

CSIRO SUBMISSION TO THE HOUSE OF REPRESENTATIVES' STANDING
COMMITTEE ON INDUSTRY, SCIENCE AND RESOURCES INQUIRY INTO

INCREASING VALUE-ADDING TO AUSTRALIAN RAW MATERIALS

Terms of Reference

That the House of Representatives' Standing Committee on Industry, Science and Resources inquire into and report on the prospects of increasing value-adding to Australian raw materials. The Committee will start with an evaluation of the current state of value-adding in Australia, and how that compares internationally. This will provide a base from which to evaluate the following topics:

- incentives and impediments to investment;
- intellectual property rights;
- national / international marketing factors which may encourage or hinder Australian value-adding;
- government intervention, both nationally and internationally;
- the location of value-adding industries and projects in regional Australia;
- resource licensing / permit arrangements;
- the impact of vertical integration within particular industries; and
- the Australian skills base and any associated impediments.

INCREASING VALUE-ADDING TO AUSTRALIAN RAW MATERIALS

SUMMARY

Australia has potential to build further on its strengths - its ability to extract or grow high quality raw materials economically and its strong research base. Australia needs industries which develop and maintain a technological edge over their counterparts to be internationally competitive.

The key message of this Submission is that CSIRO is responding to industry needs, creating value and delivering leading edge technologies, services and advice, but more could be done. Investment in research is essential to future advances and to the successful management of broader economic and environmental challenges such as the restructuring and sustainability of traditional industries.

INTRODUCTION

This submission focuses on the contribution of research and development (R&D) in value-adding for resource-based industries in agriculture, forestry and fisheries, and minerals and energy.

It highlights the measures taken to ensure CSIRO's research is relevant to the development of internationally competitive Australian industries; identifies lessons that may be drawn from interactions with industry; demonstrates the importance of R&D through examples of the recent outcomes of CSIRO's research; and summarises CSIRO's strategic research issues and objectives for value-adding.

CSIRO AND INDUSTRY

CSIRO is committed to assisting Australian industry to be innovative through R&D. Our Strategic Research Plan recognises the importance to the Government of achieving a more diverse economy which builds on Australia's comparative advantages including its proximity to growing markets and natural resources (value-adding).

The Report of the Senate Rural and Regional Affairs and Transport References Committee (the Senate Inquiry), entitled *Value-adding in Agricultural Production* (May 1997), concluded that "research is essential for the future of value-adding to Australia's agricultural production. The Committee believes that for research to be as beneficial as possible it should be closely related to particular agricultural and related industries" (*Senate Hansard*).

The Government's response observed that while "there is considerable potential to enhance the value of our exports, it is critical to do so in the context of whether or not Australia can be internationally competitive in adding that value". It also commented that "decisions on value-enhancing activities are commercial ones and are the responsibility of industry" (*Senate Hansard*).

CSIRO ensures the relevance of its work through extensive consultation as part of its strategic planning process and commercial interactions.

□ Identifying needs of industry

CSIRO's research is planned and resourced on the basis of 22 Sectors that each represent an industry group, market or natural resource of national significance:

- Food Processing
- Forestry, Wood and Paper Industries
- Field Crops
- Horticulture
- Textiles, Clothing and Footwear
- Meat, Dairy and Aquaculture
- Mineral Processing and Metal Production
- Energy
- Petroleum
- Mineral Exploration and Mining
- Integrated Manufactured Products
- Information Technology & Telecommunications
- Services
- Measurement Standards
- Pharmaceuticals & Human Health
- Chemicals & Plastics
- Built Environment
- Marine
- Land and Water
- Biodiversity
- Climate and Atmosphere
- Radioastronomy

This approach enables CSIRO to adopt a **'whole of supply chain' integration**, either within a Sector (eg: Forestry, wood and paper industries or Textiles, clothing and footwear) or between Sectors (eg: Field crops and Food processing or Meat, dairy and aquaculture and Food processing). It also enables CSIRO to adopt a 'whole-of-CSIRO' approach to research problems and to form **multi-disciplinary research** teams. This integration and multi-disciplinary approach differentiates CSIRO from other research providers.

CSIRO's comprehensive, triennial **strategic planning process** considers the relative attractiveness and feasibility of R&D for each Sector. The attractiveness criterion focuses on the potential benefits of the research and Australia's ability to capture those benefits for economic, environmental or social purposes. The feasibility aspect considers our R&D capacity and potential. The process looks at the position of each Sector including its size, structure, growth and export potential. It also considers the uniqueness of the problems facing each Sector in Australia and the potential contribution of indigenous R&D.

Sector plans are developed with the assistance of external **Sector Advisory Committees**. These Committees play an important role in helping CSIRO to identify those points at which CSIRO research can make the greatest contribution and add the greatest value to a Sector. The conduct and delivery of research is undertaken by CSIRO's Divisions in accordance with Sector plans.

CSIRO is currently in the process of preparing its strategic research plan for the 2000-01 to 2002-03 triennium. While CSIRO's appropriation has been maintained, it is clear that current resources preclude further beneficial work in many project areas.

□ Commercial Linkages and the Value-adding Chain

CSIRO has a target to earn 30% of its funding from external sources, including industry. It collaborates with a variety of parties including large multi-national and Australian companies, small to medium-sized enterprises, industry associations, consortia including through the Cooperative Research Centres program, and through informal networks.

CSIRO's structure and commercial practices enable the Organisation to meet the R&D needs of business systems. An integrated approach has been developed that aims to satisfy the expectations of consumers. This is achieved through continual improvement of processes and relationships that support the efficient development and flow of products and services from producer to consumer, ie: supply chain management. This approach is in response to a number of social, economic and business factors such as the shift from supply driven to demand driven chains and the globalisation of markets and global sourcing. The three business incentives for chain formation are: meeting very specific and varied end user and consumer demands, capturing efficiencies and controlling costs, and reducing risks (quality, quantity and food safety). Long term relationships need to be built up, typically requiring the guarantee of year round supplies ('Chains of Success').

□ **Key Lessons from Interaction with Industry**

CSIRO's interactions with value-adding industries and experience in the adoption of new technology lead to the following observations:

- a) Technology developed through **R&D is essential** to the development of a prosperous value-adding industry. CSIRO technology, services and advice are making an impact. It is important both to focus research on particular niches and to have the capacity to adopt existing technology to Australia's circumstances.
- b) R&D investment decisions need to be taken in a total industry context with **a strong end-consumer focus**, as adoption decisions made by individual firms are largely influenced by the firm's relationship with buyers and suppliers in the chain.
 - In agriculture, the key point is the emergence of vertically-integrated supply chains, usually coordinated by a retailer, domestic or off-shore, or a food service operator. Primary producers are required to supply a product for a particular customer to a unique specification detailing product attributes, cost and logistics. The production-based commodity culture has shifted to a more end-user, demand-driven differentiated-product focus.
- c) In R&D terms, Australia is relatively small and needs to marshal its research effort. This involves increasing collaboration between funders, providers and users of research - industry, universities, government science agencies and State and Federal Governments. It is often **important to work with other research partners** with complementary skills to provide an integrated solution to an industry problem.
 - Australia needs **research facilities of world scale** to be competitive. CSIRO has recently entered a number of agreements with State Governments and universities to form joint ventures or develop facilities, notably:
 - Food Science Australia with the Victorian Government
 - the Institute of Molecular Biology with the Queensland Government and University of Queensland
 - the Centre for Sustainable Energy Research and Demonstration in Newcastle with the NSW Government
 - the National Centre for Petroleum and Minerals Resources Research with Curtin university and the Western Australian Government.
- d) Maintaining a **world class skills base** in Australia, which includes research and commercial management skills, is critical to taking advantage of Australia's unique resource base and gaining a 'first mover' market position.

ROLE OF R&D IN VALUE-ADDING

Australia's resource-based industries face three major challenges over the next ten years:

- to be competitive in the global trading environment
- to achieve ecologically sustainable development
- to operate profitably.

CSIRO agrees with the Senate Inquiry conclusion that the "use of new technology resulting from research and development programs will continue to have a significant impact on the future course and success of value-adding to Australia's agricultural production". It also supports the Government's observation that it is "important to emphasise that value enhancing goes beyond simply moving raw produce to processed goods. Value-enhancing encompasses any process or service in the supply chain that adds to or enhances the value of the product for the customer".

In this context, CSIRO conducts R&D for:

- process improvement for cost reduction and international competitiveness
- improvements to existing products for marketable differentiation
- new processes for new or cheaper products
- products new to Australia, with accepted markets elsewhere
- prior advice, modifications and improvements of purchased technology
- improved environmental protection

The following examples illustrate some of the ways R&D contributes to the development of new and existing value-adding industries. For further details please refer to the briefing for Government *Recent Outcomes of CSIRO Research for Australia* at [Appendix A](#).

□ **Minerals and Energy**

Magnesium is a major example of how a new, integrated value-adding industry may be created. CSIRO has been instrumental in developing new technologies which process magnesite ore and produce light weight metal ideal for applications in the vehicle and aviation industries. A final decision is to be made shortly on the establishment of a \$700 million Magmetal production plant in Australia - a result of a thirteen-year partnership between CSIRO and Queensland Metals Corporation (QMC). The partnership has attracted domestic and foreign investment. The production plant along with associated industries, is expected to create up to 1,400 jobs and a cluster of SMEs producing automobile components. (Further details are at [Appendix A](#), page 28. A full case study on Magnesium Metal is in [Appendix C](#) *Beyond Science: Managing Projects for Success* pages 64-71.)

Further opportunities are now being investigated. Major processing step improvements are possible with new technology and these are being linked through development of **magnesium alloys and casting technology** to potential downstream, value-adding markets.

One important application now being investigated is the opportunity to go further down the chain from titania ore to titanium metal to titanium alloy products.

The critical role of emerging new technologies such as bio-mineral processing of gold, copper and uranium ores, and high pressure leaching of nickel laterites is opening the doors to develop previously unavailable and/or uneconomic resources.

Regular incremental improvements in productivity are vital to the international competitiveness of Australia's commodity producers. In the minerals area, advances in **real time mineral analysis** and **precision ore sampling** have added value by increasing consumer confidence in the quality of ore delivered and have reduced waste. Further details are at [Appendix A](#), pages 32-33.

The following table shows the value-adding production steps that occur in a number of key mineral resources, and that underlie Australia's \$41 billion minerals industry exports. Technology is the key to these value-adding processes, and industrial research is necessary to improve quality, productivity and to keep costs at internationally competitive levels.

Value-Adding for Minerals and Energy

Examples of the breadth of value-adding, and export related, activities in the industry include:

Coal	→	steaming coal/ultra clean coal fuel/metallurgical coke
Oil	→	distillation products
Gas	→	liquid fuels
Bauxite	→	Alumina → aluminium billet → metallurgical products, castings
Ilmenite	→	synthetic rutile → titanium → titania pigment
Magnesite	→	magnesia → magnesium billet → cast products
Zinc sulphide	→	zinc metal (Korea Zinc)
Copper sulphide	→	copper metal → wire / tube
Nickel sulphide	→	nickel ingot
Cobalt	→	cobalt ingot
Tin oxide	→	tin ingot
Iron ore	→	Hot Briquetted Iron (HBI) plant
	→	HiSmelt product / billet
	→	specialty steels Iron/Neodymium/Chromium (Fe/Nd/Cr) ingot
Tungsten ore (King Island Schellite)	→	tungsten ingot
Manganese oxide	→	manganese ingot
		ferro manganese
Vanadium oxide	→	ferro vanadium alloy
	→	vanadium ingot
Zircon	→	zirconia → Partially Stabilised Zirconia (PSZ)
Rare earth oxides	→	misch metal / Cerium, Lanthanum, Neodymium, etc
Ferro alloys ingot	→	ferro manganese / ferro vanadium / ferro tungsten

An analysis of CSIRO's research for the minerals and energy area is at [Appendix D *Commitment, Collaboration and Impact*](#). Please refer to pages 62 to 111 for details on Coal Preparation, Comminution, Computational Fluid Dynamics, and Melt Chemistry & Sulfide Smelting.

NATURAL GAS : AN OPPORTUNITY FOR VALUE ADDING

The natural gas industry is a value-adding industry with enormous export earning potential that could benefit from a greater national focus. The following are some observations on the status of this industry:

Australia has very large gas reserves which, at current consumption levels, would probably last for more than 100 years. The gas is mostly offshore and increasingly in deeper water, putting pressure on costs. Domestic demand for gas is expected to increase rapidly (at 5% pa) to 28% of the energy mix by 2010. Regional demand should also increase as Asia recovers from the recent economic crisis. Whilst most of Australia's gas is remote from the market, the further development of the industry has important regional development implications, especially in Western Australia.

With the exception of the North West Shelf projects, Australia has been slow in responding to the opportunity offered by the natural gas endowment. Whilst existing facilities are providing good economy of scale for Liquid Natural Gas (LNG) and LNG exports have a value of \$5.7 Billion per annum, Australia's capacity is currently inadequate to realise the full potential benefit.

The current routes to add value to gas include:

- *Compression and liquefaction to sell gas as LNG.* This is currently limited by the need for new plants with larger capacity and the reluctance of companies to invest without large, long term purchasing contracts from major overseas users.
- *Pipeline distribution to sell as domestic and industrial gas (Domgas).* The deregulation of the industry has improved competitiveness.
- *Generation of power.* Gas is now favoured for environmental reasons.
- *Energy source* or reducing gas in minerals processing such as in Hot Briquetted Iron (HBI).

Australia's capacity to capture the benefits of gas processing depend on industry investment and the development of local technological capabilities. Producers depend mostly on overseas technology which is not always suited to Australia's unique conditions and they perform very little local R&D.

Routes for capturing further value will depend on Australian R&D directed at:

- Producing higher value liquid fuels
- Decreasing production costs for the various options such as gas drying and purification
- Increasing the competitiveness of the local producers to contribute to growth in exports.

In the assessment of priorities for the petroleum industry, the team of industrial experts who advise CSIRO on this Sector have ranked the potential value to Australia of gas processing at 8 on a 10 point scale. They underscored the need for a domestic capability to develop technology relevant to Australian conditions such as the high carbon dioxide content of some Australian gas and the deep offshore location of certain fields. CSIRO research will support the industry to expand by addressing productivity and technological issues unique to Australia.

Government support would be important for the development of an Australian technology base in gas processing, especially the development of Australia's skills base. University training in process and chemical engineering is well established at undergraduate level in Australia but not at the post-graduate level in the gas processing area. Companies have good operating skills but generally lack technology development skills.

□ **Agribusiness**

Restructuring Traditional Industries

Agriculture is becoming an increasingly high technology activity. The **dairy industry** is a good example of where technology has assisted the restructuring of a traditional industry. The industry has moved to larger and much more efficient farms, and developed a highly efficient export industry selling milk powders (and other dairy products) to Asia and the Middle East. (Details at [Appendix A](#), page 79.)

Furthermore, the dairy industry is also using various growth factors from milk to produce novel, highly advanced and highly technical products which are selling world wide. For example, a new small bio-technology company Gro-Pep has appeared, producing ‘growth factors’ that aid healing and health.

It is possible that similarly major developments could happen to the **wool industry**, with moves away from visual classing to objective measurements in the shed, accompanied by far more rapid selling and distribution process with less money tied up in ‘work in progress’ and, most importantly, new wool-based products that combine the best features of wool with those of cotton and synthetics, such as sportswool and wool jeans. (Details of some of the new technologies available to support the wool industry are at [Appendix A](#), pages 61 to 64.)

Given wool's natural disadvantages compared with synthetics, such as the much higher cost to produce spun yarn and its lower processing strength, CSIRO considers that technological changes related to the whole chain - the farm, the factory and the wearer - are all essential if this industry is to have a prosperous future.

Market Pull : Quality Assurance Demands

There are growing consumer demands for ‘green’ or environmentally clean and sensitive food, fibres, timber and timber products, and for wholesome, nutritious, safe food. These ‘market pull’ quality assurance demands, enforced by retailers, are ensuring innovation and technology adoption in relevant industries.

There are demands from food processing companies for differentiated, quality raw ingredients as they take account of changing demographics, including changing food requirements of an aging population and changing family structures and income distribution.

Also forcing changes is focus on ecological sustainability, including concerns about greenhouse gas production and land and water quality.

These demands will ensure change in terms of industry innovation and technology adoption, and in particular lead to more value-adding to food, fibres, timber and timber products, both for domestic consumption and export. However, it should be noted that value adding does not necessarily require a processing transformation. For example, to meet niche market requirements, a wheat variety may have been bred specifically to meet the taste and texture expectations of East Asian noodle consumers or the wheat kept insect free in storage without the use of pesticides. The use of gene technology in plant breeding is a value-adding process. (Details of some of the new technologies available to support the food industry are at [Appendix A](#), pages 76 to 78.)

More details of CSIRO’s support for *Value-adding in Agribusiness* are provided at [Attachment A](#). Also provided are the Executive Summary of *CSIRO’s submission to the Wool Industry Future Direction Task Force* at [Attachment B](#), and *CSIRO’s Involvement with the Australian Food Industry in Exports to Asia* at [Attachment C](#).

FOREST PRODUCTS - AN OPPORTUNITY FOR VALUE-ADDING

The forest products industry is a value-adding industry with import replacement and export earning potential. The following are some observations on the status of this industry:

Australia has an annual net trade deficit in forest products in the order of \$1.5 to \$1.8 billion. While it is the fifth biggest exporter of forest products in volume terms, Australia is a major importer of high value products (particularly pulp and paper products). Australia exports more than 30% of the harvested wood at the relatively low prices of woodchips.

The commercial potential for expanding the forest products industry in Australia is considerable. The availability of logs over the next decade is expected to increase by about 30%. This will further increase with new plantings developed as part of the Government-Industry “Plantations 2020 Vision”. In value terms, an average seven-fold increase is achieved when going from logs to products. The industry also makes an important contribution to regional employment.

The major opportunities in value adding appear to be:

- a) Greater onshore processing into pulp and paper products of the woodchips currently exported. Some observers believe Australia has the opportunity for one or two world class pulp and paper mills.
- b) Use of the expanding wood supply through sawmilling for solid wood products or in a range of wood composites. The smaller scale resource and lower capital requirements associated with composites, veneer and solid wood product manufacture offers opportunities for regional processing and further employment.
- c) Use of residual wood from harvesting operations (silvicultural residues) and from processing plants for heat energy, carbon products or liquid fuels (ethanol).
- d) Use of lower quality wood in higher value products for appearance products in the building industry or products such as furniture.

Australia’s capacity to capture more value depends on industry investment and further R&D. There is a need to look carefully at the level of investment in research and skills development. The following examples illustrate the varied role R&D has played in adding value to the primary wood resource:

1. New approaches to utilisation effectively take native forest hardwood to higher value structural and appearance grade markets (flooring, furniture, etc). CSIRO showed industry that it was technically feasible to substitute regrowth logs for old growth. Over the past decade, more than 100 hardwood drying units have been installed in Victoria to allow value adding to the hardwood resource.
2. High temperature drying technology also enables radiata pine to be produced as a straight and stable timber for building and furniture manufacture. Radiata pine is now the primary house framing material in Australia.
3. A technical protocol for the establishment of pulp mills, including the management of effluents, was developed by a CSIRO-led team after the failure of the 1989 Wesley Vale proposal. This provides clear guidelines for environmental management associated with any green fields pulp and paper mill development.

□ **Strategic Research Issues / Objectives**

The following is a list by Sector of some of the strategic research issues and objectives in CSIRO relevant to value-adding:

Sector	Some Strategic Research Issues / Objectives
Services	Supply chain management
	Electronic service delivery
Information Technology and Telecommunications	Internet marketplace
Integrated Manufactured Products	Lighter weight, more energy efficient vehicles and transport equipment
	Integrated minerals-metal production-manufacturing chain
	Sensing and monitoring products and systems for the manufacturing, mining and service industries
Chemicals and Plastics	Clever chemicals for grain storage
	Smart packaging
Energy	Development of high efficiency, cost effective energy storage
	Cleaner, more efficient power generation from fossil; fuels with lower greenhouse gas emissions
	Coal briquettes, including pyrolysed with or without biomass, for household fuel
	Liquid fuels from oil shale and biomass as well as from gas
Petroleum	Increased value from gas production and processing
Mineral Processing and Metal Production	Technologies for process improvement
	Techniques to increase asset utilisation
	Techniques to treat difficult-to-treat ores
	Technologies for differentiating Australia's commodities
	Establishment of new light metal industries
Field Crops	Post-harvest technologies for quality, yield and market advantage
	Gene technology for value-added plant products
Food Processing	Consumer issues as the key to market success
	Efficient product manufacture and delivery systems
	Food and drink safety
	Ingredients innovation
	Diet and health
Forestry, Wood and Paper Industries	Wood processing and value added products
	Fibre quality, papermaking and paper quality
Horticulture	Maintaining product quality, safety and market access post harvest
	Gene technology for value-added plant products

Sector	Some Strategic Research Issues / Objectives
Meat, Dairy and Aquaculture	Consumer demands identified, understood and applied
	Minimising undesired impacts of production and processing systems
	More efficient production and processing systems
Textiles, Clothing And Footwear	Sustainable fibre and leather production
	Enabling technologies for new consumer products
	Innovative processing for quality and efficiency

Attachments

Attachment A	Value-Adding in Agribusiness
Attachment B	Executive Summary of CSIRO's Submission to the Wool Industry Future Direction Task Force
Attachment C	CSIRO's Involvement with the Australian Food Industry in Exports to Asia

Further Information

For further information please refer to:

Appendix A	CSIRO <i>Recent Outcomes of CSIRO Research for Australia : A Briefing to Government</i> November 1998
Appendix B	CSIRO <i>Strategic Research Plan 1997-98 to 1999-2000</i> (The strategic plan for 2000-01 to 2002-03 will be released in mid 2000.)
Appendix C	CSIRO <i>Beyond Science : Managing Projects for Success</i> , 1998
Appendix D	CSIRO <i>Commitment, Collaboration and Impact: CSIRO Minerals and Energy Research</i> , Parts 1 and 2, 1998

References

- *Senate Hansard* Commonwealth of Australia Parliamentary Debates, Senate Official Hansard, Tuesday, 23 June 1998
- *'Chains of Success' : Case Studies on International and Australian Food Businesses Cooperating to Compete in the Global Market* Supermarket to Asia Limited and the Departments of Primary Industries and Energy, and Transport and Regional Development. September 1998, ISBN 0-642-47316-1
- Industry Commission (1993) *Adding Further Value to Australia's Forest Products* Report Number 32, AGPS
- ABARE (1999) *Forest Products, Long-Term Consumption Projections for Australia* Graham Love, Alasebu Yainshet and Peter Grist, ABARE Research Report Number 99.5

VALUE-ADDING IN AGRIBUSINESS

The following provides background and detail on value-adding activities, by CSIRO Sector, as well as examples of significant outcomes of CSIRO R&D:

- Field Crops
- Food Processing
- Forestry, Wood and Paper Industries
- Horticulture
- Meat, Dairy and Aquaculture
- Textiles, Clothing and Footwear

FIELD CROPS SECTOR

Background

The prospects for growth in the grain, legume and pulse industries, both in commodity quantity and in product quality differentiation, are high. The Sector adds value both directly to on-farm inputs, and also indirectly to post-farm gate operations through attention to processing efficiency and quality attributes. The Sector faces some major challenges and changes in its operating environment:

- foremost is the transformation of the large agrichemical companies into life sciences companies. The entry of biology and biological research into the patent system has transformed agriculture into AgriBUSINESS. Gene technology and its related intellectual property (IP) situations will have a prominent role in the future of global crop production and trade. As the multinational companies invest in biotechnology, and gene technologies in particular, they are building up business systems of large dimensions where they control many enabling and generic IP positions for genetically modified crops, and
- the sector also faces potential market failure on a large scale as a consequence of the potential blocking IP positions of multinationals. Australian industries need to be positioned with their own valuable IP, enabling them to negotiate positions of freedom-to-operate in their own right and/or on appropriate terms in joint ventures with the multinationals. Such alliances will give Australian agriculture access to the enabling technologies needed by our industries.

Thus, recently formed alliances of direct or indirect interest to CSIRO include:

- *CSIRO Cotton varieties* - The grower-owned licensee of the highly successful CSIRO bred cotton varieties in Australia, Cotton Seed Distributors Ltd, has taken a major step to break into the US cotton seed market by entering into a joint venture through its wholly owned subsidiary, Cotton Seed International, with AgrEvo, one of the world's biggest agrochemical and biotechnology companies. In 1997 some 1200 tonnes of seed (25% of Australian sales) were shipped with the eventual aim of seed production in the US, sourcing novel traits from CSIRO germplasm combined with AgrEvo technology for the international program. This relationship will provide the opportunity for CSIRO to develop new varieties with superior

pest resistance, quantity and field performance for the Australian industry. It also makes possible a strategic alliance with AgrEvo to access other proprietary technologies which will bring a key benefit to the Australian agriculture industry.

- *AgrEvo/CSIRO Strategic Research Alliance* : A Strategic Research and Licence Agreement has been made with AgrEvo Germany and AgrEvo Australia in a five year research collaboration involving CSIRO and the Australian National University. The field of research covers genetically transformed seed and provides commercial opportunities for AgrEvo to exploit project technology internationally with special provision to protect the Australian industry. The Alliance provides CSIRO access to AgrEvo enabling and trait technology so as to provide CSIRO the opportunity to exploit other technology which would otherwise be restricted.
- *Graingene* : The 'core' of Graingene is a Joint Venture between three key parties in the Australian Grains Industry: the Australian Wheat Board Limited, CSIRO and the Grains Research and Development Corporation (GRDC). Its purpose is to enhance Australia's investment and capability in new technologies and develop innovative IP, to enable the Australian grains industry to prosper by capitalising on Australia's discoveries and by gaining access to essential IP owned by others. In addition, Graingene will draw in 'associate' research, breeding and commercialisation companies where they have expertise and IP positions in specific projects.

Australian food processing companies and public breeding groups are now aware of the growing importance of product differentiation and quality traits, and food safety in cropping products. Product differentiation will be critical for international trade. Gene technologies, apart from their direct role in breeding new cultivars, are making major contributions to the understanding of the metabolic pathways behind many quality traits. These advances have been responsible for the increasing participation of food processing companies in support of CSIRO research. The differentiation of products needed for particular markets with an emphasis on food quality, coupled with the demand for decreased chemical residues in crop products, has highlighted the need for enhanced research into the correct storage and handling of grain commodities.

Some Value-Added Research Outcomes

Better grain storage - Control systems are now an integral part of the grain storage and handling system. CSIRO's PMCAM (Programmable Microprocessor Control and Monitoring) system is a multipurpose computer-based data control system developed for aeration practices, which can be programmed to control different equipment, to log system information in files, and to remotely control the equipment and collect data. Results have confirmed that using this system, it is possible to reduce reliance on pesticides and fumigants in well-controlled and managed existing aeration facilities. In several of the trials, grain was stored in aerated, commercial stores for six months or more without applying protectant or fumigant, and successfully met market specification with regard to insect infestation (usually nil tolerance).

Cotton varieties - Ninety percent of the seed used to grow Australia's billion dollar cotton export crop was bred by CSIRO. The industry is now enjoying yields that are up to 20% greater than 10 years ago as well as advantages in cotton quality, pest tolerance, disease resistance and profit. CSIRO varieties are responsible for one third of this increase, the remainder from improved management practices. There are now six transgenic varieties that have reduced pesticide use by

50-60%. The investment of around \$30 million in CSIRO's cotton breeding research program has produced seed varieties suitable for widely varying Australian conditions and generated seed sales of up to \$15 million per annum in Australia. Projected sales will increase primarily as a result of global trading of CSIRO varieties and the introduction of transgenic cotton seed.

Whiter sugar - Using gene technology, CSIRO scientists are developing purer, whiter sugar. This research has the potential to give Australia's \$2 billion sugar industry an international competitive edge. Experiments are under way to produce low colour sugarcane varieties to reduce the browning of raw sugar - an advance that could save the sugar refining industry up to \$5 million per year in colour removal costs. Browning in sugar is due in large part to the activity of an enzyme. The gene that gives rise to this enzyme has been isolated from sugarcane and efforts are underway to reduce the production of the enzyme and so reduce the browning.

Industrial quality plant oils - CSIRO scientists collaborating with colleagues at the Swedish University of Agricultural Sciences have cloned the first plant genes for enzymes that insert epoxy groups or carbon triple bonds into fatty acids. This is an important first step towards developing oilseed crops that contain high levels of epoxy or acetylenic oils, that would be valuable raw materials for the plastics and specialty chemical industries. The research was recently published in the journal *Science* and international patents have been filed jointly by CSIRO and the Swedish group. Possible R&D collaborations with major chemical and polymer companies are now being explored.

FOOD PROCESSING SECTOR

Background

The industry's strengths include a reputation for food product quality, hygiene, safety, and freedom from contaminants, and access to a cost-competitive supply of a wide variety of raw commodities. There are also companies with leading edge technology that can be leveraged through a more highly focused and capable R&D network. The industry has proximity to the expanding international food markets, particularly the Asia-Pacific, and a multicultural domestic market demanding diversity in products which equips the industry for export markets.

The key science and technology trends are being driven by consumer demand for natural, affordable, appealing, convenient, nutritionally enhanced products that are safe. This creates powerful pre-competitive drivers in nutrition and food safety for strategic generic R&D and for more product-focussed, market end R&D better suited to individual projects with a limited numbers of partners and an appropriate focus on intellectual property protection.

Medium term outlook is for sector expansion, impact of globalisation and trade liberalisation as R&D drivers particularly to lift industry efficiency (Australia : 60% world's best practice), commercial relevance and value for money will be central to agreements between companies and R&D providers, and the critical role of R&D for business success and growth will need to be established and maintained.

Some Value-Added Research Outcomes

- New specialised milk powders for use in recombined milks were developed, winning the 1998 Sir Ian McLennan Achievement for Industry Award. Significant export market penetration has resulted.
- New performance-based microbiological standards for the fermented meat industry resulting from the investigation of the ecology of pathogenic *E coli* in fermented meat.
- Technology has been developed to enable reduction in raw material costs whilst improving or maintaining the quality of set and stirred yoghurts, thus enabling significant savings in yoghurt manufacture.
- Grain legumes have a limited market and limited value as ‘bulk commodity’ products. Therefore, a grain legume (pea) flour was fractionated into a starch-rich and a protein-rich fraction. From the protein-rich fraction, a range of aquaculture-feeds were formulated, produced, evaluated and successfully developed for various fish species to replace the relatively expensive fish meal which is mainly imported. The starch-rich fraction was successfully used to develop a range of crisp breads aimed at the health foods market.
- Scientists at CSIRO Plant Industry have, using traditional breeding techniques, developed barley varieties for low-haze beer. Lines of three varieties have been produced and are currently being grown for seed increase and testing for agronomic and malting barley characteristics. Using gene technology, scientists have also developed transgenic barley lines with new genes for improvement of malting quality and virus resistance. These are currently being assessed in the laboratory and small-scale field trials.
- The activity of piscicolin 126 as an anti-listerial agent has been demonstrated in soft cheese and ham paste. In both trials, the shelf life of the product seeded with *Listeria monocytogenes* was significantly increased. Negotiations for the commercial production of the bacteriocin with a major food ingredients manufacturer are proceeding through the CRC for International Food Manufacture and Packaging Science.

A major reduction in the fragmentation of Australia’s public sector effort in food processing R&D has been achieved. CSIRO and the Victorian Government’s Australian Food Industry Science Centre (Afisc) have formed an unincorporated joint venture called Food Science Australia. All of the staff and other resources of CSIRO’s Division of Food Science and Technology and Afisc are now managed jointly within a single management structure in the joint venture. Food Science Australia has been trading since 1 December 1997. Negotiations are in progress with the Queensland Government’s Centre for Food Technology, to determine whether it is possible for the Centre to form a closer working relationship with Food Science Australia.

FORESTRY, WOOD AND PAPER INDUSTRIES SECTOR

Background

Australia's forest-based industries are expanding. Australia has the potential to become a net exporter of forest products beyond 2005. Wood supply will increase as softwood and hardwood plantations mature. Domestic sawn wood will eventually exceed imports with an exportable surplus likely in the next three to five years. Wood-based panel production is expected to exceed domestic consumption over the medium term with a net surplus available for export. Pulpwood availability is expected to increase significantly and wood chip exports are expected to increase, with Japan taking most of our exports. Paper consumption is expected to grow by 13% over the next 5 years.

Key drivers are international ecological sustainability policies, declining native forest access, plantation expansion, greenhouse gas issues, supply of environmental benefits, increasing consumer focus, globalisation of value-added products, wood substitute competition, better composites, demand for high performance paper / paper board, green labelling and recognition of role of R&D. The Sector's response to the Government's vision of trebling the plantation area to 3 m hectares by 2020 will also be critical as will the need to facilitate improvement of the quality of exports to ensure continued differentiated market access.

Some Value-Added Research Outcomes

- A graphical numerical model of the physical processes involved in the high-temperature drying of softwoods has been developed for application in kiln design and operation in order to reduce stresses and deformities in pine board and increase performance and reliability. Initial collaborators were two companies; to date one has installed the model for refinement of kiln schedules at two sites while the other is interested in implications for kiln design.
- A prototype radio frequency vacuum drying chamber has been designed and constructed for use in the drying of hardwoods for niche market appearance products. It is aimed at enhancing drying processes at present used by industry to achieve rapid and efficient drying to high quality with minimal deformation.
- Measurement of fibre properties and relating properties to product needs and characteristics was facilitated by the development of rapid computer tomography scanning using the technologies incorporated in SilviScan-1 applicable to softwoods and now extended to hardwoods using SilviScan-2. Linkages with industry are achieved through the relevant CRC and other projects to evaluate relationships with wood and product properties.
- Trecor® – a new tree-coring instrument allowing quicker and easier sampling and testing of wood properties. Approximately 40 units have been sold locally and overseas, and overseas patents coverage sought.
- Products such as adhesives and reconstituted wood composites for veneers and fibreboards have been developed utilising hardwood forest and mill residues. Adhesives research results have been taken up by the resin manufacturing industry and the resin system is used by a board manufacturing company.

- A suite of manuals has been produced for the utilisation of Australian native and plantation hardwoods for quality value-adding in the furniture and appearance products industry and the potential for replacement of high value imports. The manuals are currently used by the Timber Promotion Council, Victoria, in conjunction with timber producers in the marketing of Australian timbers in the US, and also by a fine furniture production company.

Establishment, management and use of forests is a major national priority linked to international forest policy in areas of biodiversity, sustainable management and greenhouse gas emissions. This priority is evidenced by the appointment in October 1998 of the first Federal Minister for Forests and Conservation. All levels of government in Australia recognise the Sector's contribution to economic, social regional and environmental development. The priority is also reflected in various key national policy initiatives, including the National Forest Policy Statement (1992), the Wood and Paper Industries Strategy (1995), the international Montreal Process on sustainable forest management (1995), the Plantations Vision 2020 (1997), Australia's Response to Climate Change (1997) and the Minister's proposed Action Agenda (1999). CSIRO will continue to contribute to policy development for the Sector.

HORTICULTURE SECTOR

Background

Australia produces a wide range of temperate and tropical fruits, nuts herbs and vegetables with capacity to supply off-season products to the Northern Hemisphere. Domestic and export markets are growing. Three Common issues that are now emerging are the need for crop integrity/surety (paddock to plate management), GMO and genetic marker means of crop improvement, and sustained market access through management of new pest and disease incursions. Related to this will be the need to develop crop prediction systems to assist producers plan effectively and, particularly, to enhance supplier / retailer capacity to meet consumer demands and in a timely manner, both here and overseas.

Consumers see a strong correlation between fruits, vegetables and human health. These changes have brought pressure for increased production, with tighter product specifications, requiring higher inputs and sometimes carrying more risk. For example, prepared salads are part of the trend to minimally processed, packaged foods that must be prepared and distributed under carefully-controlled conditions. To extend shelf life, these products may be packaged in modified atmospheres. Because of their high moisture content, and the absence of any 'terminal lethality treatment' (e.g. pasteurisation) any temperature abuse may allow the growth of human foodborne pathogens such as Salmonella, Listeria, Aeromonas and Yersinia. Significant research is being undertaken to address these issues.

Some Value-Added Research Outcomes

- Based on CSIRO's successful transformation of grapevines, industry has been eager to support our integrated, long-term research plan "Grapevines for the New Millennium". Sultana vines transformed with the PPO (browning) antisense gene are being planted (with GMAC permission) at Merbein. Light coloured sultanas are an industry goal, as are fungal disease resistance, colour and quality improvement and enhanced water use efficiency.

- Researchers have identified genes critical to flowering and fruit production. This has led to a new mango flowering research project in Darwin to complement existing work on chemical induction of mango flowering and fruit set and experiments to generate seedless citrus.
- The development of Elisa kits enables detection of pesticide residues in grapes, dried fruit; species of exotic fruit flies in export fruit for the Australian Quarantine and Inspection Service (AQIS); and the work will expand to other products including wine and fruit juice.

MEAT, DAIRY AND AQUACULTURE SECTOR

Background

Research by CSIRO in meat, dairy and aquaculture includes efficient production, sustainable resource use, manufactured inputs and market and consumer issues. The primary strategy for the future of CSIRO in the sector is to develop exciting new products, technologies and production systems in a cost effective and environmentally sustainable fashion. These will help industry enhance international competitiveness, ecologically sustainable development, reduce the risk and consequences of disease outbreaks, expand market access through product development and researching consumer demand, and enhance efficiency and profitability of the industry. In the coming triennium the sector will seek to achieve faster rates of adoption by working more directly with clients and in collaboration with other research providers, and by establishing improved dialogue with industry groups and peak councils.

Some Value-Added Research Outcomes

- *Replacing fishmeal in aquaculture diets* : CSIRO, together with colleagues in the Aquaculture Diet Development Project funded by the Fisheries R&D Corporation, have formulated aquaculture diets that reduce dependence on expensive fishmeal. Up to two-thirds of fishmeal protein in prawn diets and virtually all the fishmeal in barramundi diets can be replaced with high quality meat meals. In addition, new micro-algal strains have been introduced as live feeds in the aquaculture industry and have demonstrated enhanced growth in Pacific oysters (*Crassostrea gigas*) when used as a supplement to the traditional micro-algal feeds.
- *Baby oyster formula* : Australia's \$15 million Pacific oyster-growing industry is being nurtured to new levels of growth through a dietary formula created for the industry's nursery. CSIRO, the Cooperative Research Centre for Aquaculture and industry marine researchers are developing a more efficient, cost effective and naturally-sourced formula for seed oysters, using cultured algae and pastes. With this diet, they have tripled the growth of oysters over a 3-week period.
- *Defining and mapping genetic traits in cattle and prawns* : CSIRO scientists have made impressive progress in their efforts to identify, characterise and utilise genes associated with economically important attributes in livestock. Markers associated with tenderness, yield, and marbling in ten chromosomal regions have been evaluated in Angus, Brahman, Belmont Red, Hereford, Murray Grey, Santa Gertrudis and Shorthorn breeds in conjunction with the CRC (Meat Quality). A first prawn genetic map has also been produced, and is improving the understanding of the underlying genetic basis for improving the breeding and management of farmed aquaculture species.

- *Premium quality system for analysis of veterinary pharmaceuticals* : CSIRO provides an analytical service to support the registration process for anthelmintic formulations developed by pharmaceutical companies for the Australian livestock industries. To meet the increasing demand for improved quality management in this area, scientists have developed the analytical procedures to gain AS/NZS ISO9002 accreditation. The procedures used for detection and quantification of a range of anthelmintic chemical classes in a wide variety of biological fluids and tissues are currently in the final stages of Good Laboratory Practice accreditation through the National Association of Testing Authorities. The demand for and success of this service is evident from the steadily increasing repeat business from both Australian and international animal health companies.
- *Aquaculture production and coastal management* : CSIRO , through cooperative projects with several State departments, has developed a Geographic Information System to assist industry investors and environmental managers to optimise aquaculture production and coastal zone management through appropriate site selection. Computer software developed in collaboration with the CRC for Aquaculture is assisting aquaculture farmers to improve production by monitoring the environmental conditions in their ponds. Models derived from the data are allowing accurate forecasts of production cycles to meet specific market demands.
- *Attitudinal, demographic and cultural determinants of food choice* : The production of healthy foods is an important goal for the Australian Agribusiness sectors. Analysis of consumer views by CSIRO Human Nutrition assists industry to work towards this goal. The effects of factors such as gender, age, ethnicity, income, occupation and education on food and nutrient intake, and to a lesser extent on dietary change, have been studied in several developed societies. However, mean differences in dietary intakes between social groups are often smaller than might be expected, given the variation in nutritional health status. While it has been recognised for some time that health related behaviours can be strongly influenced by a range of psychosocial factors, these factors have received relatively little attention in relation to diet.

Studies undertaken in three Asian countries and in Australia have shown a number of cross cultural differences in the key determinants of food choice which relate to personal value systems but which also vary across food products. Studies of migrant groups from the Asian region are also underway, in collaboration with sensory and nutrition specialists in key Malaysian Universities, to gain an understanding of the effects of migration on food choice and the relevance of this in relation to the use of migrant groups for tasting of foods.

- *Outsize prawns* : Japanese King Prawns, which grow up to 25% faster or larger than wild-caught prawns, have been developed by scientists in CSIRO working with a local prawn farmer. The advance has given Australia a chance to lead the world in the selective breeding of crustaceans for the burgeoning \$400 million a year aquaculture industry. Several breeding techniques were combined to produce these prawns, which have a very high value on the Japanese market.
- *Asian markets for Australian meat* : As part of its Food into Asia Program, CSIRO and the Meat Research Corporation undertook a project to identify past and current trends in food and nutrient intake and health status in the Asian region. They also identified socioeconomic

predictors of change, health and nutrition policies that could impinge on the future marketplace for beef, consumer attitudes to a range of foods, current eating practices, knowledge about the links between diet and health and sources of information about food and nutrition. Consumer surveys were undertaken in three key markets: Japan, Korea and Taiwan.

TEXTILES, CLOTHING AND FOOTWEAR SECTOR

Background

The Australian textile, clothing, footwear and leather (TCF & L) industries have the potential to add considerable value to Australian wool, cotton, hides and skins. At present this potential is far from realised due to structural issues within the industries, poor communication up and down the production and processing pipeline and a culture which has been slow to embrace innovation. Australia produces over 70% of the world's apparel wool, exports over 80% of its cotton in an unprocessed state and is a major supplier of hides, woolskins and part processed leather (wet-blue) to world markets.

The Australian TCF & L Industries have been undergoing substantial change during the last two decades not only as a result of the global changes in production and processing but because of the changes stimulated by the Button Plan (1987) which was designed to bring about a restructuring of the industry to make it more globally competitive, outward looking, export oriented and innovative. Despite substantial changes for the better sectors of the industry are among the most protected in Australian industry. Protection has been a brake on innovation, investment and the use of modern work practices. There are now, however, increasing signs that the TCF and L industries have reached the bottom of the economic trough and are now on the road to recovery and regeneration.

Industry and public reaction to the recommended decrease in tariffs as a result of the Productivity Commission's 1997 enquiry into the Textiles, Clothing and Footwear Industries and the cessation of the Import Credit Scheme in the year 2000 has led the Federal Government to initiate a consultative process with industry - "An Action Agenda" - to develop a strategic plan for the TCF and leather industries. The Productivity Commission's Report identified five key areas which need addressing by the Australian TCF industries: the industries must become more innovative and must improve their use and development of new technology; information dissemination regarding technology, supply and market opportunities needs to be improved, particularly for the large numbers of small to medium sized firms; TCF firms must place a greater emphasis on quality processes and products; stronger links must be formed between suppliers and customers along the supply chain; and the skill levels of TCF management and labour must be improved.

An integral part of the Action Agenda is the proposed Strategic Investment Plan which is designed to encourage innovation in the TCF & Leather industries in preparation for tariff reductions in 2005. The program is focussed on product innovation and the stimulation of added value production. It is a clear signal that Government is prepared to support the industries and provides an opportunity for CSIRO to assist in areas of new product development. Though the details of Government's TCF 2000 Plan to speed up the restructuring of the TCF & L Industries and provide a boost for innovation in preparation for the tariff reductions in 2005 is yet to be finalised, the Action Agenda program is well underway with industry-wide working groups developing strategies for key areas. The TCF 2000 Plan is an important one as it should stimulate opportunities and incentives to process more raw materials in Australia.

Of similar importance is the impact of the Government's Taskforce Review of the Wool Industry. Though wool is Australia's most significant textile raw material the Wool Industry, like the TCF Industries, requires fundamental and drastic restructuring especially in production, harvesting, distribution and marketing to ensure that it retains its importance to the national economy into the next millennium. CSIRO has developed and continues to develop technology that provides the technical platform for the structural reform of the Wool Industry.

While Australia produces the bulk of the world's apparel wool, wool's total share of the world's textile fibre market has shrunk to 3% though its total consumption has remained fairly constant. The natural expansion of the textile market due to population growth has been met by the dramatic rise in the use of synthetic fibres. Wool's unique properties are less advantageous in a market geared to apparel characterised by cheapness, low maintenance and casualness. Production and sheep numbers are now declining as producers leave the land or change to cropping. Further, synthetics have become relatively cheaper and new generation synthetic fibres offer properties which not only compete with those of wool but also provide novel and exciting properties which have consumer appeal. The declining fortunes of the wool industry contrast with those in the Australian cotton industry where both productivity and profitability have increased substantially. There have been significant increases in plantings although only 10% of the cotton is spun to yarn in Australia.

Only 15% of Australia's wool clip is processed in Australia to top (wool which is scoured and combed) and only 1% is processed through to the next stage, yarn. Wool marketing, distribution and processing are complex and characterised by lack of vertical integration from the time wool leaves the farm gate. There is inadequate communication along the pipeline from the retailer to the wool grower. The costs of production and inefficiencies in marketing and distribution make wool yarn 2.5-3 times more expensive than cotton or synthetic yarns.

The Australian cotton crop is produced and marketed using world best practice in sharp contrast to the situation for wool which suffers from entrenched conservative practices and culture. Though the Australian cotton yarn industry is world competitive and Australian spinning plants are run to world's best practice with near maximum utilisation rates there is still considerable scope to add value to raw cotton in Australia. By way of example around 2 million bales of cotton will be exported from Australia in the year 2000 but we will import the equivalent to 520,000 bales in the form of yarn, fabric and apparel.

Environmental and social sustainability of wool and cotton production are important issues for the future. Issues of land degradation through erosion, salination and incorrect grazing procedures are critical issues for sustainable wool production as are the use of water and pesticides for cotton production. CSIRO has developed a suite of decision support systems to help wool growers develop sustainable and profitable production systems through better grazing and soil nutrient management, improved parasite management and breeding regimes for improved yield and wool fineness. Though many of these support systems have been available for some time their uptake by wool growers has been slow mainly because of entrenched and conservative attitudes. There is now ample evidence to show that adoption of the available knowledge, technology and improved management systems can be done at relatively little cost and can bring about significant improvements to on-farm incomes while ensuring long-term ecological and economic sustainability.

The Australian early stage wool processing industry and the tanning industry have invested heavily in the environmental amelioration of wool scouring and tanning. The work done by CSIRO in

developing new and improved technologies for wool scouring and for the development of clean technologies for tanneries has been pre-eminent and has placed Australian industry in a position of strength compared to its competitors.

The adding of value to wool, cotton, hides and skins in rural and provincial centres is important for the sustainability of rural economies. Manufacturing can add economic stability to rural environments which are frequently affected adversely by climatic conditions or commodity prices. The adding of value to commodities in rural centres also provides valuable links between the producer and the processor thereby facilitating supply chain management.

Some Value-Added Research Outcomes

- *Fibre Innovation : Modified Fibre Developed to Access New Markets* : The OPTIM™ technology to produce a new fibre from wool has reached the commercial development stage with the installation in an Australian Mill of a pilot plant capable of producing 200 tonne per annum of the new fibre. The development of a larger machine, (capable of producing 1 million kilograms per annum), has been postponed to 2000 to allow a complete engineering and market analysis. The development of markets, based on new products from the fibre, is being pursued in Italy and Japan, and this is being underpinned by product development supported by The Woolmark Company. The development of shrink resist treatments for fabrics made from the OPTIM™ fibre have been put on hold, as this development is not seen as a priority.
- *Yarn Innovation : Novel Yarn Structures to Improve Fabric Performance* : The key elements to this objective are reduced pilling of fabrics, and ways to enhance the tactile comfort of fabrics. The development of new spinning technology to produce yarns with structures that increase the security of fibres and consequently are less prone to producing pills has been successful. Fabrics made from the yarns show significantly less pilling than fabrics made from conventional yarns. The technology has required the invention of a novel attachment to spinning frames and an injection moulded product has been developed.
- *Fabric Finishing* : New finishing technology is being explored to enhance quality of fabrics through the development of a rapid fabric conditioner. A prototype has been tested, and the decision to proceed with the construction of an industrial machine has been made. In another equipment development, a continuous pressure decatizer prototype has been trialled. A licensing agreement has been signed with a development program outlined until 2001.
- *Late Stage Coloration of Wool Products* : Investigations into new methods for dyeing garments and fabric, including blends, has resulted in three important outcomes. A technology using ultraviolet light to modify the wool fibre surface has been developed. The technology, known as SiroFlash, has been optimised to prepare wool fabric for printing. The technology can also be used as an alternative to chlorination as a preparation for dyeing heavy shades such as navy and black.
- *Improved Dyeing Technology* : The invention of the new fibre (OPTIM^R) has required the development of new dyeing procedures for the new fibre. The developments have been trialled successfully on an industrial scale. Three Japanese wool processors have carried out successful dyeings of modified wool top, based on CSIRO recommendations. In addition to

these developments, dyeing methods have been established for Bulky Wool (OPTIM MAXTM) utilising a range of selected acid milling dyes with a modified procedure. In the area of environmental amelioration, a European chemical manufacturer is evaluating a technology to reduce the chromium content in effluent from chrome dyeing and is planning trials with customers. Satisfactory industrial trials have been carried out in Australia.

- *Easycare* : The consumer demand for easycare garments is being addressed by the development of technologies for pure wool and wool blend slacks and trousers. Methods based on resin applications and permanent settings of creases have been developed for pure wool trousers and skirts for complete machine washability and tumble drying. A garment restraint technology to enhance crease retention during laundering has been patented. The feasibility of using SiroFlash technology to limit pilling in knitwear has been established.
- *Fibre Processing* : A significant achievement has been the development of a technology to weave worsted singles yarns without sizing. The technology has been licensed to two distributors and sales have commenced. A simple add on low cost attachment to a spinning frame which increases productivity by at least 20% or allows a reduction of 10% in the spinning limit for wool fibres of a given micron has reached the development stage. A woollen web and slubbing monitor has been used successfully in a consultancy with an Italian machinery manufacturer.
- *Leather thickness control* : As part of a collaborative project with industry to improve yield and thickness control in bovine finished leather a new thickness measuring system has been devised which is now undergoing trials in several tanneries. A software program has been developed to facilitate data management in the tannery environment. The potential to significantly reduce the shaving operation in crust leather production has been demonstrated with the subsequent reduction in shaving waste and increased split leather value.
- *Wool Style* : Building on the success of introducing objective measurement to the wool industry the establishment of an accredited objective measurement of greasy wool Style is a significant objective which is well underway to being achieved. A standard has been drafted and will be presented to IWTO in June 1999. As part of the standard development, industrial trials are progressing in collaboration with the Australian Wool Testing Authority Limited. This paves the way for the introduction of complete Sale by Description.
- *Fibre bundle strength* : A fast and accurate measurement for fibre bundle strength, together with software to predict yarn and spinning performance has been successfully completed. A number of fibre bundle strength instruments are on trial in mills in Europe, Japan, China and India. These trials have shown that the instrument is particularly useful for monitoring fibre damage due to dyeing. This damage results in inferior yarn quality and spinning performance.
- *Medical Sheepskins*: Technology to substantially improve the quality and durability of medical sheepskins has been developed. An Australian Standard has been developed by CSIRO and published. The Standard underpins the marketing of the new product by providing criteria for quality and durability. The technology has helped to increase the export markets for Australian woolskins.

- *Leathers for a New Army Boot:* Procedures and specifications for the production of a highly durable waterproof leather have been developed for the manufacture of a new army boot suitable for tropical climates. The technology has been disseminated to Australian tanners by the Army Technical and Engineering Agency.
- *Sportwool:* The development and commercialisation of a unique bi-layer fabric that allows the rapid dissipation of moisture when the wearer is undergoing high exertion allows wool to be used in innovative active sportswear products.
- *Bioclip:* A radically new technology for harvesting wool is now being commercialised. The technology is based on the biological loosening of wool in the follicle thereby causing sheep to undergo an induced moulting. Widespread adoption of the wool loosening technology and the subsequent wool collection procedures will revolutionise wool harvesting.
- *Decision Support Systems for Woolgrowers:* Software which describes the linking of forage nutrient cycles with animal production and software which can facilitate the production of fine wool in non-traditional environments has been developed.

CSIRO SUBMISSION TO THE WOOL INDUSTRY FUTURE
DIRECTIONS TASK FORCE

EXECUTIVE SUMMARY

In a competitive environment dominated by changing consumer consumption patterns and demand for informality, comfort and convenience, wool must compete with cotton and synthetic fibres that are substantially cheaper and have responded more effectively to these market signals.

CSIRO believes that the Wool Industry can have a strong future but only if all elements of the production and processing system undergo radical cultural and structural change. Australia dominates the world production of apparel wool but the industry as a whole is burdened by practices evolved decades ago which have persisted because of custom, conservatism and entrenched self-interest.

The Cotton, Dairy and Wine Industries that have variously undergone change, prosper as efficient and strategically thinking industries with real vision. All are strongly orientated towards continuing innovation and its R&D base, rapid adoption of best practices in production and processing, and, possibly most critically, conduct their affairs with minimal day-to-day intervention by government and with a maximum degree of self-help. These are not the traits of the current Australian Wool Industry. **One lesson from these three examples of rebirth is the crucial role of technology, widely adopted by most participants, in transforming the industry.**

In CSIRO's view, there are five 'success factors' that will improve profitability:

- **Increase the demand for wool textile products through innovation.** There are two ways to do this: develop new products the consumer wants and reduce the costs of producing them. While innovation alone cannot save the Wool Industry, its long term future can only be assured through radical changes in all aspects of wool production, marketing, processing and product expansion. Previous innovations from CSIRO have led to remarkable advances in wool production and sheep breeding, the selling of wool and the invention of new processes (details are provided in the attached case studies of innovation and technology transfer). However wool's competitors, synthetic and cotton textiles, constantly innovate in raw material production or development of new processing technologies to produce new products or reduce costs; so must wool to have a future. Furthermore, consumers are increasingly demanding 'clean and green' products and expect the industry to achieve much higher environmental standards than at present, especially on-farm.
- **Increase the productivity of wool production in a sustainable manner through enhanced uptake of technology.** Many growers are reluctant to adopt decision support tools for pasture, nutrition and parasite management, non-degrading grazing management, and advanced animal breeding and husbandry schemes. The grower of the future should view wool production as part of the textile industry and every sheep as a fibre generator. From CSIRO's experience in other Agribusiness sectors, there are substantial economies of scale available which allow large growers, who have embraced technology and better practices, to make profits even in the present depressed climate. Other, often smaller, growers are for financial, cultural and

emotional reasons unable to change and are, and have been for some time, largely unprofitable. They are likely to remain so. CSIRO believes that a significant proportion of growers should be encouraged to leave the Industry, or at least that industry plans must be based on the one third that produce 70% of the clip, possibly through the introduction of a minimum wool clip before a levy is applied. Only these levy payers would then have access to the innovation and promotion partnerships developed with their contributions. This approach accords with the Task Force's own focus on "businesses" rather than 'Industry'.

- **Reduce the fragmentation of the Wool Industry Pipeline and improve communications along it.** The fragmentation of wool marketing and distribution, and the complexity of the processing pipeline, acts as an impediment to the flow of critical and timely information on quality requirements from the market place back to the grower. Technology, such as quality measurement and sale by description, will greatly assist the reduction in discontinuities between the shearing shed and the fabric.
- **Improve the institutional mechanisms for transferring technology to the wool processing industry.** CSIRO believes The Woolmark Company (TWC) should focus on its responsibilities of promoting Australian wool, administering the income from licensees and managing the growers' levy. It should contract -out the management and staffing of its expensive European and Asian Development Centres for the transfer of technology developed in Australia to avoid conflicts of interest and to improve their effectiveness and efficiency. CSIRO provides over two thirds of the technology to the Centres, and believes it could run them at less than half their current cost. Its role would be assisted by its unsurpassed international recognition for research and technological excellence across the worldwide wool industry.
- **Leverage the Federal Government's TCF 2000 Program as an important opportunity for Australia's wool spinners, weavers and knitters to invest in innovation and new plant.** The Program, which follows from the Government's 'Action Agenda' for the establishment of a strategic plan for the TCF industries, will assist local industry prepare for proposed tariff reductions in the year 2005 by providing opportunities and incentives for industry to establish collaborations and supply chain networks. Wool grower R & D funds could be used to deal with strategic reform of the processing pipeline while the wool textile industry funds the shorter term more 'tactical' research initiatives. The proposed scheme now provides opportunities to shift the focus from overseas processing of Australian wool more towards the domestic processing industry with obvious benefits for rural industry. CSIRO is actively developing collaborative links with the domestic processing industry to help it become 'R & D ready' to take full advantage of the Program.'

CSIRO
MARCH 1999

**CSIRO'S INVOLVEMENT WITH THE AUSTRALIAN FOOD INDUSTRY
IN EXPORTS TO ASIA**

THE SETTING

The food industry is the second largest Australian manufacturing sector comprising 3,217 companies (1994/95) nearly 24% of manufacturing production by GDP and is a major employer in the Australian work place employing 160,000 people in 1995/96 with a sales turnover of \$37 billion (1994/95). Trade in food and particularly processed food and beverages is part of the growing global trend. In terms of global markets, 60% of Australian food exports (\$10 billion) go to Asia, which highlights the importance of this region to Australia's future economic growth. The Australian industry like its counterparts in other nations faces a period of change associated with this globalisation in trade. Successive industries will in the near future have a dependency upon an ability to respond to market segmentation and the ability to draw upon appropriate innovation to gain and maintain market supremacy.

CSIRO and others have recognised that there are multiple opportunities for appropriate technical input and technology transfer in the food industry cascade. There are a growing R & D opportunities in areas associated with manufacturing technology, including process design and control of food hygiene as well as inputs in the areas of packaging, transport, retail and the consumer. Market segmentation and food quality requires a thorough understanding of consumer needs, sensitivities and the significance of issues such as product quality, packaging, sensory attributes, nutritional and health considerations and food safety.

CSIRO has traditionally developed processes and products aimed at improving food export market performance, however until the mid 1990's much of the funding was provided by the R&D Corporations. Examples are the \$1.2 million provided by the Dairy R&D Corporation over several years for development of specialised milk powders for the Asian market, and the current 3 year Horticultural R&D Corporation supported project to develop new technologies to enable potato exports to Asian markets by sea without active refrigeration. Although such projects have been successful, they have not had the market impact that would have been the case had CSIRO been working directly with industry.

Not surprisingly there is a growing requirement for the Australian food industry to have access to relevant innovative processes and to provide a mechanism that stimulates the interaction between industry and R & D providers. As part of a Government, the CSIRO Food into Asia program was established in CSIRO in 1995 to specifically address this issue. Much of the recent research done by CSIRO for the food industry with respect to Asia has been carried out through this program. The marked success of these ventures should be expanded further.

THE PROGRAM: CSIRO FOOD INTO ASIA

The CSIRO Food into Asia Program was established to provide research to assist Australian food companies to enhance Australian exports of premium fresh and value-added processed foods into the Asian markets.

THE ACHIEVEMENTS

Currently there are 17 projects in progress with 22 Australian based companies with a total value of \$8.8M, reflecting an investment of CSIRO appropriation dollars of \$4.4M. The industries' estimated value of increased and improved exports contributed by successful completion of the projects described above is \$73.6M per year, increasing to \$358M per year after 5 years. The latter figure assumes that the research is one of several factors contributing to success.

The spectrum of projects range from processed foods including beverages to fresh foods and from short term (18-month projects) to longer term (5-year projects). The Australian based customers range from small to medium sized companies (with an annual medium turnover of \$100M) to multinational companies (with an annual turnover of \$3.9B). Also included are Australian private companies, publicly listed companies, cooperatives and rural funding bodies. Examples of this interaction are attached.

The key drivers for success and enthusiasm and the high level of interest in the current program are numerous but the most obvious ones are the following:

- * the process is highly focused on food exports and in particular the production of food products based on innovation;
- * the program is customer and/or client based i.e. the science responds to the consumer, customer or client requirements;
- * the scientific approach to the program has not been discipline based but rather a systems approach covering a range of expertise from production to processing, to the market place and to the consumer, not as a disparate compartmentalised process but as a single entity;
- * the science base has been expanded to include the relevance of the consumer base as a critical scientific input in the production of appropriate products for exports. It should be noted that of the 17 projects currently in progress, 8 of the projects involve science application near or at the consumer end of the production stream. This reflects a growing need for producing products that are of relevance to the consumer namely products of high quality and acceptance and with a strong focus on nutritional/health value and safety, as these latter attributes rank uniformly high in consumer expectation across the Asian region.

EXTENDING THE CONCEPT

The Challenge

The challenge is to determine how Australia can position itself to capture an increasing market share of the 1 billion meals or more that will be consumed per day in the future in the entire East-Asia region. The consumption of food in the East-Asia region in the future will dwarf the local Australian consumption of food (Figure 1). Moreover it will reflect a global consumption with enhanced diversity at a time with a shift to international markets and increasing market segmentation. Concurrently there will be continuing discoveries in the scientific areas covering the key fields from production to the market place, which will underpin the development of new products for the future. The challenge for Australia will be as follows:

- * to identify the client and consumer requirements that will occur in this region in the future so that Australia can respond appropriately with products of high quality and provide key requirements of consumers;
- * to harness the innovative capacities of research and development in Australia together with food industry capabilities to respond to these requirements in quality and nutrient content.

The Vision - Extending the Concept

As mentioned above, currently there are 17 projects in progress which by and large reflect the potential of 17 or more products being developed for the Asian market place, based on a high input of research and innovation. The cornerstone of the vision is to:

- * position Australia as a significant platform for integrating innovative R&D with the development of quality new food products;
- * enhance the number of existing projects and products in such a way that not only will these forerunner products be continually supported with appropriate modifications as needed with the changing market place but will be followed by additional products including generations of new food products;
- * continue to position Australia as a manufacture of innovative products of outstanding quality, of high nutritional value and of products that are responding to local needs;
- * in addition to responding to the market place at the present time, to utilize innovative processes to address foods for the future. For example foods produced using unique and novel processing procedures, foods utilising new packaging approaches, foods delivered to the marketplace in new and improved ways and foods that go beyond sustenance and promote health and potentially protect against disease.

ATTACHMENT

Red Meat into Asia - Meat Research Corporation

This three-year project (1995-1998) was undertaken to help the Meat Research Corporation to gain a better understanding of food and nutrition issues that might influence the marketplace for red meat and meat products in four Asian markets.

The project involved three phases. The first included an assessment and review of food, nutrition, trade and agricultural policies and trends in 11 Asian countries and the second, an analysis of socioeconomic factors influencing red meat imports in these countries over the past thirty years.

The third phase involved detailed consumer and health professional surveys in Japan, Korea, Taiwan and Malaysia of intakes of and attitudes to red meat and alternative protein sources; consumer knowledge of the links between diet and health; cultural and value systems impinging on food choice and sources of information about health and nutrition.

The data will enable the industry to gain a better understanding of current and emerging consumer issues in key Asian markets and enable it to proactively address these concerns such that it can further protect and expand this multimillion-dollar export industry.

“Optimisation of Fruit Transport Systems” - Australian Fresh Fruit Company Pty Ltd (AFFCO)

To ensure fruit quality is maintained during shipment and marketing in Asia, packaging and transport systems must protect the fruit from injuries (impact bruises etc), facilitate temperature management, protect against water loss and facilitate special treatments such as modified atmosphere packaging. The aim of this project is to improve the handling and transport chain for Australian fruit (particularly ‘Pink Lady’ apples) allowing AFFCO to

- Improve market returns through improved outturn quality
- Maintain and increase market share
- Open up new markets
- Extend marketing period by reducing quality loss during storage

AFFCO has identified significant potential to increase exports into Asia. AFFCO expect that the successful completion of this project will increase the returns from the export of ‘Pink Lady’ apples by \$10 million.¹