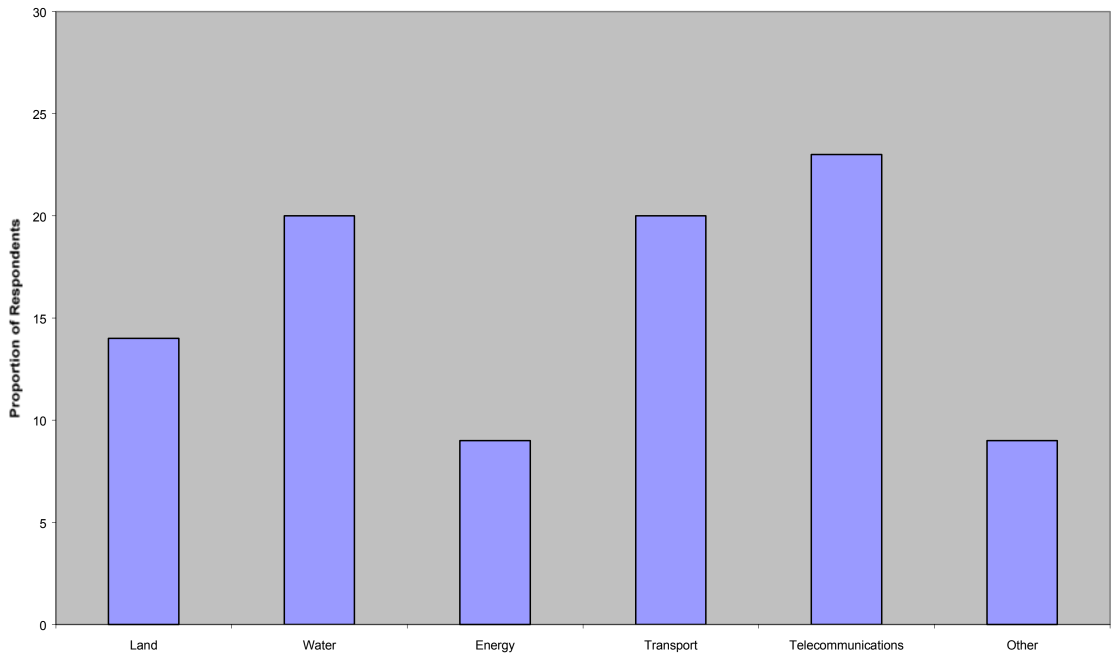
The community perception of genetically modified foods is a concern for some organisations that develop and use biotechnology in food related areas. The community’s understanding of what biotechnology involves beyond genetic engineering and GMOs is limited. Education and awareness initiatives being developed under the Commonwealth’s Biotechnology Strategy will help to address this issue.

The temporary moratorium on open air planting of GM crops is not on biotechnology per se, but limited to plant and plant materials. It provides time for more information on GMOs to be obtained, including appropriate regulatory frameworks, so that Tasmania can develop a strong, well informed policy position on the issue.

Infrastructure

Almost 43 per cent of respondents indicated that one or more of their infrastructure requirements was not being adequately met. Figure 6 shows the proportion of respondents with inadequate infrastructure, including land, water, energy, transport and telecommunications.

Figure 6 Proportion of Respondents with Unmet Infrastructure Requirements



Inadequate telecommunications infrastructure was the most frequently reported infrastructure problem with 23 per cent of respondents reporting some difficulty. Specific areas of concern are poor telephone reception and lack of mobile phone coverage in regional areas. The latter was of particular concern in relation to the occupational health and safety considerations of companies with field staff in remote areas.

Twenty per cent of respondents felt that water availability and quality were at an inadequate level for their needs. This was particularly common amongst organisations from the agriculture and aquaculture sectors. A number of respondents thought that the quality of municipal supplies were inadequate for their needs, and some were forced to buy expensive cleaning equipment. One respondent expressed concerns over the proposed Basslink development including how it would affect the release of water by the Hydro, and the changes to water availability and supply that would result.

One respondent was concerned over the impact of toxic algae on their aquaculture business whilst another respondent required improved access to seawater for their facility.

Twenty per cent of respondents reported that their transport needs were not being adequately met. Airfreight capacity, cost and future availability of airfreight in the State was a concern to some of these respondents.

Availability of Skilled Staff

Fifty-one per cent of respondents reported difficulty recruiting staff in certain skill groups from within Tasmania. The most difficulty was reported for specialist scientific and technical expertise in such areas as:

- genetic epidemiologists;
- bio-statisticians;
- molecular and quantitative geneticists;
- bioinformatics;
- metallurgists;
- food scientists;
- biochemistry;
- pharmacology;
- microbiology;
- agricultural skills with vocational experience;
- mycology;
- information technology;
- aquaculture technicians; and
- plumbers, electricians, brewers.

Other areas in which skilled staff were difficult to recruit from within Tasmania included:

- business development and management;
- venture capital and intellectual property expertise;
- marketing; and
- quality assurance.

Nine respondents reported that despite having appropriate training courses available in the State they still had difficulty recruiting staff with the skills that they required from within the State. Organisations found it difficult to attract qualified people to Tasmania from interstate and overseas. They often could not provide a salary package that was sufficiently attractive to motivate skilled staff to move to the State. Location was often cited as a reason for this difficulty. Other organisations reported that immigration laws restricted their ability to recruit staff with highly specialised skills from overseas. The development and promotion of the State's research strengths will improve the attractiveness of Tasmania as a location for skilled researchers and practitioners.

Another serious skill gap is the nationwide shortage of science teachers. In addition to this, the majority of science teachers currently in the education system have no knowledge or experience in biotechnology. This makes if difficult to educate students about biotechnology concepts and give them an awareness of the possibilities within biotechnology for a future career.

Patents and Intellectual Property

A low proportion of organisations had patent portfolios. Twenty-three per cent of organisations reported that they held at least one patent, however a large proportion of these were not related to biotechnology products or services. A number of organisations believed that they could more effectively protect their intellectual property by keeping it in-house. This might reflect a focus on development of biotechnology for the entity's own use by the private sector. The cost and complexity of applying for patents and general lack of information on the issue was raised by several respondents.

The level of awareness of patents and intellectual property rights needs to be improved within both the public and private sector. Organisations need to be educated on the advantages and disadvantages of patent protection, as well as an awareness of the risks if patent protection for intellectual property is not sought.

Participation in Government Programs

Forty-four per cent of respondents had participated in some form of government assistance program. Approximately 14 per cent of industry based biotechnology research and development was funded from government sources. The programs utilised included:

- DSD business development programs;
- AusIndustry business development programs;
- R&D START;
- R&D tax concession;
- SPIRT grants;
- Meat and Livestock Association Grants; and
- Austrade programs.

Respondents frequently reported that they had difficulty finding the time to research the availability of appropriate programs. Many respondents also found it difficult to devote resources to complete time consuming application processes for these programs.

A need was identified for more information dissemination on industry and government sources of finance including more government support in the application process for these funding programs.

Regulation

Forty-seven per cent of respondents believed that there were government regulations that unreasonably restricted the operations of their organisation. Quarantine laws and their effectiveness in preventing the introduction of pests and diseases was of concern to a number of respondents. Some respondents also reported that the current immigration legislation is hampering the recruitment of staff with specialised skills.

A further 25 per cent believed that further regulation would be desirable to improve the competitive position of their organisations. The majority of these respondents were concerned with improving quarantine and animal health regulations in the State.

A number of generic business issues were also raised including the number of licences that were required by local and State Governments and the level of payroll tax and worker's compensation.

Investment in New Technology

Investment in new technology was seen as important to business competitiveness by more than 97 per cent of respondents. Almost half of respondents could not find all the resources that they needed to upgrade technology, such as new computers and specialist research equipment, to a competitive level.

The median investment in new technology (not including research and development expenditure) was 8 per cent of turnover. Constraints to technology upgrades were reported to be predominantly finance, including lack of venture capital (including the lack of specialised management skills to access different kinds of finance) and intense competition for funds.

Competition

Nine respondents reported that competitors posed a significant threat to their organisation. This was despite having a somewhat high knowledge of their competitor's business strategies and their competitor's business capabilities. Public companies had the greatest level of knowledge whilst government institutions had a relatively low level of knowledge about their competitors.

Three respondents from the private sector expressed concern that they were unable to compete for contract work on a level playing field with publicly funded research organisations.

Legal Risks

The Centre for Law and Genetics at the University of Tasmania is producing a report that examines the impediments of biotechnology in the State from a legal perspective. The draft report highlights the need for government, producers and users of biotechnology to be aware of the potential for legal liability from their biotechnology activities and to take mitigative actions to reduce this potential.

Opportunities

There are a large number of opportunities identified by industry for biotechnology in Tasmania. The opportunities include specific biotechnology-based products and services, strategic opportunities from emerging national and international industry trends and generic opportunities from to improvement in the business climate for biotechnology in the State. The significant opportunities cluster into areas that Tasmania is traditionally good at, including agriculture, aquaculture, environment and population health research.

Specific Opportunities

More than 60 biotechnology products and services were identified, particularly in the following areas:

- genetic epidemiology;
- polyunsaturated fatty acids (PUFAs);
- new crop varieties;
- new poppy varieties;
- new aquaculture species;
- vaccine development, particularly in aquaculture;
- tissue cultured plant varieties;
- human pharmaceuticals (pharmacogenomics);
- environmental remediation and waste management products;
- cold adapted enzymes; and
- a range of shellfish varieties.

The biotechnology sector expects these opportunities to generate significant export revenue for the State as well as the creation of employment over a range of skill levels and in regional areas of the State. For many of these opportunities the location of Tasmania is not a significant barrier to their pursuit.

These opportunities will also help Tasmania maintain its competitive position in a number of areas, particularly in the poppy and aquaculture industries. They will also result in establishing a critical mass in biotechnology that will attract further biotechnology opportunities to the State.

A selection of the opportunities with significant potential are detailed below. More details on these opportunities cannot be provided, as they are commercial in confidence.

Polyunsaturated fatty acids

The Tasmanian Institute of Agricultural Research (TIAR) is examining the commercial potential of its research into polyunsaturated essential fatty acids (PUFAs). PUFAs are a high value low volume product and some uses have significant value – eg one kilogram of pure PUFAs for pharmaceutical applications is worth around $5 million. PUFAs also have commercial applications in food, particularly infant nutrition and animal production. The commercial potential of

TIAR's research will be influenced by factors including the nature of the intended use and the scope of pre-existing patents.

Menzies Centre for Population Health Research

The Menzies Centre is pursuing the opportunity to establish itself as a world-renowned research institution for genetic epidemiological research. The Centre has achieved initial success in the identification of one of the genes responsible for glaucoma and is currently working on the genetic basis for a number of diseases including multiple sclerosis, osteoarthritis, diabetes (type I&II), melanoma and prostate cancer. The Centre has secured private sector funding for its genetic epidemiological research and there is potential to increase this substantially. This may provide the critical mass to stimulate the development of a human health biotechnology cluster in the State.

The opportunities for the Menzies Centre are based on a number of key strengths. These include the genetic structure of the Tasmanian population, an extensive genealogy database, access to medial records and phenotyping databases, a respected and committed epidemiology unit, a responsive population, a supportive government and university and private sector linkages.

Poppies

The Tasmanian poppy industry is estimated to have a value in excess of $175 million annually to the Tasmanian economy. There are a number of opportunities in the development of new genetically modified poppy plant varieties that have significant potential to increase employment, generate significant revenue to the State as well as maintaining the competitive position of the industry. Some industry participants consider this opportunity to be at risk by the State Government's decision to impose a moratorium on growing GM plant and plant materials other than in authorised contained research until a State policy position is reached (anticipated before 20 July 2001). This moratorium allows time for the State to develop an informed policy position on the issue.

Opportunities Identified from Emerging National and International Industry Trends

The identification of new market opportunities is critical to the growth of the biotechnology sector in the State. A number of opportunities have been identified from emerging national and international industry trends that compliment Tasmania's biotechnology capabilities. For instance the export of specialist knowledge, conducting human clinical trials, bioinformatics and genomics, and utilising our natural diversity.

Export of Specialist Knowledge

Tasmania has highly regarded expertise in a number of areas, including aquaculture, agriculture, Antarctica and the Southern Ocean, forestry, population health research and environmental management. This is a potentially valuable resource that could be exported interstate and overseas. The development of a database of experts available as consultants would facilitate the development of this opportunity. A number of organisations are already undertaking consultancy work including the University of Tasmania and the Australian Maritime College.

Conducting Clinical Trials for the Japanese Biotechnology Industry

The Japanese biotechnology industry comprises more than 2000 companies and is growing strongly. Japanese companies are cash rich and are realising that they need to pursue more than just their domestic market if they wish to expand.

There has been anecdotal evidence reported during the Australian Biotechnology Association's (ABA) July 2000 conference that it is difficult for Japanese biotechnology companies to conduct human clinical trials for pharmaceuticals in Japan. The United States and Europe are already conducting human clinical trials for Japanese biotech companies. There are opportunities for Australia as well as Tasmania to investigate partnerships with Japanese biotechnology companies for the clinical trial phase of product development.

The Convergence of Biotechnology and Information Technology

Tasmania has placed significant resources into developing a vibrant, successful information technology industry with a high skills base. There is an opportunity to develop synergies between information technology and biotechnology in the emerging disciplines of bioinformatics and genomics. There is already an emerging capability in genomics within the Menzies Centre, and the recently announced Centre of Excellence in Research and Training for IT&T is an opportunity to develop high level skills in this area.

A specific opportunity that utilises both biotechnology and information technology is the development of databases that contain a species' genome, the human genome project is one example of this. Tasmania has many unique species, as well as commercial plant and animal varieties that could have their genomes sequenced.

There is growing international interest in the value of these underlying gene pools as they potentially have commercial value. They can be used as a platform to discover mechanisms to improve product yield or quality as well as other characteristics such as drought resistance, disease resistance and salt tolerance.

The New Zealand firm, Genesis, is developing platform databases on a number of species including fruit and forestry trees, livestock, grasses and microbes. Through a joint venture with Fletcher Challenge they built a database on one forestry species in 1995. By 1999 they had established the company ArborGen to commercialise this database. They currently receive royalties from licensing their intellectual property based on this database. There are opportunities for Tasmania to undertake similar projects if the management of data is undertaken appropriately.

Utilising Tasmania's Natural Diversity

There is growing international recognition of the potential economic value of bioprospecting. Tasmania's wealth of unique terrestrial and aquatic plant and animal life may be a source of pharmaceutically active compounds that can be used to treat disease in humans and animals. For instance, in 1994 the Tasmanian Herbarium entered into a bioprospecting agreement with AMRAD Discovery Technologies, now known as ExGenix. The CRC for Antarctic and Southern Ocean Studies has a long-standing contract with ExGenix in relation to the discovery of novel microbes from the Antarctic. With appropriate management and advice, there may be other opportunities for Tasmania to capitalise on its natural resources with support from commercial partners.

It should be recognised that biotechnology can be used to support Tasmania's clean green image. For instance, it can be used to improve waste management, sustainable agricultural management practices, as well as having the potential to reduce the use of chemicals in food and fibre production.

The benefits to Tasmania's environment and image contributed by biotechnology that is applied to remedial works and prevention of contamination should not be under-valued.

Sector Development Opportunities

Utilising Federal Funding Initiatives

Tasmania is yet to strategically position itself to obtain Federal Government funding opportunities that target biotechnology research, development and commercialisation. There will be a variety of opportunities available through the National Biotechnology Strategy, which is outlined in more detail in Appendix C. However, this Strategy may target biotechnology projects that are much larger in scale than Tasmanian projects in need of financing.

Education and Awareness

Six respondents suggested that raising community education and awareness of biotechnology would provide them with significant opportunities. For instance, it would broaden the community's perception of biotechnology from just genetically modified organisms to include applications in environmental remediation, health and medicine, forestry and mining, as well as highlighting the potential environmental benefits from using biotechnology. It would also increase the level of support for industries using or developing biotechnology.

Biotechnology Australia is undertaking a national project to provide curriculum advice on the development of biotechnology teaching resources. There is an opportunity for Tasmania to utilise these Federal Government resources to enhance the community's understanding of this issue as well as encouraging more students to consider biotechnology professions. It also helps to address the lack of expertise in biotechnology amongst science teachers.

There is also an opportunity to encourage more students to enter science professions which would support biotechnology sector development over the longer term as well as supporting the development of an innovative, knowledge-based economy. For instance, through its Enterprise Learning Centres Launceston College is aiming to increase the awareness and interest of its students in science professions, including biotechnology.

The Chief Scientist's recent report, The Chance to Change, makes a number of recommendations to increase the enrolments in science. These include providing 200 HECS scholarships for students undertaking combined science/education qualification and 300 for students of the enabling sciences (mathematics, physics and chemistry). The report also recognises that "in the future, students are likely to study science if they know they will receive returns in terms of reward, prestige, and salaries commensurate with other professional fields" (Chief Scientist August 2000 p.24).

Maintaining the Research Momentum

The crucial component of any knowledge-based economy is the basic research that underpins it. It is therefore vital that the current research base in Tasmania is at least maintained, if not strengthened. Respondents expressed concern over the future of a number of Tasmanian research institutions. In particular, ongoing funding for Co-operative Research Centres in their current form was raised as a serious concern. This could impact on future biotechnology development in the State as well as the competitive position of a number of industries that utilise the outcomes of their cutting edge research.

For instance the CRC for Antarctica and the Southern Ocean, the Aquaculture CRC and the CRC for Sustainable Production Forestry will not have their public funding renewed. Whilst the research may continue in other forms this is not guaranteed. The Chief Scientist's recent report examining the science capability of Australia recommended that the CRC Program be expanded to encourage greater SME access and to facilitate stronger networks between the science, engineering and technology (SET) base and industry, nationally and internationally.

Developing an Entrepreneurial Culture in Tasmania

If Tasmania is to further develop its strengths in the biotechnology sector, not only is there a need to ensure that the research base is maintained and supported, but there is also a need to undertake research with a greater commercial focus. This can be achieved by further developing linkages between industry, the University, other public research institutions and the wider community. Currently an average of 63 per cent of research and development undertaken by public research organisations with a biotechnology focus was reported to be commercial in nature.

A report: *Interactions Between Universities and Industry (1998)* noted that universities failed to adequately promote commercialisation of research. Universities stand to gain from the commercial success of spin-off and start-up companies that are based on their intellectual property through licensing, royalty streams and equity. To benefit, they need to be flexible and responsive to commercial processes.

The University of Tasmania has recognised a number of barriers to commercialisation and is currently addressing two key issues. First, the University is contemplating the establishment of a funding mechanism to address the lack of funds to develop early phase innovation to a stage that is sufficiently advanced to interest a commercial partner.

Secondly, the University currently has proposals before it to change its Intellectual Property Policy to increase the incentives for researchers to be involved in commercialisation.

Potential spin-off and start-up companies have access to the existing technology incubator at the Tasmanian Technopark. This is an important resource that could facilitate the commercialisation of research and should be fully utilised by the biotechnology sector. The Technopark has had considerable success in the development of high technology start-ups, and would provide biotechnology firms with an appropriate environment in which to grow and develop.

Key Findings and Conclusions

A significant level of biotechnology related research and development occurs in public research organisations in Tasmania and a high proportion of the total (63%) is directed at commercial outcomes.

- The University and State Government should work closely together to secure continuing and new funding of basic research in priority areas.
- The State Government, public research institutions and industry should aim to increase funding for collaborative and applied research in strategic areas.
- Increasing the returns from research will provide public research institutions with a source of funding for basic and applied research.

The rate of commercialisation and returns from commercialised projects in public research institutions could be increased.

- Public research institutions should underpin an increasing focus on commercialisation with the expertise to manage IP developments, identify potential markets/uses and partners and manage legal and commercial negotiations with financiers and other partners.
- The University is currently examining ways to fund early phase development of its research and provide greater incentives for researchers to be involved in commercialisation.
- Scientific disciplines should expose students to basic and targeted business development and management principles.
- Management of contract research (where the commissioning party owns the outputs) should be distinct and separate to the management of research activity from which the organisation might ultimately seek a commercial return.
- The State Government should facilitate improved awareness about the availability of State and Federal Government funding programs and private sector services relating to the research, development and commercialisation of biotechnology.

There is a low level of awareness about intellectual property rights and the costs and benefits of patent coverage.

- The level of understanding of intellectual property is critical to maximising the value of research and development activity and should be improved.
- The importance of protecting and managing IP should be raised by disseminating information to targeted groups via briefings, seminars and other methods. This should be supplemented with improved and easier access by organisations to IP expertise including patent attorneys and specialist expertise in niche areas. DSD and other government agencies have a key role in assisting institutions and industry with access to information provided by IP Australia and other sources.

Small and medium biotechnology enterprises find it difficult to access finance.

- Access by SMEs to seed and early stage development financing that falls below the investment threshold of venture capitalists and other providers of development finance should be improved. Improved targeting of SMEs and better information on alternative early stage financing options will better equip SMEs to attract later stage development capital.
- Access to venture and development capital for smaller investments at the seed and early development stage is being facilitated through Commonwealth and State programs and services. Details of these programs are listed in Appendix C.

Recruitment of staff with specialised scientific, technical and business development skills is difficult, and is made more difficult by Australia's immigration legislation.

- Australia's immigration policies provide flexibility to address demonstrated skill gaps in niche areas. The length of time to complete approvals may vary depending on factors such as visa and other conditions relating to the country of origin. Tasmania works with the Commonwealth to facilitate access to Tasmania by migrants with the required specialist skills. The application and approval process should be monitored to identify areas that can be improved.
- A strategic assessment of specialised skill shortages in the medium term should identify areas of possible sustained skill shortages. Enrolment strategies can be refined and the content of courses altered to address identified needs where a significant and sustained mis-match is expected.
- The Skills Response Unit in DSD is one coordinating point to facilitate a more detailed examination of skill shortages, strategies and mechanisms to overcome shortages.

There are opportunities to strategically position the State to obtain Federal Government funding under the National Biotechnology Strategy and other programs.

- This can be achieved by working closely with the Federal Government, including the prior identification of Tasmania's strengths and capabilities in biotechnology.
- Tasmania should respond to strategic priorities where Commonwealth funding programs exclude relatively small-scale projects that require seed and early stage development capital.

Water quality, water availability and telecommunications infrastructure were seen as impediments to the development of some areas of the biotechnology sector.

- Access to water and inferior water quality were important infrastructure issues for the agriculture and aquaculture sectors. These types of issues are more relevant to users of biotechnology than developers. The State Government is preparing a

Water Development Plan to be completed by June 2001 to examine opportunities for irrigation.

- Inadequate telecommunications infrastructure, particularly poor telephone reception and lack of mobile phone coverage in regional areas was an issue reported by one in five respondents. The State Government is focussing on improving the telecommunications infrastructure within the State. A study into the alignment of telecommunications infrastructure with industry development goals is to be conducted as part of the Intelligent Island program.

Tasmania's quarantine and animal health status was seen as a key strength for the agriculture and aquaculture biotechnology sectors in Tasmania.

- There needs to be continued support for Tasmania's strict quarantine and animal health regulations.

Tasmania's temporary moratorium to prevent the growing of GM plant and plant materials other than in authorised contained research until a State policy position is reached (anticipated before 20 July 2001) is of concern to some parties in the agriculture biotechnology sector.

- The moratorium is not on biotechnology per se, but limited to plant and plant materials. The temporary moratorium is an opportunity to formulate an informed whole-of-government policy position on the issue. Importantly, authorised contained research on GM plant and plant materials is permitted during the formulation of a policy position on the issue.

Appendices

Appendix A Report Team, Participants and Contributors

Biotechnology Sector Analysis Project Team

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Huon Valley Mushrooms	Mike Brown
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North Forest Products	Greg Holz
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Pollution Solutions	David Archer
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Tas Tiger Abalone	Mike Wing
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Tasmanian Ornamental Fish Farm	Shane Willis
Thomas Enterprises Pty Ltd	Richard Thomas

Appendix B Breakdown of Biotechnology Sectors

Human Health - Bio

- diagnostics (e.g. immunodiagnostics, gene probes, biosensors)
- therapeutics (e.g. vaccines, immune stimulants, biopharmaceuticals, rational drug design, combinatorial chemistry)
- gene therapy (e.g. gene identification, gene constructs, gene delivery, xenotransplants)

Genomics/Bioinformatics/Bioprospecting

- genomics and molecular analysis (e.g. DNA/RNA/protein sequencing and databases for humans, plants, animals and microorganisms, structure function studies)

Ag-Bio

- plant biotechnology (e.g. tissue culture, embryogenesis, genetic markers, genetic engineering, plant breeding, floriculture)
- animal biotechnology (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering, animal breeding)
- biofertilisers, biopesticides, bioherbicides, biological additives, microbial pest control, hormones, pheramones, and other agrichemicals

General Biochemicals/Fine Chemical Feed Stock

- custom bio-synthesis of biologicals (e.g. peptides, proteins, nucleotides, hormones, growth factors)
- custom synthesis of fine chemicals (e.g. monomers, fuels, lubricants, fine chemical feed stocks, cosmetics)

Food Production and Processing

- food processing (e.g. food products, food components, enzymes, yeasts, bacteria culture)
- functional foods, additives, nutrichemicals (e.g. probiotics, unsaturated fatty acids)

Specialist Service Provider

- contract research and development to the biotechnology industry (e.g. high throughput screening, clinical trials)
- consulting to the biotechnology industry

Aquaculture/Marine Biotechnology

- fish health and nutrition (e.g. diagnostics, therapeutics)
- brood stock genetics and animal breeding (e.g. tracking superior traits, genetic modification, triploiding oyster seed)
- bioextraction and marine bioprospecting (e.g. polymers from seaweed, antifreeze, proteins from fish flavours, food additives from algae)

Mining/Energy/Petroleum/Chemicals

- microbiologically enhanced petroleum/mineral recovery

- cleaner industrial bioprocessing (e.g. biodesulphurization, biocracking, bio-recovery)

Forest Products

- silviculture (e.g. ectomycorrhizae, tissue culture, somatic embryogenesis, genetic markers, genetic engineering)
- cleaner industrial bioprocessing (e.g. biopulping, biobleaching, biological prevention of sapstain)

Environment

- biofiltration and treatments (e.g. treatment of organic emissions to air/water)
- bioremediation, waste management, phytoremediation (e.g. cleanup of toxic waste sites using microorganisms, marine bio-fouling, animal wastes)
- diagnostics (e.g. detection of toxic substances using bioindicators, biosensors, immunodiagnostics)

Equipment/Supplies and Bioengineering

- equipment manufacture, instruments, consumables, reagents
- bioengineering, large scale fermentation and contract manufacturing, down stream processing

Appendix C Biotechnology Industry Development Programs

National Programs

Biotechnology Australia was established in May 1999 to develop and coordinate the Federal Government's non-regulatory involvement in biotechnology, in particular:

- the development of the National Biotechnology Strategy released in July 2000;
- the development and implementation of a public awareness and information program;
- improved intellectual property strategy and management; and
- improved access to biological and genetic resources.

The Commonwealth Biotechnology Consultative Group (BIOCOG) was established in December 1998, and is made up of industry, research and government representatives, and reports to the Biotechnology Ministerial Council, as well as providing advice to Biotechnology Australia.

Commonwealth expenditure in 1999 on biotechnology research and development was more than $250 million distributed across a range of programs including:

- Higher Education Research Funding (24%)
- CSIRO (19%)
- National Health and Medical Research Institute (16%)
- Australian Research Council Grants (14%)
- Cooperative Research Centres Program (12%)
- R&D START Grants & Loans (6%)
- Rural R&D Corporations (8%)
- Pharmaceutical Industry Investment Program (1%)

The Australian Biotechnology Report was produced jointly by ISR and Ernst & Young and was released in October 1999, it provides a profile on the Australian biotechnology industry and its performance. Ernst & Young produce similar reports for the United States, Europe and Canada.

In July 2000 the National Biotechnology Strategy was released. This incorporated:

- a $20 million biotechnology innovation fund to provide proof of concept funds;
- a public awareness program which was allocated $4 million in funding to provide the public with balanced information on the applications of biotechnology and the regulatory systems that have been put in place;
- doubling of the national medical research budget through the National Health and Medical Research Council over the next five years;
- the Capital Gains Tax has been halved for individual investors, and reduced in line with reductions in company tax rates; and
- commercialisation of emerging technologies (COMET) program, this was launched in November 1999 with funding of $30 million over three years.

The strategy also includes a number of existing programs that have been repackaged into the National Biotechnology Strategy, these include:

- R&D Start Grants;
- CRC funding;
- R&D tax concession;
- Pooled Development Funds (PDFs);
- Innovation Investment Fund (IIF);
- Technology Diffusion Program;
- Special Research Centres Program;
- The Strategic Partnerships with Industry Research and Training (SPIRT);
- Science Lectureship Scheme; and
- Major National Research Facilities Program (MNRF)

Queensland

Queensland is investing $270 million over ten years in a Bioindustries Strategy. This strategy involves infrastructure development, resource development, accessing capital, commercialisation, communications and positioning. The Queensland Bioindustries Taskforce has been established in the Department of State and Regional Development to implement this strategy. In addition to this, the Minister for State Development has established a Biotechnology Advisory Group comprised of representatives from the bioindustries sector, the community and stakeholders.

The Queensland Government has invested a significant amount towards the establishment of the Institute for Molecular Bioscience (IMB) at the University of Queensland in conjunction with the CSIRO. They aim to have more than 700 world class scientists and researchers working at the institute by 2002.

They have also released a Code of Ethical Practice for Biotechnology in Queensland in conjunction with the Biotechnology Advisory Group.

New South Wales

The NSW Department of State and Regional Development manages a number of Innovation Advisory Centres. They offer advice to inventors and innovators who want to develop their ideas commercially. This agency also provides general investment attraction and facilitation services that are not specific to biotechnology.

Victoria

The Victorian Government has committed funding of $310 million over the five years to 2003-2004 for the development of Victoria's science, technology and innovation capabilities.

The Victorian Government has contributed $50 million towards the $400 million Bio21 Parkville Development. It is envisaged that all biotech precincts such as the Alfred Research and Education Precinct at Prahran and the Monash Medical Precinct at Clayton will all come under the Bio21 umbrella.

Bio21 will enable groups to share facilities and resources and develop projects on a collaborative basis. The founding partners of Bio21 include the Walter and Eliza Hall Institute of Medical Research and the University of Melbourne and the Royal Melbourne Hospital. It will also include a commercial arm, Bio21 Commercial, that will give local researchers and smaller biotech companies access to financial expertise and international markets and ensure that new discoveries reach their commercial potential and reap the economic rewards. Construction of the Parkville project will begin in October 2001.

Victoria is currently developing a Biotechnology Strategic Plan.

South Australia

South Australia has established a Biotechnology Office within the Premier's Department.

Western Australia

Western Australia has a WA State Agricultural Biotechnology Centre located within Murdoch University. They have a research staff of 55, with a total staff of 80. They involved in molecular biology research and development into primary production of commercial livestock or crop plants, or their subsequent processing for added value. They are involved in technology transfer, particularly to Agriculture WA and to industry. They develop the technology to the stage where it can be developed commercially by industry.

Australian Capital Territory

ACT Research and Development Grants Scheme aims to increase the availability of funding to small and medium enterprises wishing to undertake research and development. This is not targeted at any one industry.

The $4 million Canberra Business Development Fund (CBDF) is a public-private joint venture and provides funding for businesses in the ACT to turn innovative ideas into businesses.

The ACT also has other general business assistance and development programs.

Tasmania

Tasmania has a number of industry development programs supporting science, technology and innovation. These include:

The Innovation, Science and Technology Unit

The Innovation, Science and Technology (IST) Unit was established in early 1999 to support innovations, science and technology in Tasmania. The key objectives of the unit are to:

- assist the growth of science and technology based industry and research in Tasmania;

- develop and foster a culture of innovation across Tasmanian industry;
- develop and manage programs and projects that assist technology firms in Tasmania; and
- develop and manage programs and projects that assist the take up of technology by firms in Tasmania.

The IST Unit develops and manages the Tasmanian Innovations Program. This program has an annual budget of $1 million and offers financial assistance for small and medium-sized firms to commercialise innovative new products, services and processes. The Tasmanian Innovations Program is overseen by the Tasmanian Innovations Advisory Board.

The Innovations Program is being expanded to facilitate networking between innovators, investors and others to pursue the commercialisation of innovations. The first networking event, known as the i-cubed network was held in June 2000 and brought together venture capitalists, business angels, innovators and intermediaries. The IST Unit is also developing a database of business angels within Tasmania.

The IST Unit has also commenced initial work on developing a Tasmanian Science and Technology Policy with early input from other government departments, the University of Tasmania, CSIRO, and the Antarctic Division and others.

Tasmanian Technopark

The mission of the Tasmanian Technopark is to develop, support and market a viable, sustainable, internationally competitive technology and innovation based industry sector in Tasmania. The Tasmanian Technopark was created in 1988 in response to the demand for quality facilities for industries specialising in advanced technology research, development and manufacture.

Technopark Management Services (TMS) provides appropriate infrastructure to facilitate growth of technology and innovations based industry.

Finance Facilitation Program

Tasmania's Finance Facilitation Program (FFP) is a resource for businesses requiring financial assistance. The Department of State Development (DSD) works with firms to determine the best way to provide the funding needed to sustain growth and to encourage the development of new and emerging activities, so local businesses can achieve their full potential.

Over-reliance on debt funding from traditional banking sources has tended to limit the development of Tasmanian businesses, including many with high growth potential. The exploitation of equity capital opportunities is now critical to the growth prospects of the State's key industry sectors.

The FFP is an important element of the Tasmanian Government's Industry Development Plan, underpinning a commitment to increase the availability of suitable finance to enable Tasmanian businesses to grow. The strategic aim is to accelerate sustainable economic expansion in the State.

Through the DSD Finance and Finance Facilitation Unit, the Government is able to provide financial advice and assistance to projects of strategic importance to the local economy.

The unit's second function is the provision of finance facilitation services to assist local businesses to expand or fund new ventures. There is no charge for these services.

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