Review of Research, Development and Extension in the Queensland Food and Fibre Sector

Prepared by a Working Group of the **Smart State Council**

May 2008

Smart State Council

An initiative of the Queensland Government

Dear Premier

Please find attached the Smart State Council working group report on Research, Development and Extension (RD&E) in the food and fibre sector.

The report makes clear the substantial economic, environmental and social value of the food and fibre sector to Queensland, both now and in the future. It outlines an ambitious but achievable 2030 Smart State Vision for the sector and identifies RD&E as central to achieving this vision.

It also provides direction for government investment and delivery of food and fibre RD&E services for Queensland, advocating a national approach and a new strategic intent for the Department of Primary Industries and Fisheries. It also identifies the need for action in overcoming a critical skills gap in food and fibre RD&E and new ways to improve access to research and development for adoption and commercialisation.

I commend it to you.

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Smart State Council

The Smart State Council was established in June 2005 as a central advisory body to provide high level advice to the Queensland Government on emerging Smart State issues and trends, and to propose measures to position Queensland to respond to challenges and opportunities.

The Smart State Council is chaired by the Premier of Queensland and comprises Government Ministers, the Queensland Chief Scientist and representatives from Queensland's business and research communities.

This paper was prepared by an independent working group for the Smart State Council. The views expressed in this paper are those of the group and do not represent Queensland Government policy.

Executive summary

Although originally conceived as a report covering research and development (R&D) in the food and fibre sector, for completeness the report also needed to encompass the 'extension' component of R&D activity. Extension is the important phase in the R&D cycle that facilitates adoption of the R&D outputs. Hence the term 'RD&E' is used throughout the report.

The food and fibre sector is valuable to Queensland economically, environmentally and socially. Accordingly, the 2030 Smart State Vision proposed for the sector encompasses all three of these dimensions.

The report concludes that RD&E has an important role in underpinning growth in the food and fibre sector but that a national RD&E effort is required to meet the needs of government and industry. Three opportunities for substantially improving Queensland's performance in food and fibre RD&E are also identified:

- a new strategic intent for the Department of Primary Industries and Fisheries (DPI&F)
- developing and implementing an integrated RD&E human resources strategy
- government-led action to improve access to research and development for adoption and commercialisation.

The current prominence of food-related issues in the media and other forums makes this report a timely reminder of the importance of the food and fibre sector to our welfare, as well as the critical role of RD&E in underpinning the prosperity of the sector.

Value to Queensland of the food and fibre sector

Value to our economy

For 2007-08, the Queensland DPI&F is forecasting the gross value of primary industry production at $12.5 billion. This forecast includes $9.6 billion of farm gate production and $2.9 billion in first-round processing. For 2007-08, Queensland food and beverage manufacturing (excluding first round processing and termed 'elaborately processed') is estimated at $2 billion. Queensland's output of services to agriculture is valued at $476 million.

The sector accounts for almost $7 billion in exports, or 19 per cent of Queensland's total exports, making it Queensland's second largest exporter. Combining first-stage processed and elaborately processed goods, food and beverage manufacturing is the State's second largest manufacturing sector, with a turnover in 2001-02 of $2.8 billion – or 21 per cent – of total manufacturing in Queensland.

Growth for primary industry proudction is forecast at 3.2 per cent per annum to 2013-14. Applying this to the 2007-08 output forecast for the primary production sector, output would rise to $15 billion in 2013-14. Using the same growth forecast, by 2030 Queensland's output would rise to $25 billion (in today's prices).

This projection does not include opportunities for growth in the areas of value-added (elaborately transformed) products, new food and fibre products, biofuels, advanced biomaterials, technologies or services.

Value to our environment

Given advances in farming technology and practices over the last few years, it is realistic to aim to reduce resource degradation, and in some areas reverse the decline, even with increases in agricultural productivity. In addition, the food and fibre sector has the potential to contribute much more widely through the provision of ecosystem services (ecoservices) by beneficially managing, for example, carbon, biodiversity and salinity.

As well as making government investment in natural resource management more effective, creating markets for ecoservices (ecomarkets) will be important if we are to unlock private and philanthropic investment in natural resource management.

Value to our society

Apart from economic wealth, Queensland's food and fibre sector is responsible for the inexpensive, reliable and ethical production of high-quality, safe, nutritious food and other agricultural based products such as cotton and timber. The sector employs tens of thousands of Queenslanders and helps sustain rural and regional communities. Transferring our knowledge of sub-tropical and tropical production systems to the developing world also contributes to world food security, poverty reduction and improved natural resource management.

Our food and fibre production system works so well that the public largely takes for granted the contribution it makes to the quality of life of all Queenslanders.

Value to our future

The long term-trend is for strongly increasing world demand for food and related services and technologies. In addition, new industries based on advanced biomaterials and biofuels are needed to replace our current reliance on fuels and industrial materials derived from non-renewable sources, especially oil.

Current economic and environmental trends are heralding the transformation of Queensland's traditional agricultural industries into the bio-industries of our future and our land managers into our most important environmental stewards.

In the 21st Century, food and fibre science is the science of opportunity. Opportunity for continued economic and social prosperity for our State, in particular our rural communities and regions. Opportunity for better sustaining and preserving our natural heritage. Opportunity to help feed the world, millions of whom still face malnutrition and even starvation. Beyond even that, in the small molecules of our diverse plants and animals lies the opportunity to create new foods, fuels and materials that, for now, we only dream of creating.

The Smart State Vision for 2030

The ability to meet all three requirements of sustainability – economic, environmental and social – is what will set Queensland apart in world food and fibre markets and ensure that we realise the full value of this sector to our community.

Economically, there is also an opportunity to go beyond the 'business as usual' growth scenario for the industry, which would see the value of food and fibre primary production reach $25 billion by 2030. Growth in world demand for food and fibre products, services and technologies is of such a scale that Queensland should set itself a more ambitious but achievable target. In addition to generating at least $25 billion from traditional sources of food, fibre and value-added products and services by 2030, we should also aim to generate an additional $10 billion in economic wealth from new products, technologies and services, including at least three new 'billion dollar' industries.

As the opportunities are wide, Queensland will need to act in a focused manner to ensure that we can grasp the ones most likely to come to fruition. Implementation of the recommendations in this report will assist in providing focus for our efforts.

The proposed vision for the food and fibre sector encompasses all three dimensions of sustainability. While this vision cannot be achieved by R&D on its own, its contribution will be essential.

By 2030, the Queensland food and fibre sector will be (in 2008 dollars):

A thriving industry generating at least $25 billion from traditional food, fibre and value- added products, services and technologies, with significant new services, technologies and at least three new billion-dollar industries generating an additional $10 billion in economic wealth.

A world leader in integrating environmental and economic values for a 'small and light' ecological footprint and a better environment.

An industry that supports resilient regional communities and is valued by all Queenslanders for its contribution to our quality of life.

Value to Queensland of food and fibre RD&E

In the 30 years to 2003-04, productivity growth for Australian agriculture has averaged 2.8 per cent, substantially higher than that for Australia's mining and manufacturing industries and most service sectors. One estimate is that around 2 per cent of this growth is attributable to technical change arising from RD&E.

Well planned, strategic action by both government and industry will be critical in achieving the through-chain innovation needed to realise the economic, environmental and social potential of the sector.

In particular, this innovation will need to overcome challenges of scale, distance, global competitiveness and climate change and variability.

Through innovation we must make the most of our advantages: low sovereign risk and an open economy; a strong biosecurity system reinforcing our advantage as an island nation; and our systematic ability to adapt to change.

From an innovation perspective, RD&E helps provide new knowledge and ideas critical to the innovation process, along with vital links between knowledge production, application and diffusion.

A better RD&E system

The current RD&E system

A proliferation of research investors and providers has meant that the food and fibre RD&E sector is cluttered with institutions and weighed down with unnecessary transaction costs. At the same time there has been an increase in the breadth of research requiring investment in the food and fibre sector.

These two trends contribute to a number of deficiencies in the current RD&E system, including: duplication and fragmentation of Australia's research effort; overstretched research funding and capability; inefficiencies and high transaction costs when investing in research; and critical gaps in research capability.

The future RD&E system

To overcome deficiencies in the current RD&E system, the Primary Industries Ministerial Council (PIMC) has developed a national framework for RD&E. This council is comprised of Australia's primary industries Ministers.

This framework is based on the concept of 'National R, Regional D & Local E'. Underpinning this concept is an acceptance that, while research (R) can be provided from a distance, regional adaptive and applied research or development (D) is required to test, refine and demonstrate the technology. Local extension (E) enables the transfer of the regionally tested innovation to users in the region and helps provide feedback that informs further R&D.

At a practical level, this will lead to the development of 'virtual centres' that allow for the consolidation of infrastructure in fewer locations while supporting networked development and extension efforts.

At its meeting in April this year, PIMC made clear its resolve to move forward in implementing the national RD&E framework.

Queensland's response

Almost always it is a combination of organisations – state and federal, government and non-government – that makes investment in RD&E under a partnership arrangement. As such, maintaining and improving collaborative partnerships is essential to Queensland's future RD&E efforts.

The strength of the national RD&E framework is the recognition it gives to consolidating resources to create critical mass at the level of basic research (National R), while at the same time recognising that research must be adapted for regional and local conditions (Regional D and Local E). This framework provides the opportunity to streamline current arrangements, deepen collaboration between research investors and providers and retain the joint public-private investment model that has underpinned Australia's successful RD&E effort over a number of decades.

Implementation of the national RD&E framework will be important to the future success of Queensland's food and fibre sector.

Key Finding 1: A national RD&E effort is required

The current RD&E system is cluttered with institutions and weighed down by unnecessary transaction costs. Implementation of the national RD&E framework for primary industries would overcome these deficiencies by consolidating resources at the research level while ensuring research outputs are accessible and relevant through a networked approach to development and extension.

Successful implementation of the national RD&E framework for primary industries would be of substantial and enduring benefit to Queensland's food and fibre sector.

Opportunities

The Department of Primary Industries and Fisheries

Queensland Government investment in food and fibre RD&E is principally through the DPI&F. DPI&F is well-served by a large network of well-qualified, highly performing RD&E staff. its RD&E is making a substantial contribution to the Queensland economy and has done so for a long time.

Implementation of the national RD&E framework, along with the emergence of new RD&E providers at regional and local levels, creates a new operating environment that requires DPI&F to explicitly identify itself as having the critical 'broker' role for Queensland in: negotiating arrangements at the national level; marshalling resources at the State level; and communicating and responding to industry RD&E needs.

In this context, it is also appropriate to consider the often divergent cultural requirements between managing a government department and those for managing RD&E. Accordingly, alternatives to the traditional model of DPI&F as both an investor and provider across the spectrum of RD&E services need to be considered.

At a practical level, this will see a 'mixed model' of research investment and delivery. While in some areas DPI&F may retain the dual role of investor and provider, in others it may have only an investor role while in some research areas resources may be reallocated. Rather than attempting to do everything, the strategic intent for DPI&F would be 'the right resources, in the right place, at the right time'.

Key Finding 2: A new operating environment

The cultural conflict between the requirements for managing a government department and the requirements for managing RD&E is likely to lead to a long-term decline in the capacity of DPI&F to retain the joint roles of research investor and research provider. At the same time, implementation of the national RD&E framework for primary industries, and the emergence of new RD&E research providers, is creating a new operating environment for DPI&F.

Collectively, these trends mean that alternatives to the traditional model of DPI&F as investor and provider across the spectrum of RD&E need to be considered and a 'mixed model' of research investment and delivery implemented.

Attracting and retaining skilled people

As with many industries, a critical skills shortage has emerged in the food and fibre sector, including in RD&E. Employment in the sector is characterised by overall lack of attractiveness.

To redress the situation, school, vocational and higher education components of food and fibre education need to be more fully integrated both in terms of curriculum and infrastructure to ensure that the system produces graduates with skills the industry needs.

Rather than implement a separate process for food and fibre RD&E to those already underway, efforts must be made to include specific actions for targeting and attracting people to the RD&E component of the food and fibre sector.

Key Finding 3: Government-industry action on skills shortage

A critical skills shortage exists in food and fibre RD&E and this is undermining the future of the industry. Concerted government-industry effort is required to better integrate school, vocational and higher education components of food and fibre education, including curriculum, infrastructure and employment conditions, to ensure that the industry has access to the skills it needs. This strategy needs to encompass both the attraction and retention of skilled staff

Private investment in food and fibre RD&E

Food industry investment in RD&E

A number of reasons have been identified for why food businesses may not invest in research: they may not see a need; they may not have the funding; they may lack R&D management capability; or the transactions costs may be too high.

To overcome these difficulties, as part of its broker role, DPI&F needs to coordinate government action to facilitate investment in food industry RD&E including the provision of appropriate infrastructure, a food industry extension service and incentives for investment.

Commercialisation of research

Scattered amongst Queensland (and Australian) research institutions are ‘good ideas’ that have genuine commercial potential. However, a gap exists in funding arrangements, as technologies requiring proof-of-principle research are considered ‘too early’ to attract venture capital funding and either remain unfunded or are sub-optimally assigned to third parties.

Bringing together good ideas generated by food and fibre research into the one investment package could substantially reduce commercialisation risk and make private investment in food and fibre research commercialisation more attractive.

Realising this opportunity will require government leadership in establishing the investment vehicle and generating support from research institutions and the private sector for participating in the fund.

Key Finding 4: The is a need to improve the investment, adoption and commercialisation of research

Small and medium enterprises in the food industry face a series of hurdles in adopting and investing in R&D, including high transactions costs, lack of funding, lack of incentives and limited capacity for managing R&D.

A gap in research funding arrangements at the proof-of-principle level is inhibiting commercialisation. This gap could be overcome by government-led 'packaging' of research for private investment, thereby reducing financial risk.

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1 Introduction

Although originally conceived as a report covering research and development (R&D) in the food and fibre sector, it became obvious that the report needed to encompass the 'extension' component of R&D activity. Extension is the important phase in the R&D cycle that achieves adoption of the R&D outputs. Extension also provides the feedback loop into R&D investment from the 'on-the-ground' users of the outputs of R&D activities. Accordingly, rather than the more familiar term 'R&D', this report uses the term 'RD&E', which is commonly used in the primary industries sector, but is less common elsewhere.

The report has been divided into four parts. The first part provides a brief overview of the value of the sector economically, environmentally and socially, both now and in the future. This section concludes with a 2030 Smart State Vision for the sector across these three dimensions. The purpose of this section is to answer a fundamental question: why the food and fibre sector is important to Queensland.

The second part of the report outlines the important role that RD&E has had in underpinning growth in the industry. It argues that RD&E has a critical role in the innovation process and therefore a continuing role in enabling the industry to overcome challenges and make the most of our advantages.

The third part of the report identifies the need for Queensland to support a national RD&E effort, while the fourth part of the report identifies three opportunities for substantially improving Queensland's performance in food and fibre RD&E:

- a new strategic intent for the Department of Primary Industries and Fisheries;
- developing and implementing an integrated RD&E human resources strategy, and
- government-led action to improve access to research and development for adoption and commercialisation.

The current prominence of food-related issues in the media and other forums makes this report a timely reminder of the importance of the food and fibre sector to our welfare, as well as the critical role of RD&E in underpinning the prosperity of the sector.

2 Value to Queensland of the food and fibre sector

This section outlines the importance to Queensland of the food and fibre sector economically, environmentally and socially, both now and in the future. It concludes with a Smart State Vision for the industry in 2030, which provides the context for the report recommendations.

2.1 The food and fibre sector

The term 'food and fibre sector' covers a vast range of industries and supply chains. In Queensland, at the primary production level the term covers over 30 different commodities. As can be seen in Figure 1, terms such as 'horticulture', 'grains' and 'livestock' encompass a broad range of products. For example, horticulture covers fruit, nuts and vegetables, while amenity horticulture covers nurseries, turf and cut flowers. Terms such a 'food processing' can encompass anything from first-stage processing (e.g. milk and cream processing) to more elaborate processing (e.g. yoghurt, low-fat yoghurt, drinking yoghurt, frozen yoghurt, yoghurt covered muesli bars).

At the primary production level, a commodity can be sold into a variety of markets. In the case of horticulture, for example, produce can be exported or sold into the domestic market; through a wholesaler (e.g. the Brisbane Market); to a processor (e.g. flour miller, cannery); to a retailer (e.g. Woolworths); or direct to a consumer (e.g. farmers' market). From a consumer perspective, product can be bought fresh (e.g. whole fruit or vegetables), partly processed (e.g. cut salad), processed (e.g. cooked, canned, juiced or frozen fruit or vegetables) or as an ingredient in another product (e.g. bottled sauce, frozen meal, restaurant meal).

Each of these products has its own supply chain which in turn comprises a number of components, including production (farms), storage, handling and transport, processing, wholesaling, retailing and consumption. Additionally, supply chains are supported by a number of ancillary industries (e.g. food packaging, chemicals, fertilisers) and services (e.g. finance, marketing, agronomic consultancy services, research and education). Federal, state and local government agencies have a key role in influencing the operation of supply chains through policies and regulations across a range of areas (e.g. interest rates, tax, trade and quarantine, workplace health and safety, environmental protection, food safety, transport, land planning and agriculture).

RD&E is an important component in each step of food and fibre supply chains: it operates across commodities and at various stages of the supply chain, from production through to storage, transport and handling, at the processing stage and even in retail. Although pervasive and critical in ensuring that consumer requirements are met, RD&E is for the most part invisible; consumers simply take it for granted that their food and fibre demands will be met with new and better quality products and services.

Figure 1: Gross value of production, Queensland food and fibre production and processing

Commodity GVP (a)	2007-08 (d) $m	Commodity GVP (a)	2007-08 (d) $m
Livestock disposals		**Other field crops**	
Cattle and calves	3414	Sugarcane (g)	810
Sheep and lambs	55	Cotton (raw) (h)	80
Pigs	220	Other crops	360
Poultry	300	**Total other crops**	**1250**
Other livestock	10	**Cereal grains**	
Total livestock disposals	**3999**	Wheat	350
Livestock products		Barley	55
Wool	120	Grain sorghum	410
Milk (all purpose)	255	Maize	55
Eggs	100	Other cereal grains	10
Total livestock products (e)	**475**	**Total cereal grains**	**880**
Total livestock	**4474**	**Total crops**	**4675**
Horticulture		**Total agriculture**	**9149**
Fruit and nuts		**Fisheries (c) (i)**	
Bananas	500	Trawl	85
Pineapples	70	Non-trawl	105
Mangoes	45	Aquaculture	85
Mandarins	95	**Total fisheries**	**275**
Strawberries	130	**Forestry and logging (c) (j)**	**200**
Avocados	80	**Total primary industries (farm gate)**	**9624**
Macadamias	25	**First round processing value added (k)**	
Apples	50	Meat processing (c)	941
Table grapes	40	Sugar Processing (c)	340
Other fruit and nuts	105	Milk and cream processing (c)	140
Total fruit	1140	Fruit and vegetables processing (c)	191
Vegetables		Flour mill and feed processing (c)	164
Potatoes	45	Seafood processing (c)	20
Tomatoes	225	Log sawmilling and timber dressing and plywood and veneer manufacturing (c)	347
Capsicums & chillies (f)	100	Lifestyle horticulture services (c)	700
Other vegetables	430	Cotton ginning (c)	9
Total vegetables	800	**Total primary industries (first round processing)**	**2852**
Total fruit and vegetables	**1940**	**Total primary industries**	**12476**
Amenity horticulture			
Nurseries (c)	410		
Turf (c)	70		
Cut flowers (c)	125		
Total amenity horticulture	**605**		
Total horticulture	**2545**		

(a) *Gross value of production* is defined as the gross value of commodities produced (GVP). It is a measure of economic output. In this publication, GVP relates to the output of primary industry commercial operations only. The GVP is the value of recorded production at wholesale prices realised in the market place (e.g. cattle sold at saleyards, sugarcane at the mill door, fruit and vegetables at the wholesale market). It is derived by multiplying the output from each primary industry by the average wholesale price paid to producers.
(b) As the Australian Bureau of Statistics (ABS) has not yet released final figures for 2005-06 and 2006-07, estimated GVP figures for these years are using DPI&F estimates only.
(c) DPI&F estimates.
(d) DPI&F forecasts.
(e) Excludes minor commodities such as honey, beeswax, mohair.
(f) DPI&F estimate does not include chillies.
(g) Gross value of sugarcane at mill door.
(h) Includes value of cotton seed and lint.
(i) Includes catches from both commonwealth-managed (including Torres Strait, Gulf of Carpentaria and East Coast tuna fisheries) and state-managed fisheries
(j) Australian Bureau of Agricultural and Resource Economics (ABARE) estimates.
(k) See Notes section for definition of *value-added*.

Source: Department of Primary Industries and Fisheries, Queensland

2.2 Value to our economy

For 2007-08, the Queensland Department of Primary Industries & Fisheries (DPI&F) is forecasting the gross value of primary industry production at $12.5 billion. This forecast includes $9.6 billion of farm gate production and $2.9 billion in first round processing. For 2007-08, Queensland food and beverage manufacturing (excluding first round processing and termed 'elaborately processed') is estimated at $2 billion. Queensland's output of services to agriculture is valued at $476 million.

The sector accounts for almost $7 billion in exports, or 19 per cent of Queensland's total exports, making it Queensland's second largest exporter. Combining first stage processed and elaborately processed goods, food and beverage manufacturing is the state's second largest manufacturing sector, with a turnover in 2001-02 of $2.8 billion, or 21 per cent of total manufacturing in Queensland (latest available census data). [1]

The Queensland food and fibre sector is faced with a paradox: there are serious pressures affecting its long-term competitive position but also substantial opportunities for expansion and growth in existing and new markets. The pressures include:

- a long-term decline in farmers' terms of trade (the ratio of prices received for their products relative to the prices paid for the inputs they use), despite presently high commodity prices
- increasing export and domestic competition from overseas suppliers with low production costs, high volume capacity, subsidised production and less regulation, such as Chile, Brazil, Argentina, Thailand and South Africa
- increasing demand on limited resources, including water, land, fish and infrastructure
- high expectations and a strong orientation toward food that is healthy and produced ethically using methods that have minimal impact on the environment and natural resources – this while consumers remain price sensitive
- The potential failure of the Doha Round of World Trade Organisation negotiations that are aimed at reducing or even removing trade-distorting subsidies and market access restrictions

These pressures are balanced by an optimistic outlook for increasing demand for food and fibre products in Asia and the Middle East and new opportunities for value-added products and services including:

- new foods and value-added food products (see Figure 2)
- biofuels (see Figure 3)
- advanced biomaterials (see Figure 4)

[1] Australian Bureau of Statistics, Manufacturing Industry Queensland, cat. No. 8221.3.55.001

- services and ancillary industries, e.g. transport, storage, packaging, finance, consultancy services, research and intellectual property revenues.

Consider the following example of the growth potential for the sector. The Australian Farm Institute has analysed trends in the potential demand for livestock products, relative to forecast increases in Australian production, of 11 Asian nations to 2020. The study concluded that, in the period 2007-2020: [2]

- Beef consumption will increase by 7.1 million tonnes (Mt), of which 1.9 Mt will be imported and 5.2 Mt will be produced domestically – an import requirement that is 86 per cent of Australia's current total beef production.
- Pork consumption will increase by 17.7 Mt, of which 1.2 Mt will be imported and 16.5 Mt will be produced domestically – an import requirement that is 260 per cent of Australia's current total pork production.
- Chicken meat consumption will increase by 7.4 Mt, of which 1 Mt will be imported and 6.4 Mt will be produced domestically – an import requirement that is 140 per cent of Australia's current total chicken meat production.
- Dairy product consumption will increase by 77 Mt (whole fresh milk equivalents), of which a projected 5.2 Mt will be imported and almost 72 Mt will be produced domestically – an import requirement that is 50 per cent of Australia's current total dairy production.

Furthermore, as a result of increased demand on animal production, the forecast increase in demand for feedgrains is between 350 and 450 Mt of feedgrains by 2020, a 20-30 per cent increase on current global production levels. The ability of Asian countries to meet this demand will be limited by resources, including available arable land.[3]

Expanding markets for food and fibre produce will also provide opportunities for growth in the provision of food and fibre services and ancillary industries. Analysis by the Australian Bureau of Agriculture and Resource Economics (ABARE) shows that in 2001-02, inputs (in value terms) into food manufacturing comprised raw material agricultural products (32 per cent), major services[4] (26 per cent), labour (17 per cent), food products (13 per cent) and other industrial inputs[5] (12 per cent).[6] This analysis illustrates that growth in food manufacturing will have flow-on effects to other industries, including employment. With strong growth in world demand for food and fibre products, Australian companies with specific expertise in food and

[2] *Australian Farm Institute Insights*. 2008. Vol 5, No 1, p.6.
[3] ibid.
[4] Includes transport and storage; business services; banking, finance and insurance; utilities; scientific and technical research; mechanical repairs; property services; communication; construction services; government administration.
[5] Includes paper containers and products; plastic goods; sheet metal products; commercial fishing; glass products; oil and gas.
[6] Short, Christopher, Chester, Courtney and Berry, Peter. 2006. *Australian Food Industry: Performance and Competitiveness*. ABARE Research Report 06.23, Prepared for the Australian Government Department of Agriculture , Fisheries and Forestry, Canberra, December. p. 3.

Figure 2: Future foods

Commercial drivers for new foods are health and wellness; fresh/natural/authentic food; convenience; sensory excitement and novelty, and eco-ethical production values.

Sciences underpinning these new opportunities include genomic biology of plants and animals; food physiology; sensory quality (molecular and materials origins); sensors and packaging; health and wellness biology and nanotechnology.

Naturally functional foods: Messages regarding the health benefits of 'natural' foods provide evidence supporting the benefit of a 'natural diet' rich in Queensland produce over one rich in (fortified) processed foods and nutritional supplements.

Guaranteed origin and quality: Modern advances in sensor and communications technologies can be used to leverage Queensland and Australia's image as a producer of best quality foods from sustainable sources.

Easy-fresh: Using advances in packaging and 'stay-fresh' minimal processing technologies can deliver fresh food to distant consumers with added convenience and excellent eating quality.

Exotic foods: Tropical/indigenous crops not widely known in international markets can be selected on the basis of molecular and materials characteristics to provide a stream of novel sensory experiences for discerning palates.

From, Scoping Study on Foods for the Future, R&D Strategy Group, Department of Primary Industries & Fisheries, Queensland

Figure 3: Biodiesel

Pongamia pinnata is one option being explored by Queensland scientists for its potential to support sustainable production of biodiesel.

Pongamia is a fast-growing tree with the potential for high oil seed production and the added benefit that it can be grown on marginal land.

The tree can live for up to 100 years, with the potential to not only produce oil to replace fossil fuels, but also to absorb carbon dioxide from the atmosphere. Both features would contribute to mitigating greenhouse gas emissions. Moreover, the leftover portion of *Pongamia* seeds can be used as feed for cattle, sheep and poultry.

Australia's diesel requirement is 18 billion litres per year and *Pongamia*-derived diesel could replace up to 20 per cent of this requirement with an initial target of 7000 sq km of plantations. Meeting 100 per cent of Australia's requirement would require 35,000 sq km. Australia has around 1-2 million sq km of unused marginal land on which the tree could be produced, for example, disused mine sites.

The ARC Centre of Excellence for Integrative Legume Research (CILR), located at the University of Queensland, is leading this research and has research partnerships. CILR has developed partnerships with Pacific Renewable Energy, BioEnergy Research and Origin CSG Ltd to explore the commercial potential of *Pongamia*.

Figure 4: Advanced biomaterials

Biomaterials are value-added materials produced from moderate to high-level biological sources. Biomaterials include building and packaging materials, biofuels, natural agricultural chemicals, rubber, bioplastics and polymers. 'Advanced biomaterials' also includes bio-inspired solutions and extraction of molecularly active species.

Alternatives to petroleum-based polymers: Synthetic polymer-based materials have the potential to be replaced by alternatives derived from processable biopolymers produced from crops rich in polymer feedstocks such as oils or starch or from fermentation of agricultural products. Queensland cultivates different crop types from those being investigated in Europe and North America, providing opportunities for differentiation.

Identifying bioactives in Queensland's biodiversity: Queensland's biodiversity provides a potentially rich source of novel biomaterials with diverse application such as new oils and fibres, natural bioactive molecules, including for control of agricultural pests.

Biomimetic products: Many developments in advanced bio-materials are inspired by nature's solutions to environmental challenges and opportunities. Queensland scientists have a wealth of knowledge on the function of agricultural and ecological systems that can be used to identify or create advanced biomaterial applications based on novel properties and organisms.

From, *Scoping Study on Advanced Biomaterials*, R&D Strategy Group, Department of Primary Industries & Fisheries, Queensland

fibre services, ancillary industries or technologies will have opportunities to directly market this expertise to overseas markets, leading to further export growth for Queensland.

Although Australia will not be the only country competing to take advantage of these opportunities, ABARE analysis indicates that Australia has a comparative advantage in some areas of the growing world food trade:

> *Analysis of the rate of growth of food exports on a product line basis indicates that over 75 per cent of the total food exports is in products in which the Australian share of export markets is increasing. In addition, 35 per cent of total exports are occurring in products for which the rate of annual growth in trade exceeds that of the growth in world trade for products in total. That is, 35 per cent of Australian food product exports are being shipped to growing world markets and are increasing their share of world trade at the same time.*
>
> *Conversely, only a small share – 6 per cent – of exported product lines are in markets for which both trade is declining and Australia is losing market share.*[7]

This means that, although Australian farmers will not be the only ones seeking to take advantage of the growth in the world food trade, we are successful in targeting growth areas.

From a Queensland perspective, despite this State being only the third largest producer of manufactured food products in Australia, Queensland has the largest share of exports, with shipments valued at more than $5 billion (in 2005-06 dollars) in the substantially transformed and elaborately transformed categories. These exports were predominantly meat ($3 billion) and sugar ($1 billion). Other exports from Queensland included seafood ($151 million), fruit and vegetables ($94 million), dairy ($75 million) and oil and fat ($46 million).[8]

Growth for primary industry production is forecast at 3.2 per cent per annum to 2013-14. Applying this to the 2007-08 output forecast, output would rise to $15 billion in 2013-14. By 2030, Queensland's output would rise to $25 billion (in today's prices).[9] It is important to note that this projection encompasses only primary production and first stage processing and does not include additional opportunities for growth in the areas of new foods and value added food products, fuels, advanced biomaterials, ancillary industries or services.

[7] Short et al. *pp 5-6.*
[8] ibid. p. 12.
[9] Analysis provided by the Department of Primary Industries and Fisheries

2.3 Value to our environment

Food and fibre production is constrained by the availability of natural resources and by the necessity of minimising the impact of agricultural activities on the environment. These constraints range from water availability and price to land degradation, chemical run-off, biosecurity issues and vegetation management. From a climate perspective, there is also a need to develop agricultural systems that mitigate greenhouse emissions, manage short-term climate variability and adapt to long-term trends associated with climate change.

While data is poor, it is believed that natural resource inputs into agriculture have degraded by around 0.1 per cent per annum, implying a net input of natural resources (not taking into consideration off-site impacts). On the other hand, total area of land in agricultural production declined by around 0.5 per cent over the past 20 years.[10] Given advances in farming technology and practices over the last few years, it is realistic to aim to reduce resource degradation and, in some areas, reverse the decline, even with increases in productivity (see Figure 5 for an example).

Figure 5: Sustainable farming systems in Central Queensland

Development of practical sustainable farming practices suited to a region has shown that major environmental benefits can be obtained at a profit.

In Central Queensland, researchers worked with farmers and industry to develop and compare sustainable farming practices that improve soil health and prevent soil erosion. Quick adoption of sustainable practices such as zero till farming, better water and nitrogen management, and the use of legumes in crop rotations was achieved by 75 per cent of farms in the region.

An estimated 5 million tonnes of soil loss has been prevented by farmers adopting these practices. Farmers gained an extra $20 to $35 dollars return per hectare each year from improved soil fertility and an estimated 750 000 tonnes of soil was prevented from entering waterways. The return on investment in RD&E is estimated at over $4 of direct financial benefit for every $1 invested in research.

Partners involved in Phase One of the project

The farmers of Central Queensland
Department of Primary Industries & Fisheries
Department of Natural Resources and Mines
Central Queensland University
CSIRO
Grains Research and Development Corporation
Land and Water Australia
Graham Spackman & Associates Pty Ltd
Pioneer Hi-Bred Australia Pty Ltd
Incitec Fertilisers Pty Ltd
Queensland Cotton Merchandising
Wesfarmers Landmark
S&B Agronomics
Natural Heritage Trust

Source: Department of Primary Industries and Fisheries, Queensland

[10] Mullen, J.D. 2002. *Farm Management in the 21st Century*, invited paper presented at the 46th Annual Conference of the Australian Agricultural and Resource Economics Society, Canberra, February, 2002.

However, the food and fibre sector has more to contribute to the environment than simply reducing its environmental impact. Instead, it has the potential to contribute much more widely through the provision of ecosystem services (ecoservices). Australia's Bureau of Rural Sciences (BRS) describes ecosystem services as:

> *…an emerging concept that supports sustainable and profitable agriculture and improved natural resources management.*
>
> *…Ecosystem services look at all of the benefits that society receives from production landscapes – not just agricultural commodities, but also biodiversity, water supply and carbon storage benefits. It provides a framework to maximise the net benefits that society receives from agro-ecosystems.*[11]

The need to examine the role of ecoservices, and the potential to create markets for these services, arises from the limitations of the current approach to natural resource management which predominantly relies on regulation and public funding to achieve environmental outcomes.

> *To date Australia's conservation approach has been largely reliant on regulation and government funding. Forecasted increased demands on government funds resulting from an ageing population, the impacts of climate change and continued erosion of natural resources due to past mistakes and consumption patterns, is likely to make this approach progressively less successful.*
>
> *Without marked increases in private funds for conservation investment, Australia will be forced into over-reliance on regulation and direct subsidy, limiting the nation's capacity to respond to a growing fiscal challenge.*[12]

One estimate is that the investment required for meeting natural resource targets related to sustainability is $65 billion over ten years, although this estimate predates awareness of the potential financial and ecosystem impacts of climate change.[13] Creating markets for ecoservices (ecomarkets) will be important for unlocking private and philanthropic investment in natural resource management, as well as making government investment in natural resource management more effective.

A key aspect of these markets is the creation of Market Based Instruments (MBIs), an approach that 'uses market-like instruments to positively influence the behaviour of people' by altering market prices, setting caps on resource use, improving the way a market works or creating a new markets.[14] Where the traditional approach of regulations and penalties provides a disincentive to engage in environmentally damaging behaviour, MBIs provide a

[11] http://www.daff.gov.au/brs/forest-veg/Ecosystem_Services (accessed 7 April 2008)
[12] Martin, Paul. 2008. *Concepts for private sector funded conservation using tax-effective instruments*. Land and Water Australia, Canberra. pp. 1-2.
[13] Madden and Duggan, quoted in Martin, 2008. p. 25.
[14] Department of Agriculture, Forestry and Fisheries, *What are market based instruments?*, Commonwealth of Australia, Canberra. p. 1.

positive incentive to encourage people to address environmental issues. The advantages of MBIs include:[15]

- providing flexibility for participants in adopting better natural resource management practices
- encouraging innovation to address environmental issues
- contributing to long-term and self-sustaining solutions
- addressing market failures (where markets do not ensure the sustainable management of natural resources, for example, landholders may have little incentive to conserve a wetland of significant environmental value)
- enabling measurement of progress against regional goals and targets
- supporting transparency, that is, landholders have a clear understanding of assessment and funding processes.

MBIs work best when there are a number of ways of solving a problem, but each has different costs to individuals and the community. They reduce compliance costs by 'encouraging greater change where change is relatively cheap or easy, rather than asking all participants to make the same level of change.'[16] Examples of potential MBIs for the food and fibre sector are outlined in Figure 6.

Figure 6: Ecomarkets of the future

Carbon Units

Under most carbon trading schemes parties may offset emissions by buying carbon credits that in turn fund carbon 'sinks' such as plantations or other carbon sequestering initiatives. Opportunities for farmland conservation include: farm-forestry; non-clearance or restoration of native habitat; reduction of inputs such as fuel or chemical fertilisers; farming for carbon reduction outputs, such as biofuels; management of grassland and woodlands to build soil carbon; and minimum till or other carbon conservation farming. Thus far the potential for farmers to participate in Australia's carbon-trading program is not well understood, and there are disputes about the capacity of some approaches (notably minimum tillage) to provide for a credible carbon-reduction strategy.

Salinity Units

A salinity unit helps manage the discharge of saline water. Under a typical salinity scheme, the Government sets a salinity cap and issues tradable permits – emitters who lack sufficient permits must buy them from someone who has foregone their right to emit or has otherwise agreed to offset that emission. It is possible to issue credits to those who engage in conservation farming, reserves, other salt holding or salt removal practices. As long as the salinity units can be traded through a third party, then there is a private market investment opportunity. Farm conservation practices that can impact on salt levels include reduced irrigation, use of deep-rooted perennial plants, forestry and land and water use planning. Salinity removal strategies include salt resistant plants and engineering solutions.

Source: From Martin, Paul. 2008. Concepts for private sector funded conservation using tax-effective instruments. Land and Water Australia, Canberra. pp. 37-39

[15] Ibid.
[16] ibid.

Current Australian ecomarkets include the *BushTender*, *EcoTender* and *BushBroker* programs initiated by the Victorian Government (see Figure 7). Evaluations of Victoria's *BushTender* scheme indicate that this approach preserved 25 per cent more vegetation than a grants scheme would have under the same budget.[17]

Adoption of advanced farming technology and practices, coupled with greater use of MBIs and other public policy innovations, will see Queensland achieving the 'win-win' of a 'smaller and lighter' ecological footprint along with a substantial increase in economic wealth.

Figure 7: Examples of current Australian ecomarkets

BushTender

Over three million hectares of Victoria's remaining vegetation occurs on private land, of which approximately 60 per cent is a threatened vegetation type and is estimated to support 30 per cent of Victoria's threatened species populations. BushTender *aims to improve the management of existing areas of native vegetation on private land. Landholders nominate their own bid price in a competitive tender and choose a range of actions to protect and enhance native vegetation. This could include fencing of native vegetation to exclude stock, control of environmental pests and weeds and supplementary planting of native understorey.*

Successful bids are those that offer the 'best value for money' in terms of the native vegetation and biodiversity outcomes resulting from landholder commitments and the landholder price for delivering these. Successful landholders receive periodic payments under contractual agreements with the Department of Sustainability and Environment or Catchment Management Authority.

EcoTender expands the BushTender approach to include potential improvements to river and estuary health.

BushBroker

BushBroker *provides a system in which native vegetation credits can be generated and traded, allowing interested landholders to provide credits on behalf of others. Landholders can provide native vegetation credits by protecting and better managing remnant bushland, through activities such as tackling weeds, controlling rabbits or fencing off stock.*

Credits can also be earned by revegetating previously cleared land with native plants indigenous to the area and by protecting scattered paddock trees to encourage natural revegetation. Putting freehold land into conservation reserves can also earn credits. Landholders who have earned credits are then able to sell them. Buyers of credits include those who are required by legislation to offset their clearing in one area by purchasing an offset credit in another area according to 'like for like' criteria.

Source: From Department of Sustainability and Environment, *EcoMarkets: Valuing Our Environment*, State Government of Victoria, Melbourne. p. 6

[17] Department of Agriculture, Fisheries and Forestry, *Managing Our Natural Resources: Can Markets Help?* Commonwealth of Australia, Canberra. p. 3.

2.4 Value to our society

The basic physiological needs of people are food, water, clothing and shelter and the Queensland food and fibre sector contributes substantially to meeting these needs through its production of meat, grains, fruit, vegetables, dairy, sugar, cotton, wool and timber. Apart from economic wealth, the sector is responsible for the inexpensive, reliable and ethical production of high quality, safe, nutritious food and other agricultural-based products.

Indeed, the Australian food and fibre production system works so well that the public largely takes for granted the contribution that this sector makes to our quality of life.

The sector also employs tens of thousands of Queenslanders and helps sustain rural and regional communities. It includes approximately 25 000 production focused businesses, 36 000 people employed in food and beverage manufacturing[18] and including the self-employed, provides jobs for around 125 000 Queenslanders (refer to Figure 8 for direct employment in agriculture). In addition to creating direct employment, the food and fibre sector also creates indirect employment in manufacturing, utilities, construction, communications, finance and business and personal services.

Figure 8: Agricultural Employment by State and Territory, 2003-04[a] ('000 employed persons)

Industry/Sector	NSW	VIC	*QLD*	*WA*	*SA*	*TAS*	*NT*	*ACT*
Agriculture, forestry and fishing	94.1	82.2	85.4	48.2	45.2	16.8	2.3	*0.4
Agriculture	83.2	74.1	76.0	37.5	37.5	10.6	1.4	*0.4
Horticulture and fruit growing	17.8	24.7	24.4	8.3	16.2	2.7	*0.7	*0.1
Grain, sheep and beef cattle	49.2	32.0	36.3	25.0	16.0	5.6	*0.6	*0.2
Dairy cattle	*4.7	9.2	*1.2	*1.2	2.4	*1.0	…	*0.1
Poultry	*3.3	*2.4	*2.4	*0.8	*0.5	*0.4	…	…
Other livestock	*2.5	*3.0	*2.4	*0.8	*1.2	*0.2	…	…
Other crops	*1.2	*0.9	8.0	*0.3	*0.1	*0.2	*0.1	…
Agriculture nec	*4.6	*1.8	*1.5	*1.1	*1.2	*0.6	…	*0.1
Services to agriculture	*5.4	5.6	5.2	6.0	*2.0	*1.0	*0.1	…
Forestry and logging	*3.6	*2.1	*0.3	*1.4	*1.3	3.4	*0.1	…
Commercial fishing	*1.6	*0.6	*3.7	3.3	4.3	1.8	*0.6	…
Agriculture, forestry and fishing nec	*0.6	…	*0.2	…	*0.2	*0.1	*0.2	…

Source: Productivity Commission. 2005. *Trends in Australian Agriculture*, Research Paper, Canberra. Appendix C: Supplementary Employment Data, p. 149.

*…indicates industries where employment is either nil or negligible. [a] Data are based on survey information, and so information for Agriculture, Forestry and Fishing subdivisions and groups, or at state and territory level, is less reliable than more aggregate information at division or national level. Estimates with a relative standard error of 25 per cent or greater are preceded by an asterisk (for example, *5.2) to indicate that they are subject to high standard errors and should be interpreted with caution.*

[18] Department of Agriculture Fisheries and Forestry, Australia. 2007. *Australian Food Statistics 2006* Commonwealth of Australia, Canberra. p. 53.

From a social perspective, there is an interaction between the evolution of the primary production sector and the regional and rural communities in which the sector is located. Both have been subject to severe adjustment pressures. Rural and regional communities have experienced declining services, loss of jobs, an increase in poverty, ageing populations and an exodus of young people.[19] Feeding into this dynamic has been the decline in the number of farms. Over the period 1999-2005, the number of farms decreased by around 12 per cent from 30 753 to 27 132.[20]

As farm numbers and other economic activity declines so does the social and institutional capital of rural and regional towns. These effects range from lost job opportunities for professionals who had previously provided community leadership to the loss of the young people who make up the membership of sporting clubs and an overall continuing decline in services.[21] Such trends discourage people from moving to rural and regional areas to take up employment or invest in local industry, which exacerbates community decline.

Solutions to the problems of rural and regional communities go beyond the food and fibre sector. However, the contribution that this sector can make in sustaining these communities is considerable. In particular, there is the opportunity to improve the economic welfare of the average performing medium and large size farms (see Figure 9). Medium size farms, which comprise 37 per cent of all farms, are of particular importance to the social and institutional life of regional and rural communities as they come closest to the traditional image of the family farm. Increasing the economic performance of these farms would have considerable social benefits, both directly to farm families and to their communities.

With the increasing complexity of farm management, advisory services and other ancillary industries have become more important. Increasing the wealth of medium and large farms will encourage expenditure, and therefore growth, in ancillary services and industries located in rural and regional areas. Such industries range from agronomists to farm machinery dealerships and retail agribusiness. Such employment opportunities are challenging and come with high income-earning potential. They are therefore potentially attractive to people who prefer the country lifestyle over a city one but also want the challenge of interesting work.

At the same time that the food and fibre sector could contribute more to the quality of life of Queenslanders, it can also contribute to the quality of life of millions across the world. Principally, this is done through exports of our food and fibre products. However, Queensland also contributes to improving world food security, reducing poverty and improving natural resource management through transferring our knowledge of sub-tropical and tropical production systems to other parts of the world. This knowledge will be particularly valuable to our South Pacific and Southeast Asian neighbours, which are already benefiting from our assistance.

[19] Alston, Margaret. 2004. 'Who is down on the farm? Social aspects of Australian agriculture in the 21st century', In *Agriculture and Human Values*, 20(1): 27-46. p.44.
[20] Analysis provided by Department of Primary Industries Queensland, based on data published by the Australian Bureau of Resource Economics.
[21] ibid.

Figure 9: Patterns of Queensland farming

Micro farms

Micro farms produce an annual output of less than $22 500 per annum from gross sales. This group consists of 20 per cent of all farms but produce less than 1 per cent of total output. Their primary income source is off-farm and they are often high in equity and debt free. They are not particularly focused on productivity, preferring capital growth and the country lifestyle.

Small farms

Small farms produce an annual output of greater than $22 500 but less than $100 000 from gross sales. These farms are largely casual or 'hobby' operations, with generally low rates of return, with most income sources off-farm. This group consists of 33 per cent of all farms and produce less than 10 per cent of total output.

There is dichotomy in this group, with average small farms experiencing negative rates of profitability (around -2 per cent rate of return on assets), while top performing farms generate positive rates of profitability (around 1 per cent return on assets).

The average farms are not economically sustainable in the longer-term, although if the perceived non-financial benefits are high enough they may keep operating indefinitely. Top performing farms are largely economically sustainable and both groups supplement their farm income with off-farm investments and income.

Medium farms

Medium farms produce an annual output greater than $100 000 but less than $500 000 per annum in gross sales. This group comprises 37 per cent of all farms and produces almost 40 per cent of total output. Most farms in this group would support one or two family members working full-time on the farm. This group is also closest to the traditional image of faming life.

Average medium farms experiencing low rates of profitability (around 0 per cent rate of return on assets) are not economically sustainable in the longer term. Off-farm income by some family members may be necessary to maintain the farm household.

Top-performing medium farms generate positive rates of profitability (around 6 per cent return on assets). Their primary income is on-farm and they have the capability to maintain long-term viability due to a large focus on productivity gains.

Large farms

Large farms produce an annual output of greater than $500 000 per annum in gross sales. This group comprises only 10 per cent of all farms but they produce around 60 per cent of total output. Some are corporate farms, but most are family farms.

Average large farms are generally experiencing low rates of profitability (around 1 per cent rate of return on assets). They are largely focused on productivity and financial returns however tend to be relatively undiversified in terms of on-farm income and more susceptible to external events such as drought.

Top performing large farms generate positive rates of profitability (around 7 per cent rate of return on assets). They are characterised by consolidation (one farm buying up neighbouring farms to create critical mass) and are focused on expansion, productivity gains and financial returns (for corporate farms, this includes returns to shareholders and directors).

Source: Analysis provided by the Department of Primary Industries and Fisheries, Queensland, based on data published by the Australian Bureau of Agriculture and Resource Economics.

2.5 Value to our future

Strong world economic and environmental drivers will make the food and fibre sector of increasing importance to Queensland's future.

Over the last year, prices for rice have risen 122 per cent, wheat prices by 95 per cent, soybeans by 83 per cent and corn 66 per cent. The World Bank estimates that prices for all foods have risen 83 per cent in the past three years.[22] In response to higher prices and food shortages, there have been food riots in several countries, including five deaths, and the UN World Food Program has warned of a 'silent tsunami' of hunger threatening the lives of 20 million children.[23] From an Australian perspective, while overall inflation rose 4.2 per cent over the last year, food prices rose 5.7 per cent.[24]

While some of the rise in food prices is due to short-term factors such as drought, the long term trend is for strongly increasing world demand for food and fibre products and related services and technologies. In part, this is due to the rapid economic development of countries such as Brazil, Russia, India and China. In addition, rising wealth in Asia has seen a shift in food consumption patterns from a mainly rice-based diet to a more Western-style diet that includes greater quantities of animal products and processed foods.

At the same time as there is rising demand for food, there has been rising demand for renewable fuels. This has seen large transfers of land from food production to biofuel production in countries such as the United States and Brazil, a trend that is underpinned by large biofuel subsidies. While these subsidies may not continue, there is no question that the recent increase in biofuel production foreshadows the development of new industries around advanced biomaterials and biofuels, which are needed to supersede current fuels and industrial materials, particularly those derived from oil.

Professor Jeffrey Sachs, one of the world's most influential economists and a special advisor to the UN Secretary-General, has summarised the situation as follows:

> *I think these pressures are going to be with us for quite a long time to come. We really are such a big, crowded planet with so much growth, of course particularly in the Asian region with China's growth, with India's growth, that we're pushing hard not only on the food supplies, of course, but also on energy which is why we have oil prices at about $120 a barrel. ...*
>
> *This is really a growing large world economy pressing against scarce resources. Of course, for a country like Australia, if the rains are good, this is a great boon because as a natural resource country, this is a tremendous rise of prices.*

[22] Nason, D. 2008. "First signs of the coming famine", *The Australian*, 26 April, 2008.
[23] ibid.
[24] ibid.

> *What it does mean is that this relative scarcity of commodities is pushing up against the capacity of the world economy to grow right now. It will definitely be a factor in the slowdown of global growth. We have to think longer term of alternative technologies, better technologies for energy, for food supply, a lot more research. This is again, one of the areas where we've done very, very little in recent years, is actually thinking ahead to alternatives and to ways to boost the food supply and help make our food system more resilient to climate shocks.*[25]

The food and fibre sector is not only needed to meet increased demand for food and fibre products; this sector is also needed for its skills in managing environmental risks such as climate change, loss of biodiversity and salinity. Land managers who have the ability to integrate economic and environmental values in agricultural production systems will be inordinately valuable, not only for the food and fibre products they produce, but for the services that they can provide in improving and sustaining our natural environment.

Current economic and environmental trends are heralding the transformation of Queensland's traditional agricultural industries into the bio-industries of our future and our land managers into our most important environmental stewards.

In the 21st Century, food and fibre science is the science of opportunity. Opportunity for continued economic and social prosperity for our State, in particular our rural communities and regions. Opportunity for better sustaining and preserving our natural heritage. Opportunity to help feed the world, millions of whom still face malnutrition and even starvation. Beyond even that, in the small molecules of our diverse plants and animals lies the opportunity to create new foods, fuels and materials that, for now, we only dream of creating.

[25] http://www.abc.net.au/lateline/content/2007/s2233195.htm (accessed 6 May 2008)

2.6 The Smart State Vision for 2030

The ability to meet all three requirements of sustainability – economic, environmental and social – is what will set Queensland apart in world food and fibre markets and ensure that we realise the full value of this sector to our community.

Economically, there is also an opportunity to go beyond the 'business as usual' growth scenario for the industry, which would see the value of food and fibre primary production reach $25 billion by 2030. However, growth in world demand for food and fibre products, services and technologies is of such a scale that Queensland should set itself a more ambitious but achievable target. In addition to generating at least $25 billion from traditional sources of food, fibre and value-added products and services by 2030, we should also aim to generate an additional $10 billion in economic wealth from new products, technologies and services, including at least three new 'billion dollar' industries. Examples of a potential billion dollar industries include: cellulosic ethanol derived from sugarcane waste; high oil tree crops planted in marginal areas that produced biodiesel; and tropical hardwoods and timber products. New technologies include animal vaccines, stay fresh food packaging and biopesticides.

As the opportunities are wide, Queensland will need to act in a focused manner to ensure that we can grasp the ones most likely to come to fruition. Implementation of the recommendations in this report will assist in providing focus for our efforts.

The proposed vision for the food and fibre sector encompasses all three dimensions of sustainability. While this vision cannot be achieved by R&D on its own, its contribution will be essential.

By 2030, the Queensland food and fibre sector will be (in 2008 dollars):

A thriving industry generating at least $25 billion from traditional food, fibre and value-added products, services and technologies, with significant new services, technologies and at least three new billion dollar industries generating an additional $10 billion in economic wealth.

A world leader in integrating environmental and economic values for a 'small and light' ecological footprint and a better environment.

An industry that supports resilient regional communities and is valued by all Queenslanders for its contribution to our quality of life.

3 Value to Queensland of food and fibre RD&E

RD&E has underpinned growth in the food and fibre sector and plays a critical role in industry innovation. RD&E will have a continuing role in enabling the food and fibre sector to overcome challenges and make the most of our advantages.

3.1 Research, development and extension

Research-based innovation in the food and fibre sector comprises three interrelated elements: research, development and extension or 'RD&E'. While these components overlap, there are distinct differences:

- *research* refers to scientific discoveries that originate in laboratories or other controlled experimentation or measurement processes.
- *development* refers to scientific work aimed at applying research discoveries and other observations to develop practical tools and technologies that meet industry needs.
- *extension* refers to 'public and private sector activities relating to technology transfer, education, attitude change, human resource development, and dissemination and collection of information'.'[26] Extension is the key mechanism for seeing the 'R&D' put to use.

Although extension is a term commonly used in the primary production sector, it is equally applicable to the food sector.

> *Food science describes the components of a food or raw material, how they fit together and what, how and why certain things may happen to them when foods are stored and/or processed and, because the effects of light and temperature are sometimes very important, displayed for sale. The food technologist takes this information and selects the processing and packaging conditions necessary to ensure that, as far as possible, only the favourable things will happen. There is, therefore, what has been called a spectrum of food science and technology with science at the one end and technology at the other. There is a large area in the middle where science informs technology and technology seeks the help of science. It is, therefore, inevitable that food science and technology is viewed as an entity covered by a singular verb.*[27]

The 'singular verb' is extension. For the RD&E system to work effectively there must strong interaction and feedback loops between all three components of research, development and extension.

[26] Marsh, S.P. and Pannell, D.J. (2000). *The New Environment for Agriculture: Fostering the Relationship Between Public and Private Extension*, RIRDC Publication No. 00/149, Rural Industries Research and Development Corporation, Canberra, p. 1.
[27] Dr Keith Farrer (forthcoming)

3.2 A history of RD&E success

There is a widely held view that dependence on natural resources is inherently disadvantageous and that nations dependent on natural resources must shift their economies to more advanced or high technology industries that are strongly associated with innovation. However, such analysis relies more on theory than it does on evidence, as countries such as Sweden, Finland, Canada, Australia and New Zealand have all developed low and medium technology industries that have driven growth.[28] These low and medium technology industries include, among others, food processing, timber products and textiles and clothing. In fact, resource-based industries such as mining and agriculture 'have a vital role in Australia's balance of trade'.[29] It is similarly the case for Queensland.

Despite a commonly held view that resource-based industries lack sophistication in their technology base, these industries, including the food and fibre sector, are often 'intensive users of R&D and intensive users of scientific knowledge'.[30] Nowhere is this more evident than in the performance of Australia's agricultural industries.

In the 30 years to 2003-04, the long-term trend in multifactor productivity growth (changes in output per unit of combined inputs) for Australian agriculture has been 2.8 per cent. This growth rate is substantially higher than that for Australia's mining and manufacturing industries and most of Australia's services sector (refer Figure 10). One estimate is that around 0.5 per cent of this growth is attributable to factors such as public infrastructure and farmer education. However, the larger component, around 2 per cent, is attributable to

Figure 10: Labour, capital and MFP growth rates by sector/industry, 1974-75 to 2003-04

Sector/industry	*Labour Productivity*	*Capital Productivity*	*Multifactor Productivity*
Agriculture	**3.3**	**2.7**	**2.8**
Mining	**2.6**	**-0.8**	**0.2**
Manufacturing	**3.2**	**-1.2**	**1.6**
Services			
Electricity, Gas and Water	4.1	0.4	1.8
Construction	1.6	-1.6	1.0
Wholesale Trade	2.1	-1.0	1.2
Retail Trade	1.5	-2.5	0.8
Accommodation, Cafes and Restaurants	0.0	-2.5	-0.6
Transport and Storage	2.8	1.1	2.3
Communications	6.5	1.0	4.2
Finance and Insurance	2.2	-3.2	-0.1
Cultural and Recreational Services	-0.5	-3.1	-1.6
Market Sector	**2.2**	**-0.7**	**1.1**

[28] Smith, Ken. 2007.*CEDA Project Paper 3 Competing from Australia: Innovation and growth in resource-based economies*. Committee for Economic Development of Australia, Melbourne.
[29] Scott-Kemmis, Don. 2004. 'Innovation systems in Australia', *Innovating Australia*, Ian Marsh (ed.). Committee for Economic Development of Australia, Melbourne. p. 45.
[30] Smith, 2007. p. 35

Source: http://www.pc.gov.au/commission/work/productivity/performance/industry.html

technical change arising from public and private investment in R&D and its adoption. Of this, around 1.2 per cent is estimated to be accounted for by investment in domestic R&D and a further 0.8 per cent by 'spill-ins' from foreign R&D. [31]

If all productivity gains at the rate of 1.2 per cent are attributed to domestic research since 1918, the internal rate of return on Australian research investment would be 15 per cent and the benefit-cost ratio 8.1:1. This analysis does not take into consideration benefits accruing beyond 2003.[32] Given that the productivity rate for Queensland's agricultural industries is similar to the Australian average, it is likely that this analysis is the same for Queensland.

RD&E-based inputs in the food and fibre sector are indirect and flow from the 'knowledge infrastructure' of society such as personnel movements, inter-firm cooperation and links with universities and research institutes. The food processing sector, for example, is highly dependent on food science and technology for improvements in productivity and maintaining its competitive position. The knowledge bases of food technology and food science (described in Figure 11) feed directly into key activities of food processing, for example, preparation of materials, cooking, nutritional and contaminants monitoring, packaging and distribution.[33] In summary:

> *The R&D/science use of [resource] sectors is…not measured with available science and technology indicators, and they are often regarded as traditional and low technology sectors. Yet many of these industries – in particular, food processing – have a good claim to be at least as science-based as something like [information and communications technology]. Because the science and R&D use of these industries flows indirectly from the overall knowledge infrastructure, the growth and innovation performance of such industries – and hence the overall economy – depends on the structure, efficiency and funding of the infrastructure.* [34]

This report is concerned with precisely this issue: the structure, efficiency and funding of the knowledge infrastructure underpinning the prosperity and sustainability of Queensland's food and fibre sector.

Figure 11: Food science & food technology

…food science integrates the application to food of several contributory sciences. It involves knowledge of the chemical composition of food materials (for all food consists entirely of chemical substances); their physical, biological and biochemical behaviour; human nutritional requirements and the nutritional factors in food materials; the nature and behaviour of enzymes; the microbiology of foods; the interaction of food components with each other, with atmospheric oxygen, with additives and contaminants, and with packaging materials; pharmacology and toxicology of food material, additives and contaminants; the effects of various manufacturing operations, processes and storage conditions; and the use of statistics for designing experimental work and evaluating the results.

[31] Mullins, John. 2007. *Productivity Growth in Australian Agriculture*, March 2007. p. 48.
[32] ibid.
[33] ibid. p. 42.
[34] ibid. p. 36

Likewise, food technology draws on, and integrates, the application to food of other technologies such as those of steel, tinplate, glass, aluminium, plastics, engineering, instrumentation, electronics, agriculture and biotechnology.

Institute of Food Science & Technology (UK), quoted in Smith 2004, p. 42

3.3 Our challenges

The Queensland food and fibre sector faces a number of challenges that must be overcome to achieve success: scale; distance; contestable markets and climate change and variability.

3.3.1 Scale

Relative to the rest of the world, Australia's population is small and Queensland's population even smaller. Although a strong exporter, on a global scale Queensland's food and fibre industries are relatively small, with only beef, and to a lesser extent sugar, having a significant share of global trade. The small scale of the Queensland (and Australian) food and fibre sector means that it cannot withstand inefficient allocation, segmentation and unproductive internal competition for scarce funding, skills and other resources.

As our domestic market is relatively small, we need to grow our industries by seeking export opportunities, including through collaboration with other Australian companies that may traditionally be rivals in domestic markets. One example of such an initiative is Barley Australia. Established in 2005 by seven Australian barley industry companies, it provides leadership for the industry, including managing end use market R&D projects and providing market focus for Australian barley breeding programs. It also aims to increase recognition and international competitiveness of Australian barley through initiatives such as trademarking.

From an RD&E perspective, not only is it vital to collaborate nationally to create critical mass, but we also need to collaborate internationally, including by accessing research generated overseas and adapting it to Australian conditions.

3.3.2 Distance

When the export destinations of Queensland agriculture are taken into consideration, the geographical scope of Queensland's food and fibre sector is vast. For the people and organisations operating within Queensland's food and fibre supply chains, distance and location substantially affect the movement of people and products and also have significant implications for the flow of information and knowledge critical for successful innovation. Managing this challenge requires a substantial investment in infrastructure, including roads, rail, ports and telecommunications.

At a production level, Queensland's food and fibre sector encompasses tropical, sub-tropical even temperate conditions. Queensland is also the most geographically decentralised state with respect to agriculture (Western Australia is a larger state but its agriculture is centralised in the southwest corner). The location of industries will determine, among other things, climatic impacts, pest, weed and disease pressures, and natural resource availability and management, particularly in terms of water. All of these factors add to the complexity of managing food and fibre supply chains due to the need to ensure reliability and consistency in product quality in a variable environment.

Distance affects all facets of the food and fibre sector, including RD&E. It operates not only at a domestic level (for example, linking urban-based research with rural-based farms) but also at an international level (for example, linking Australian-based universities with their overseas counterparts). Distance is a constant challenge and one that must be consciously managed by the sector.

3.3.3 Global competitiveness

Advances in information and communications, as well as transport, storage and handling technologies, have assisted Queensland in becoming a successful exporter of food and fibre products. These technological advances, along with increased investment and improvements in production capability, have also seen a substantial increase in export and domestic competition from overseas suppliers with low production costs, high-volume capacity and less regulation such as Chile, Brazil, Argentina, Thailand and South Africa. Export markets in Southeast and Northeast Asia are particularly subject to increasing levels of contestability.

Due to the strong export orientation of the industry, it is also subject to changes in world economic conditions, including world supply and demand for different food and fibre products. In addition, currency fluctuations alter the competitiveness of Queensland exports by altering the price of our exports relative to that of our international competitors. Although these risks can be managed to some extent through financial instruments such as currency and commodity futures, they nevertheless represent a significant challenge to the industry.

Although Queensland has a long history of success in food and fibre markets, we cannot be complacent about the future. Constant effort is required to maintain our competitive position in the face of the increased contestability of global markets. This includes being mindful that not only are our export markets contestable, but so too are our domestic markets.

3.3.4 Climate Change

Some risks to the food and fibre sector arise from the fact that it is based on a natural system where some threats cannot be controlled, only managed. One key natural threat is climate.

Long- and short-term climatic risks arise due to global warming, climate variability, cyclones and drought, which can cause the relocation of agricultural production within Queensland, across Australia and even globally. Climate change will affect different industries in different ways. For example, the increase in temperature is likely to see a decrease in soil moisture necessary for plant growth and productivity. On other hand, changing climate conditions may also offer the opportunity to plant more frost-sensitive horticultural crops due to a decline in frosts. It is also possible that rainfall in northern Australia will be more reliable than that of southern Australia and this may prompt relocation of some food and fibre industries to northern Queensland where water will be more readily available.

The risks posed by climate change and variability are principally managed by preparedness for dealing with the consequences of adverse events should they eventuate (e.g. drought and flood) and adaptation to changed conditions (e.g. global warming). The risk-preparedness and adaptive capacity of Queensland's food and fibre sector is one of its key strengths and fundamental to the future sustainability of the industry.

3.4 Our advantages

Although the food and fibre sector faces challenges, the sector does have substantial advantages relative to our competitors: a biosecurity advantage due to being an island nation and strong biosecurity management capability; low sovereign risk and an open economy; and strong adaptive capacity.

3.4.1 Biosecurity

Being an island, Australia is protected from many of the pest, plant and animal diseases found in other parts of the world and has strong quarantine and surveillance systems in place to maintain this status. Our island biosecurity provides advantages relative to our competitors in trade and market access, human health and food safety and productivity and sustainability. For example, an outbreak of foot and mouth disease could cost the Queensland economy $9 billion and have a long-lasting impact as it attempts to regain lost market share.

Our island biosecurity status in preventing incursions is enhanced by key biosecurity management measures such as the National Livestock Identification Scheme (NLIS). NLIS is a world-leading system for livestock identification and traceability. It is a permanent 'whole-of-life system' that enables individual animals to be identified electronically and tracked from property of birth to slaughter, for food safety, product integrity and market access purposes.[35] It provides Australian beef exporters with an exceptional competitive advantage relative to other beef exporters who cannot match this capability.

Although our island status assists in preventing biosecurity incidents, the size and location of Queensland also places us in a unique position relative to other Australian states in dealing with biosecurity threats. Queensland is the only jurisdiction providing substantial RD&E and biosecurity services to sub-tropical and tropical industries. All other states have a greater opportunity to share RD&E and biosecurity responsibilities. Queensland has also had a series of high-cost biosecurity incidents consistent with its geographical position close to Asian/Pacific neighbours. This biosecurity risk is compounded by Queensland's lengthy, remote and sparsely populated northern coastline, making early detection of incursions particularly difficult.

To deal with this these risks, we require strong surveillance and emergency management capabilities for detecting and responding to incursions and eradicating them where possible.

[35] www.mla.com.au/TopicHierarchy/IndustryPrograms/NationalLivestockIdentificationSystem/default.htm (accessed 8 may 2008)

For example, Red Imported Fire Ants could cost the Australian economy $8.9 billion (it currently costs Texas $1.2 billion a year to manage) and impact greatly on productivity and social amenity. Other recent incursions have included papaya fruit fly, citrus canker and equine influenza. The rigorous response of our biosecurity services has resulted in eradication of papaya fruit fly, programs that are on track to eradicate citrus canker and equine influenza and the strong possibility that Queensland will be will be the first place in the world to eradicate Red Imported Fire Ants.

3.4.2 Low sovereign risk and an open economy

Australia is highly regarded for its low sovereign risk, strong global economy, track record of economic and regulatory reform and leadership role in the Pacific region.

The Index of Economic Freedom, developed by the Heritage Foundation (a United States think tank) and *The Wall Street Journal,* provides a good measure for assessing the relative attractiveness of different countries as a destination for investment, including investment in R&D. For 2008, Australia's economy was rated fourth in the world in terms of economic freedom, and was considered particularly impressive in terms of financial freedom, property rights and freedom from corruption. [36]

Australia was ranked third out of 30 countries in the Asia-Pacific region (behind Singapore and Hong Kong) and our overall score was well above the regional average. Australia also has a very high level of economic freedom compared with other countries in the Southern Hemisphere, apart from New Zealand (ranked 5) and Chile (ranked 8). Of particular relevance to Queensland, Australia also compares well with other tropical or sub-tropical countries such as Brazil (ranked 101) and those in Central America and Asia. [37]

Australia's regulatory arrangements in areas of intellectual property rights and the use of gene technologies are of particular importance in determining the destination for investment in food and fibre research. Intellectual property rights ensure that value generated by research investment can be captured by the investor, while transparent, risk-based regulatory arrangements for genetically modified (GM) products, provide the opportunity to undertake cutting-edge research. For example, Queensland's decision not to follow other states in implementing a moratorium on the commercialisation of GM crops was one of the factors in Syngenta's decision to invest in sugarcane biofuels research through its partnership with the Queensland University of Technology (see Figure 12).

[36] http://www.heritage.org/research/features/index/country.cfm?ID=Australia (accessed 8 May 2008)
[37] ibid.

Figure 12: Syngenta Centre for Sugarcane Biofuel Development

In 2007, agreement was reached between the Queensland University of Technology (QUT), qutbluebox (QUT's commercialisation arm), Farmacule Bioindustries and Syngenta to establish the Syngenta Centre for Sugarcane Biofuels Development at QUT.

Syngenta is a global agribusiness company with an annual turnover of over US$9 billion and an annual R&D budget of around US$800 million. Under the agreement, Syngenta will relocate four researchers to QUT and all researchers in the centre will have access to resources and expertise of other Syngenta operations, including complementary genetic technologies. This is the first centre of this type to be established by Syngenta and the decision to make the investment was based on the following four factors.

Pioneering genetic research

The Centre for Tropical Crops and Biocommodities at QUT, headed by Professor James Dale, has pioneered research in genetic technologies to highly express enzymes in plants. This will potentially enable the economic conversion of cane waste into sugars that can produce ethanol (called cellulosic ethanol) without compromising the sugar potential of the cane.

Cellulosic ethanol could replace 30 per cent of vehicle petroleum annually and provide an 80 per cent saving on greenhouse gases compared with conventional petrol. Unlike current ethanol production methods, which replace food with fuel production, cellulosic ethanol from sugarcane would see food and fuel produced from the same crop.

Through-chain research capability

The sugarcane expertise of the Centre for Tropical Crops and Biocommodities at QUT includes not only sugarcane genetic technology but also encompasses Sugar Research and Innovation (SRI), an internationally-recognised sugar processing engineering consultancy. SRI joined the Centre for Tropical Crops and Biocommodities in 2005, relocating 20 SRI researchers from Mackay to QUT.

Strong government investment

With this critical mass in research expertise, QUT was able to attract significant Queensland Government funding, including a $3.1 million investment from Queensland's Smart State Innovation Building Fund to construct a pilot plant in Mackay. This investment leveraged a further $3.4 million investment by the Federal Government under its National Collaborative Research Infrastructure Strategy.

Given the long-term and high-risk nature of developing and commercialising cellulosic ethanol, tangible government support for this research helped reduce the commercial risk of the project and therefore made investing in research on sugarcane cellulosic ethanol in Queensland attractive to Syngenta.

Brisbane: an excellent place to do business

Syngenta identified a number of cultural and business reasons for doing business in Queensland:

- a strong and predictable intellectual property regime
- the ability to conduct field trials of genetically modified (GM) crops and overall Queensland government support for the technology, including commercialisation of GM crops (this is in contrast with other states, which had moratoria on the commercialisation of GM crops)
- a world-leading centre for sugarcane research, with the possibility of interaction with a number of different groups
- a good environment, with an enviable quality of life, in which to locate staff
- a willingness and a tradition in Australia of researchers working with industry, which will make commercialisation of the technology easier to achieve.

Source: Personal communication, Dr Manuel Sainz, Group Leader, Sugarcane Research, Syngenta Centre for Sugarcane Biofuels Development; www.smartstate.qld.gov.au, www.news.qut.edu.au

3.4.3 Adaptive capacity

The ability to cope with continuous change is a feature of Queensland's food and fibre sector. This culture has helped foster open, competitive and resilient industries that are well positioned to cope with future changes in economic and market conditions, technological innovation and changes to the natural environment, such as global warming.

Australia's leadership in economic reform in agriculture is reflected in the relatively low level of government support for agriculture. The Organisation for Economic Cooperation and Development (OECD) estimates that government support for Australian agriculture has decreased from 8 per cent in 1986-88 to 5 per cent by 2004-06.[38] This compares to a decline in the OECD average over the same period from 38 per cent to 29 per cent.[39] Of the government support provided to agriculture, 15.7 per cent is support for RD&E.[40] Competition and facing undistorted market signals has created the incentive for change to occur, leading to higher productivity, improved industry competitiveness and productivity gains.[41]

In terms of natural risks, Queensland has a long history of successfully managing climate variability and drought, as well as exotic and endemic plant pests, diseases and weeds. Examples include developing pest resistant plant varieties; new tools for analysing and predicting weather and its impact on farm conditions; conservation tillage techniques to preserve subsoil moisture; the development and use of animal vaccines; and the use of financial instruments such commodity futures for managing risk.

These examples indicate how adept Queensland farmers are in adapting and using new services and technologies in the face of changing environmental, market and economic conditions.

3.5 Strategic action on innovation

While the challenges facing the food and fibre sector are considerable, the identified advantages are particularly important when comparing Queensland with other countries that also have tropical and sub-tropical farming systems. For the most part, these are developing countries (such as those in Southeast Asia) and therefore have comparatively weaker political, industrial and economic capacity to manage sophisticated food and fibre supply chains. The relative sophistication of Queensland's supply chains, underpinned by a strong RD&E system, is a key competitive advantage for our sector (see for example Figure 13). Our advantages can also be leveraged to attract research activity to Australia.

[38] Government support rose in 2006 to 6% as a result of a major fall in the value of farm production and a small increase in drought relief payments related to the most devastating drought on record.
[39] Organisation for Economic Development and Cooperation. 2007. *Agricultural Policies In OECD Countries: Monitoring And Evaluation 2007*, Organisation for Economic Development and Cooperation, France. p. 83.
Note: Government support rose in 2006 to 6% as a result of a major fall in the value of farm production and a small increase in drought relief payments related to the most devastating drought on record.
[40] Figure derived from OECD data, ibid, p. 85.
[41] Harris, David. 2005. *Coping with change – farm level adjustment and policy reform.* Rural Industries Research and Development Corporation, Canberra. p. 2.

Overcoming our challenges and making the most of advantages will require continued innovation by the food and fibre sector. There are three aspects to innovation:

- the origination of new knowledge and ideas – knowledge production
- the deployment of ideas within a real world context – knowledge application
- the diffusion of this applied knowledge and its adaptation in use – knowledge diffusion.[42]

Investing in the capabilities, and in the linkages between them, is required to develop a successful innovation system.[43] In the food and fibre sector, along with R&D, this can mean action across range of areas including logistics, marketing, natural resource management, education and training and government policy and regulation.

R&D provides new knowledge and ideas necessary to overcome inherent challenges facing the industry and to realise opportunities for growth (see Figure 14 for examples). Completing the innovation process requires extension, as this provides a critical link between the knowledge production, application and diffusion elements of Queensland's food and fibre innovation system.

Figure 13: The impact on the beef industry of the introduction of eating quality standards

Meat Standards Australia (MSA), trademarked by Meat and Livestock Australia, is a voluntary beef and sheepmeat grading system that labels beef and sheepmeat according to a guaranteed grade relating to eating quality. The standards are based on extensive research that provides insight into the factors that impact on eating quality across each stage of the meat production process, including breeding, growing, handling, processing, retailing and cooking.

In 2006-07, 715 856 head of cattle were graded through the MSA program in Australia, an increase of 10.9 per cent on the previous year. In Queensland, MSA graded beef provided an average retail margin of $2.79 per kilogram higher across all cuts of meat in comparison with non-MSA beef.

MSA provides incentives and targets for producers to achieve standards that provide quality premiums. This has driven changes in the way meat is produced, with an increasing trend to younger cattle with more rapid weight gain and the greater use of feedlots for finishing cattle to improve eating quality. Additionally, initiatives such as BreedPlan and BullPower, along with other technologies in disease management, reproduction and nutrition, have become more relevant to producers, as the MSA program provides a pathway to greater profitability.

MSA is leading to rapid integration of the numerous components of the beef industry and has become a catalyst for driving increased beef industry productivity and profit. The whole beef production chain is becoming better understood and more tightly controlled in the quest for best results.

MSA also provides a standard by which international purchasers of Australian beef can ascertain and guarantee quality. MSA standards are in the process of being adapted for international use and will enhance Australia's capacity to market product, particularly high-value cuts. A new pasture-fed MSA standard, currently under consideration, will increase the eligibility of a larger proportion of the Australian beef herd for MSA coverage.

Source: Department of Primary Industries and Fisheries, Queensland

[42] Innovation Review Committee, 2008. *Review of the National Innovation System: A Call for Submissions*. Department of Innovation, Industry, Science and Research, Canberra. p. 4.
[43] ibid.

While some innovations can be achieved unilaterally within an organisation, substantial improvements in performance will often require through-chain innovation – that is, the cooperation and collaboration of many businesses and even government agencies to make the innovation work. Well planned, strategic action by the food and fibre sector – both government and industry – will be critical in achieving the through-chain innovation needed to realise the economic, environmental and social potential of the sector.

Figure 14: How RD&E adds value to the Queensland food and fibre sector

Sorghum Breeding: A 20-fold return on investment

DPI&F has been a leader in sorghum breeding for over 30 years. Around $20 of benefit has been generated for each dollar invested by the Queensland Government and industry in DPI&F sorghum breeding.

The major benefits of departmental sorghum breeding have come from farmers using hybrids that have progressively increased yields and developing midge-resistance (midges are an economically-damaging pest of the sorghum plant).

In addition to increased yields, DPI&F sorghum breeding has provided other benefits such as increased flexibility in planting and major reductions in pesticide use. All commercial hybrids currently being released by private breeding companies incorporate DPI&F germplasm.

The farm gate value of the Queensland sorghum crop, about 70 per cent of the national crop, will be worth over $360 million in 2007-2008. Sorghum is value-added by the animal industries with about 60 per cent used locally in feedlots and intensive animal industries.

Sorghum needs less water than other major grains and will increase in importance as the effects of global warming become more apparent. Along with climate change and variability, the projected doubling in global meat consumption by 2050 highlights the continuing importance of sorghum for Queensland.

Major research partners in sorghum breeding are:

- DPI&F, Queensland
- Grains Research and Development Corporation

Source: Department of Primary Industries and Fisheries, Queensland

BullPower: Bull Selection and use

Profit margins per animal can be increased on larger cattle stations by reducing bull numbers if this can be achieved without compromising production and quality.

'BullPower' was developed to provide graziers with information and tools to assess the breeding soundness of bulls and to reduce overall bull numbers from 4 to 5 per cent to 2.5 to 3 per cent of the herd. Graziers benefit through lower capital and operating costs that result in increased gross margins per animal.

Analyses indicate that adoption of BullPower over 10 years up to a conservative level of 10 per cent of Northern Australian herds (90 per cent in Queensland) would return over $9 for every dollar invested. That is, approximately $28 million would be generated from the $2.9 million investment in research.

The beef industry is Queensland's largest agricultural industry and its largest exporter, providing an estimated $3.7 billion worth of animals for meat and live export in 2008. Over 17,000 Queensland properties hold around 10 million cattle representing about 45 per cent of the national beef herd.

Partners in the BullPower project were:

- DPI&F, Queensland
- James Cook University
- Department of Primary Industry and Fisheries, Northern Territory
- Meat Research Corporation (now Meat and Livestock Australia)

Source: Department of Primary Industries and Fisheries, Queensland

4 A better RD&E system

Although the food and fibre sector has been well served by the current RD&E system, increasing competitive and environmental pressures, and the scarcity of RD&E resources, has prompted a reassessment of current arrangements.

4.1 The current RD&E system

There are multiple providers (organisations that undertake research) and investors (organisations that fund research) in food and fibre RD&E. Some organisations undertake both functions. The most influential investors and providers are identified in Figure 15.

The number of players involved in the provision of food and fibre RD&E has developed over time and for logical reasons – each has particular capabilities and was established to serve particular interests. The difficulty is that the stakeholders being served by each group are often the same people – for example, DPI&F invests in research to benefit Queensland beef producers, as does Meat and Livestock Australia, CSIRO, the CRC for Beef Genetic Technologies and The University of Queensland, along with other research institutes and the private sector. In some instances these investors are brought together to concentrate on specific research questions (for example, through the CRC). However, often research providers are in competition with each other to source funding for similar purposes and often from the same research investors. Priorities can be difficult to identify on an industry-wide basis and investor priorities compete with the priorities of the research providers.

Institutional arrangements are such that organisational outcomes (often rightly) predominate to favour organisational benefit over collaboration and a shared approach. While collaboration and a shared approach are encouraged, the drivers of organisational behaviour are often at odds, or at least not supportive, of such activity: often there is no compelling economic reason for organisations to collaborate. Funding occurs through a variety of institutional arrangements that are often specifically negotiated for one-off projects or programs.

Figure 15: Food and fibre RD&E investors and providers

Rural R&D Corporations (RDCs)

With the exception of Land & Water Australia and the Rural Industries Research and Development Corporation (which are partly or entirely funded by the Federal Government), these are federal statutory or private companies funded by levies on producers that are matched by the Federal Government. As these levies are raised on a commodity basis, these organisations have a commodity focus, with a national mandate to plan and invest on behalf of their stakeholders (producers and the Federal Government) in research related to that commodity.

State Departments of Primary Industries

Each state government is both an investor and a provider of research through an equivalent of Queensland's DPI&F. In addition, these state agencies are usually the principal providers of extension services and substantial investors in research infrastructure.

Commonwealth Scientific & Industrial Research Organisation (CSIRO)

CSIRO covers a diverse range of scientific disciplines and research interests. Five Divisions are focused on areas relevant to the food and fibre sector: plant industries, livestock industries, sustainable ecosystems, marine and atmospheric research and Food Science Australia (in partnership with the Department of Primary Industries, Victoria). In addition, CSIRO has a significant 'flagship' investment in Food Futures. Some investments within flagship programs on Climate Adaptation, Water for a Healthy Country and Wealth From Oceans will also be of relevance to the food and fibre sector.

Cooperative Research Centres (CRCs)

This is a Federal Government program that emphasises the importance of collaboration between business and researchers to maximise the benefits of research through an enhanced process of utilisation, commercialisation and technology transfer. It also has a strong education component with a focus on producing graduates with skills relevant to industry needs. There are 14 agricultural and rural-based CRCs.

Universities and Technical and Further Education (TAFE) Institutes

A number of Queensland universities undertake food and fibre related research, including national Centres of Excellence (which are supported by the Australian Research Council). Universities have a key role in producing the graduates that will provide the skills base for food and fibre RD&E efforts, including researchers and teachers. TAFE Institutes provide vocational training in a number of disciplines related to food and fibre R&D, particularly in relation to on-farm management capability.

Independent research institutes

A number of industry-based research institutes provide important RD&E services. These include BSES Ltd (formerly Bureau of Sugar Experiment Stations) and the Australian Institute of Marine Science.

Agrifood businesses

Agrifood businesses invest in and provide RD&E services and, in some instances, act as providers of RD&E services on behalf of government investors. Private sector agronomists and consultants, in particular, have a key role in providing extension services.

Natural resource management bodies

Queensland has established fifteen regional natural resource management bodies. These organisations have an important role in undertaking community-based natural resource management in regional areas and often fund and manage RD&E activities of relevance to the food and fibre sector.

Put simply, the RD&E sector is cluttered with institutions and weighted down with unnecessary transaction costs. Statistics relating to contract management for DPI&F put this into context.[44]

- In 2006-07, the Queensland Government invested approximately $61 million in RD&E and a further $51 million was sourced through competitive grants from sources other than the Queensland Government.
- In securing and managing this investment, DPI&F science units are currently working with about 90 external investors and providers, plus a number of small fee-for-service contractors.
- There are currently 586 RD&E projects under management.
- A total of 868 contracts were handled by science units in 11 months to May 2007. About 360 of these contracts could be considered 'project' contracts (that is, contracts related to a project agreement with external investors), while the remainder relate to activities to support the projects (for example, agreements for transferring plant breeding material, agreements to license technologies and agreements for conducting research trials on farmers' properties).

Along with an increase in the number of research investors and providers, there has also been an increase in the breadth of research requiring investment in the food and fibre sector. In addition to the need for investment in traditional science areas – for example agronomy, veterinary science, biology and entomology – the application of revolutionary sciences such as biotechnology and nanotechnology have substantial potential to create new value from the sector.

Further adding to the breadth of the research agenda is the need to reduce the impact of agricultural production on the environment, with RD&E having to encompass not only productivity and product quality, but also natural resource management issues including water use efficiency, soil health, biodiversity and climate change. Increased biosecurity threats have also seen an increase in RD&E requirements.

The cluttered institutional environment and a broadening of the food and fibre research agenda has had the following negative impacts:

- Research effort is not always aligned and efficient – it can be duplicated, fragmented or misdirected.
- The traditional pool of funding, and of science and research capability, is overstretched in trying to address a wider range and increasingly complex set of issues.
- Transaction costs for the delivery of RD&E are substantial, with economies of scale not being realised and considerable duplication of effort in negotiating and managing special purpose collaborative arrangements and one-off projects.

[44] Information supplied by the Department of Primary Industries & Fisheries, Queensland

- Critical gaps in capability are emerging, particularly in addressing cross-sectoral issues.
- There is an erosion of science skills within primary industries due to instability of funding and direction.

4.2 The future RD&E system

The challenges facing the current RD&E system have become prominent on the national agenda of the Primary Industries Ministerial Council (PIMC). This council is comprised of Australia's primary industries Ministers.

In 2005, PIMC initiated the development of a national strategic framework for primary industries RD&E. The aim of the initiative is to ensure Australia's RD&E capacities 'are aligned with future industry needs, to initiate collaboration that strengthens Australia's position in international markets and to ensure that RD&E delivery is both more efficient and effective.'[45]

The paper estimated that Australia currently invests $1.1 billion annually. However, it noted that RD&E expenditure for the primary industries sector had flattened, that the sector was facing increased competition for this investment and that there were limited prospects for increased funding. It concluded that 'Australia's primary industries are at risk of losing their competitiveness if more is not made of this investment'.[46]

To improve the management of RD&E in Australia , PIMC has proposed the concept of 'National R, Regional D & Local E'. Underpinning this concept is an acceptance that, while research (R) can be provided from a distance, regional adaptive and applied research or development (D) is required to test, refine and demonstrate the technology. Local extension (E) allows for the transfer of the regionally tested innovation to users in the region.[47]

Under the framework, current levels of investment are maintained, but cost efficiencies are sought and effectiveness improved. At a practical level, this will lead to the development of 'virtual centres' that allow for the consolidation of infrastructure in fewer locations while supporting networked development and extension efforts.

[45] Primary Industries Ministerial Council, 2005. *Securing the Future for Australia's Primary Industries: Development of a National Research Development & Extension (RD&E Framework). A Discussion Paper*. p. 1.
[46] ibid.
[47] ibid.

At its meeting on 17 April 2008, PIMC made clear its resolve to move forward in implementing the national RD&E framework, stating in its communiqué:

> *Council acknowledged that effective research and development is essential to continued productivity growth. To use research resources more effectively and achieve better outcomes for industry, Council agreed to accelerate the development of the National Research, Development and Extension Strategy.*[48]

4.3 Queensland's response

The inherent challenges faced by the food and fibre sector - and the value of this sector to Queensland – require that deficiencies in the current RD&E system be remedied. In considering Queensland's response to the proposed national framework for RD&E, it is important to recognise that it is very rare for RD&E investments to be made by a single organisation. Almost always it is a combination of organisations – state and federal, government and non-government – that makes the investment under a partnership arrangement. As such, maintaining and improving collaborative partnerships is essential to Queensland's future RD&E efforts.

However, we need to streamline current arrangements, deepen collaboration between research investors and providers and retain the joint public-private investment model that has underpinned Australia's successful RD&E effort over a number of decades. The national RD&E framework provides an excellent opportunity to achieve these objectives.

The strength of the national RD&E framework is the recognition it gives to consolidating resources to create critical mass at the level of basic research (National R), while at the same time recognising that research must be adapted for regional and local conditions (Regional D). Such adaptation is essential due to natural variations in production conditions caused by factors such as climate, pest, weed and disease pressures, soils and water availability (Local E).

The importance of the Regional D and Local E components of the system cannot be underestimated and should not be neglected in the move to consolidate national research investment. While this will mean a degree of complexity in institutional arrangements will remain, this complexity merely reflects the geographical scope of Australia's food and fibre production system and will be necessary if we are to leverage the full benefit of Australia's national research effort.

[48] Primary Industries Ministerial Council, *Communiqué*, 17 April 2008.

To give effect to the proposed national RD&E framework, action will be required across four areas:

- a national strategic plan outlining the priorities and outcomes we want to achieve
- an implementation plan outlining the human resources and infrastructure needed to deliver on the strategy
- funding arrangements that reflect the short, medium and long-term investment requirements of the strategic plan
- 'rules of engagement' that streamline and simplify collaborative research arrangements, including in areas such as intellectual property, contracts, reporting and research evaluation.

A well-resourced and effective national body with national oversight to undertake the necessary planning, and to develop the rules of engagement, is also required.

For Queensland, implementation of the national RD&E framework will be important to the future success of our food and fibre sector. To make the most of the opportunities this framework will bring, we need to show bold leadership in implementing the national RD&E framework, including:

- being an advocate for a national plan, funding that is adequate in level and duration, streamlined 'rules of engagement' and a well-resourced and effective national body with national oversight
- identifying and investing in areas of comparative advantage for Queensland food and fibre RD&E and reallocating resources from research areas where Queensland does not have a comparative advantage
- strategically investing in applied research and extension so that Queensland's regions and local areas benefit from national and international research efforts.

The successful implementation of this framework is important to the future of Queensland's food and fibre sector and to realising the Smart State Vision for 2030.

Key Finding 1: A national RD&E effort is required

The current RD&E system is cluttered with institutions and weighed down by unnecessary transaction costs. Implementation of the national RD&E framework for primary industries would overcome these deficiencies by consolidating resources at the research level while ensuring research outputs are accessible and relevant through a networked approach to development and extension.

Successful implementation of the national RD&E framework for primary industries would be of substantial and enduring benefit to Queensland's food and fibre sector

5 Opportunities

This part of the report identifies three opportunities for substantially improving Queensland's food and fibre RD&E performance:

- a new strategic intent for the DPI&F;
- developing and implementing an integrated RD&E human resources strategy
- government-led action to improve access to R&D for adoption and commercialisation.

5.1 The Department of Primary Industries & Fisheries

Queensland Government investment in food and fibre RD&E is principally through the DPI&F. As such, it will be the principal agency for positioning Queensland within the national RD&E framework, with a critical role in coordinating Queensland Government investment and policy in relation to the sector.

5.1.1 Trends in DPI&F investment in food and fibre RD&E

DPI&F has approximately 1300 employees working in RD&E. DPI&F also has a network of research facilities that services a wide range of industries over tropical and sub-tropical agro-ecological zones. These facilities also support research programs in collaboration with partners such as Research and Development Corporations (RDCs) and Cooperative Research Centres (CRCs). Many DPI&F sites are multi-functional, incorporating a mix of research infrastructure (such as laboratories, glasshouses and field sites), with offices, administration facilities and client service delivery functions at the one location.

In 2006-07, the Queensland Government invested approximately $61 million in RD&E. A further $51 million was sourced through competitive grants from sources other than the Queensland Government, principally RDCs and the Australian Centre for International Agricultural Research (ACIAR). Although amounts fluctuate from year to year, nominal expenditure by DPI&F in 2005-06 was only slightly higher than that in 1998-99. After adjusting for inflation, both internal and external revenues show a steady downward trend. Given the importance of RD&E to the future of the food and fibre sector, the decline in investment is of concern.

Although investment in research has been declining, DPI&F is in the process of revitalising its research facilities, including rationalisation and upgrading of facilities. In particular, DPI&F is moving to co-location with other research organisations as a method of improving research facilities while at the same time reducing infrastructure costs. Major investments include:

- the Centre for Advanced Animal Science, Gatton (with The University of Queensland)
- the Queensland Crop Development Facility, Redlands (with The University of Queensland and Queensland University of Technology)

- an upgrade of the Bribie Island Aquaculture Facility
- the Health & Food Sciences Precinct, Coopers Plains (with Queensland Health and Food Science Australia)
- the Ecosciences Precinct, Boggo Road (with Department of Natural Resources and Water, Environment Protection Agency, Department of Mines and Energy and CSIRO).

DPI&F researchers are also co-located in the Institute of Molecular Biosciences at The University of Queensland.

Recent DPI&F infrastructure investments indicate a recognition that the previous model of investing in research infrastructure solely for the purposes of departmental research cannot be sustained and a new investment model of co-location and investment is required. This trend is being reflected in decisions by other state governments to rationalise their food and fibre research facilities and co-locate major research facilities with other agencies. The trend to co-location is also consistent with the national RD&E framework, although consolidation and co-location of infrastructure at the local and regional levels is not yet evident.

Overall, Queensland's food and fibre sector has been well-served by DPI&F investment in RD&E. Its large network of well-qualified and highly performing RD&E staff has made a substantial contribution to the sector over a long period of time. However, in September 2007, the Minister for Primary Industries and Fisheries, The Hon. Tim Mulherin, indicated that changes needed to be made in the way that DPI&F traditionally operates. In particular, he stated that:

> *As the chief investor for agriculture in this State I have requested my department review exactly how we should be doing business in Queensland and how, in our capacity as an economic development agency, we can best maximise the profitability of primary industries.*
>
> *There will be frankness in determining how and where we invest for the food and agribusiness of the future.*[49]

Although this statement was made in relation to co-location of facilities and the establishment of new Centres of Excellence, changes in the way DPI&F operates need to go beyond the relocation of facilities. A 'cultural conflict' exists between the requirements for managing a government department and the requirements for managing RD&E. For example:

- Where making research progress requires that people take risks, departments are traditionally risk averse.
- Standard departmental management and reporting frameworks may be unsuited for managing and reporting on research projects.

[49] Hon. Tim Mulherin MP, *10 billion plus reasons to focus on the future of Queensland's agriculture*. Presentation to the Committee for Economic Development of Australia, Queensland Branch, 18 September 2007.

- Job classification and salary levels may be uncompetitive for comparable positions in other organisations.
- Specialist skills and flexible decision-making procedures for managing intellectual property and commercialisation may be lacking and difficult to acquire.
- where departmental budgets vary on an annual basis, achieving medium to long-term research outcomes requires a longer-term commitment. There can be adverse impacts on staff attraction and retention, and therefore research capability.

Such cultural conflicts suggest that, over the long-term, attempts by DPI&F to retain the role of both research investor and research provider may lead to an overall decline in research quality due to a progressive decline in research capability. In other words, DPI&F will become an increasingly less attractive place to work for high-calibre researchers and research results will suffer as a consequence. In considering the future of DPI&F, alternatives to the traditional model of DPI&F as both an investor and provider across the spectrum of RD&E services need to be considered.

5.1.2 A new operating environment

The national RD&E framework will usher in a new operating environment for DPI&F, providing the opportunity to reposition DPI&F in food and fibre RD&E. In particular, it will enable a stronger division between the investor and provider roles. Sugar research provides an example of how such an arrangement can work. In 1998, a Memorandum of Understanding (MoU) was established between DPI&F and BSES Ltd to provide accountability for the use of the funding that DPI&F provides to BSES. MoUs between DPI&F and BSES in subsequent years have focused on delivering outcomes that are of high priority to DPI&F. In addition to this MoU, Cabinet approved the provision of $1 million per year for three years to BSES to counteract the incursion of sugarcane smut.

Such arrangements have the benefit of achieving critical mass in expertise and infrastructure, as well as ensuring that researchers are located in a culture that is supportive of research activities. It provides a mechanism for the government to continue to invest in research in accordance with government priorities, while at the same time ensuring accountability for research delivery.

At the development and extension end of RD&E, DPI&F has a strong role as both the investor and provider, and has traditionally been a critical link between research and its application and use at regional and local levels. However, even in extension, new providers are emerging in the private sector (such as agronomic consultants), as well as in the higher education sector (such as TAFE colleges), that could prove more efficient and effective in providing applied science and extension services for the Queensland food and fibre sector.

Implementation of the national RD&E framework, along with the emergence of new RD&E providers at regional and local levels, creates a new operating environment for DPI&F characterised by two broad trends: the need to rationalise and consolidate Queensland RD&E resources; and the opportunity to leverage local, regional, national and international RD&E

efforts through mutually beneficial investment arrangements. This includes the capability to outsource delivery requirements while at the same time retaining the important investor role.

This new operating environment requires that DPI&F explicitly identifies itself as fulfilling a critical 'broker' role for Queensland: negotiating arrangements at the national level; marshalling resources at the State level; and communicating and responding tactically to industry needs within an overall strategic investment framework.

Positioning DPI&F as a key broker is not intended to diminish the importance of, or supplant, other Queensland research investors and providers that have established networks and capabilities. Instead, it is intended to ensure that there is leadership in developing and implementing a food and fibre RD&E strategy that is consistent with both government and industry priorities, in particular implementation of the national framework.

At a practical level, this will see DPI&F implementing a 'mixed model' of research investment and delivery. While in some areas DPI&F may retain the dual role of investor and provider, in others it may have only an investor role. In some research areas it may reallocate resources because there are other providers who are better positioned to meet Queensland's RD&E requirements.

Rather than attempting to do everything, the strategic intent for DPI&F would be 'the right resources, in the right place, at the right time'. Properly supporting this strategic intent would require a new way of doing business, including:

- a mixed model of RD&E delivery that is underpinned by clear principles for outsourcing RD&E requirements to other research institutions and the private sector;
- operational and administrative procedures to ensure that the department has the necessary organisational flexibility and authority to make timely decisions, and
- a timeframe for government investment in food and fibre RD&E that matches the strategic requirement for a medium to long-term commitment to achieving RD&E outcomes.

Key Finding 2: A new operating environment

The cultural conflict between the requirements for managing a government department and the requirements for managing RD&E is likely to lead to a long-term decline in the capacity of DPI&F to retain the joint roles of research investor and research provider. At the same time, implementation of the national RD&E framework for primary industries, and the emergence of new RD&E research providers, is creating a new operating environment for DPI&F.

Collectively, these trends mean that alternatives to the traditional model of DPI&F as investor and provider across the spectrum of RD&E need to be considered and a 'mixed model' of research investment and delivery implemented.

5.2 Attracting and retaining skilled people

As with many industries, a critical skills shortage has emerged in the food and fibre sector, including in RD&E. This is evidenced by a substantial decline in student numbers in the period 2001-2006 in subject areas relevant to the food and fibre sector, including: natural and physical sciences; agriculture, environmental and related studies; and food, hospitality and personal services. This decline includes a 17.5 per cent fall in the number of students studying agriculture and environmental and related studies (see Figure 16).

The food industry is also concerned by the lack of qualified food technologists and the very low number of students studying food technology (averaging less than 50 a year across Australia). Qualified staff are having to be recruited from overseas under skilled visas. In addition, European students who have to complete work experience overseas as part of their degree are being targeted to fill gaps in capability.

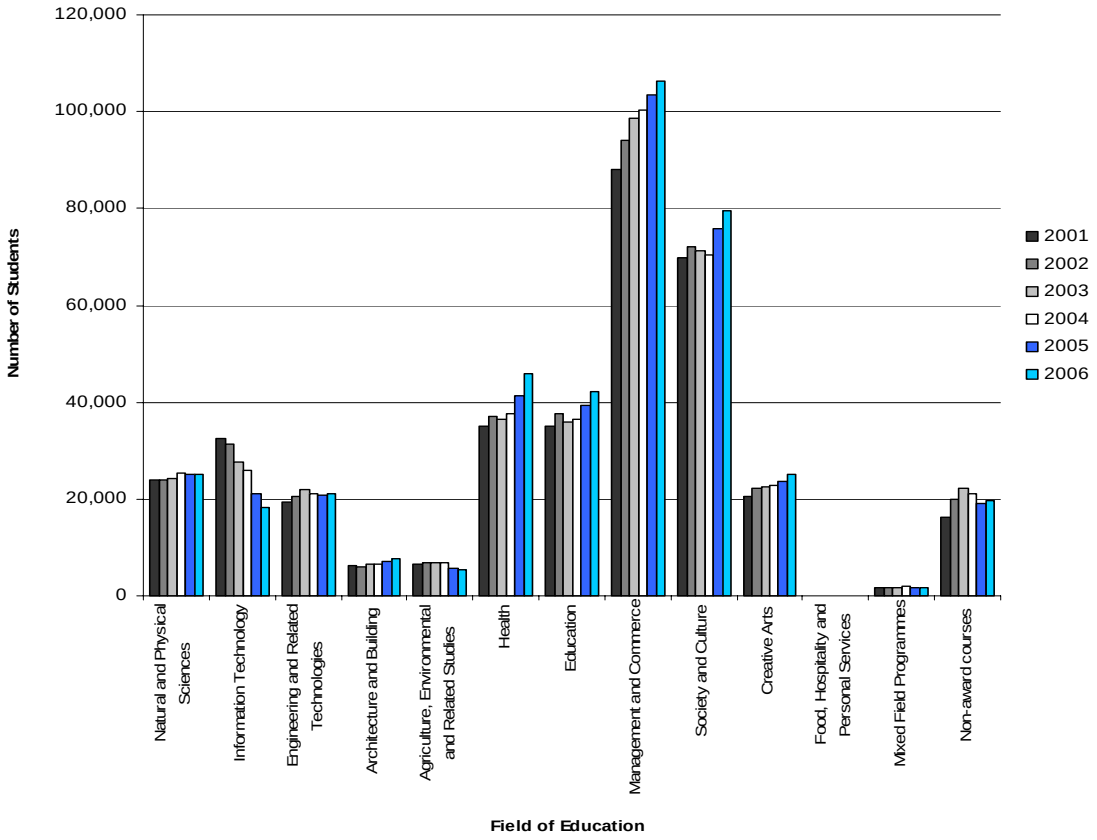
Overall lack of attractiveness (perceived and real) inhibits employment in food and fibre RD&E because:

- capability is increasingly stretched
- there is an absence of new and younger workers entering the sector and an ageing workforce with significant numbers approaching retirement
- the sector has uncompetitive working and remuneration conditions and poor career structures
- at the 'on farm' end, there is increasing competition for human resources, particularly from the mining and construction sectors, as well as city based business.

The situation facing the food and fibre sector is summarised in a magazine interview with Professor Rick Roush, Dean of Land and Food Resources, University of Melbourne:

> *'There's a general sense out there that agriculture is on hard times, that it's a declining industry, that the jobs are all boring and don't pay well and stuck out the back of 'Woop Woop', so the overall image of agriculture and land management in general as a career path isn't a very strong one.'*
>
> *But he says the real story, according to University of Melbourne data, shows that 95 per cent of graduates find jobs soon after they graduate in sophisticated agricultural-related work and their salaries, on average, are $5000 more than other graduates at about $45 000 a year.*

Figure 16: Commencing students at Australian universities, 2001-2006



Source: http://www.dest.gov.au/sectors/higher_education/publications_resources/profiles/students_2006_selected_higher_education_statistics.htm

> *'A significant number of jobs are in business, commerce, research and development and so forth, and many are in urban areas, not necessarily regional and rural areas, and a lot of the jobs are international,' he says. 'It's not about wool-classing any more, it's about designing integrated irrigated systems or trying to figure out exactly how to deal with changing rainfall patterns.''*[50]

To redress the situation school, vocational and higher education components of food and fibre education need to be more fully integrated, both in terms of curriculum and infrastructure, to ensure that the system produces graduates with the skills the industry needs. Options for consideration include:

- establishing 'gateway' schools for the food and fibre sector
- strengthening opportunities to combine vocational training with education in the last two years of high school
- ensuring appropriate infrastructure is available and well located
- targeting post-graduate students with generic skills in relevant disciplines (for example, biotechnology, nanotechnology) for careers in the food and fibre sector.

As the lead government agency in Queensland's food and fibre sector, DPI&F is responsible for coordinating the development and implementation of a combined industry-government strategy for education and training in the food and fibre sector, with the aim of attracting and retaining people in the sector and equipping them with the skills the industry needs. This will need to be done in cooperation with other agencies, such as the Agri-Food Industry Skills Council and the Australian Institute of Food Science and Technology.

Rather than implement a separate process for RD&E to those already underway in the food and fibre sector, efforts must be made to include specific actions for targeting and attracting people to the 'RD&E' component of the sector. Action is required at a number of levels to attract and retain qualified people in different segments of the RD&E system:

- in the 'new' sciences, such as biotechnology and nanotechnology
- in the traditional sciences, such as agronomy and food technology
- in extension
- in on-farm capability.

Differences in employment opportunities and skills between these segments require different recruitment and retention tactics, including improving employment conditions for 'knowledge' workers in the RD&E system. Although attracting new entrants into food and fibre RD&E is important, the retention of existing staff remains a high priority.

[50] Marino, Melissa. 2007. 'High-tech farming needs careers push', In *Ground Cover*, Issue 70 - September - October 2007.

Improving employment conditions and career paths will be important to both sets of workers. Possible initiatives include:

- improving the ease with which researchers can move in and out of research agencies and between the private and public sectors
- providing opportunities to shift between research, development and extension roles
- improving remuneration
- supporting overseas work and study
- creating opportunities for sabbaticals, where not commonly available
- establishing more stable funding arrangements
- improving the cultural support for research, particularly more streamlined administration and reporting. In the case of DPI&F, this may include transferring research staff from the department into research institutes.

State and national planning processes for the food and fibre sector should incorporate strategies for retaining and attracting skilled workers into food and fibre RD&E . This will be an important dimension of DPI&F's RD&E 'broker' role in the new operating environment.

Key Finding 3: Skills shortage requires government-industry action

A critical skills shortage exists in food and fibre RD&E and this is undermining the future of the industry. Concerted government-industry effort is required to better integrate school, vocational and higher education components of food and fibre education, including curriculum, infrastructure and employment conditions, to ensure that the industry has access to the skills it needs. This strategy needs to encompass both the attraction and retention of skilled staff.

5.3 Private investment in food and fibre RD&E

5.3.1 Food industry investment in RD&E

At the agricultural end of the food and fibre sector, producers have been consistent investors in RD&E over a number of years, as producers pay a levy on production that is matched by the Federal Government. These funds are invested in RD&E by industry-based RDCs, which are accountable to both industry and government for investment decisions and outcomes.

While many food companies invest in development, very few invest in research. There is also no investment in extension comparable to that operating in the primary industries sector. However, it should also be noted that innovation is not simply about R&D. It can take place in other areas, for example in improved processes or service delivery. Most Australian food businesses are adept at innovation due to the need to remain competitive internationally.

A number of reasons have been identified for why food businesses may not invest in research:

- they may not see a market need
- they may not have the funding, including insufficient government incentives to invest
- they may lack the capability to manage a research project
- the transactions costs in identifying a suitable research partner and contracting the research may be too high, particularly in determining ownership of intellectual property arising from the research.

Some of these issues require action at a federal level, as would be the case for tax incentives. The current National Innovation Review is expected to provide recommendations for action in these areas. Some research institutes have also implemented initiatives to aimed at engaging with small and medium enterprises (SMEs), such as the of the CSIRO Small and Medium Enterprise Engagement Centre. However, in Queensland, there is an important gap to be filled in facilitating information flows between research agencies and food businesses, as well as ensuring transaction costs for contracting research are kept to a minimum.

DPI&F has previously been identified as having an important broker role in the new RD&E operating environment. This role should include facilitating the development of research investment and management capability in Queensland food industry SMEs, including research partnerships between industry and research institutions. Specific areas for action include the provision of appropriate infrastructure, a food industry extension service and incentives for investment.

5.3.2 Commercialisation of research

From a commercialisation perspective, traditionally researchers have attempted to access private sector funding by approaching companies that may have an interest in commercialising research. This strategy has met with only limited success. The alternative route of accessing venture capital funding has been even more difficult. At the same time, there is only limited capability and funding amongst research institutes, including government agencies, to support commercialisation activities.

Successful strategies for commercialising research recognise there are different levels of risk and that different organisations have a greater or lesser capacity to manage risk. Some organisations may be better able to diversify (like banks and insurance companies) or more skilled at choosing projects for inclusion in a risk management portfolio (like venture capitalists).[51] To be successful at commercialisation, 'financial and organisational vehicles capable of managing the special forms of risk inherent in contemporary technological innovation' must be established.[52]

[51] West, J. 2004. 'Financing Innovation: Markets and the Structure of Risk', In *Innovating Australia*, Ian Marsh (ed.). Committee for Economic Development of Australia, Melbourne. p. 18.
[52] ibid. p. 12.

Scattered amongst Queensland and Australian food and fibre research institutions are 'good ideas' that have genuine commercial potential. However, when offered as individual commercialisation opportunities, these good ideas present too great a risk for private finance. Bringing these good ideas together into the one investment package could substantially reduce risk so that the entire package, rather than individual commercialisation opportunities, attracts private sector investment.

This type of initiative has been undertaken in Australia's medical research community through the establishment of its Medical Research Commercialisation Fund (MRCF) (see Figure 17). This fund recognises the gap in existing arrangements where technologies requiring proof-of-principle research are 'too early' to attract venture capital funding and therefore either remain unfunded are or sub-optimally assigned to third parties. To fill this gap, MRCF has been established with the following important characteristics:

- it is willing to invest in genuine early-stage (proof-of-principle) research;
- it enables research institute, government and private sector funding to be combined under a single investment vehicle
- it is managed by people with relevant expertise and understanding of their sector and adds value to existing commercialisation capability for the institutions participating in the fund
- in contrast with most venture funds, which are closed-end 10 year funds, it is open-ended, or 'ever green', enabling it to continue to make early-stage investments and maintain consistent risk tolerance.

The food and fibre sector would benefit greatly from the establishment of a similar type of fund for commercialising technologies designed for its industries. However, realising this potential will require government leadership in establishing the necessary financial and organisational vehicle and in generating the necessary support and participation from research institutions and the private sector.

Key Finding 4: There is a need to improve investment, adoption and commercialisation of R&D

Small and medium enterprises in the food industry face a series of hurdles in adopting and investing in R&D, including high transactions costs, lack of funding, lack of incentives and limited capacity for managing R&D.

A gap in research funding arrangements at the 'proof-of-principle' level is inhibiting commercialisation. This gap could be overcome by government-led 'packaging' of research for private investment, thereby reducing financial risk.

Figure 17: Medical Research Commercialisation Fund

Established in 2007, the purpose of the MRCF is described as: *'…an innovative investment collaboration which invests in life science opportunities from its member medical research institutes. The $30 million fund provides its member institutes benefit from access to risk tolerant investment funds for proof-of-principle experiments as well as for the formation of new companies. The objective of each participating Institute is, through the collaboration, to enable the commercialisation of their intellectual property through a structured funded process to realise its value. The fund provides its investors, Statewide Superannuation and Westscheme, with early access to investment opportunities from Australia's leading medical research institutes and their affiliated hospitals/research organisations.'*

Key attributes of the fund are that:

- The fund can invest up to $2 million into each opportunity.
- The fund can make small $10 000-$200 000 investments into very early, but promising, technologies. Making small investments very early provides a faster process to get funding into institutes to support proof-of-concept or 'killer experiments' and avoids the unnecessary establishment of a start-up company in the early stages.
- The fund has the right to provide additional funding on pre-agreed terms if the project is successful.
- The fund can invest in license deals or revenue-generating projects that will provide a revenue stream 'annuity', but may not provide an investment exit opportunity.
- Most venture funds are closed-end 10 year funds. However, the MCRF is open-ended, or 'ever green', enabling it to continue to make early-stage investments and maintain consistent risk tolerance.

The Governing Board of the Fund (Fund Trustee) is chosen by the Founding Institutes and Investors. Member institutes (of which there are 36) each own one share in the Fund Trustee.

Member institutes contribute $35,000 per annum to operating costs of the fund. Additional contributions to the operational costs are provided from state governments and the investors, including:

- the Victorian and New South Wales Governments, which contribute $300 000 per annum each;
- the Western Australian Government, which contributes $150 000, and
- the investors, which contribute $300 000 per annum.

Source: Presentation to Queensland medical research institutes, Brandon Capital Partners, March 2008 and www.brandoncapital.com.au