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Sustainable co-innovation: the food supply chain as a case study

Submission to the Review Panel of the National Innovation System

Date: 18/03/2008

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Confidentiality status: PUBLIC DOCUMENT

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EXECUTIVE SUMMARY

This submission responds to the call for participation in the review of the National Innovation System on February 2008. My submission deals with the following aspects:

- 1) Innovation is a process that goes beyond theoretical conception, through technical invention to commercial exploitation. Therefore, R&D is an element of innovation.
- 2) One key distinction between R&D and innovation is that in the former, we don't necessarily know the outcomes. To create an innovation, the desired outcome must be known before tackling the problem with R&D.
- 3) All research has a purpose. However, a commercialising purpose is very different from a knowledge-seeking purpose. Funding mechanisms to deliver in both areas will have to follow very different rationale. My view is that grants investing in knowledge-seeking endeavours should be discussed separately from the discussion of a national innovation system.
- 4) It is clear that some industries will benefit from a market push innovation model than from a technology push innovation model. The food supply chain is an example of an area that would benefit from a market push approach.
- 5) There is a need for a concerted approach to innovation in the food industry, from agricultural production and rural based manufacturing to retail, thus adopting a value chain perspective. Such a concerted approach should recognise the highly dynamic nature of the food manufacturing industry, the benefits of market driven innovation and the usefulness of policy as an instrument to encourage innovation in the marketplace.
- 6) The current innovation system, which focuses on CRCs, RDCs, public R&D organisations and universities, has delivered a small number of innovations to the marketplace.
- 7) NFIS had a strategic role in supporting business innovation, manufacturing, supply chain and value addition projects. Additionally, NFIS approached food innovation with a 'whole-of-the-chain' perspective. The termination of this initiative leaves a vacuum in R&D focused to food manufacturing and other areas of knowledge required to introduce food innovations in the marketplace (e.g. supply chain, consumer science and packaging).
- 8) A new "sustainable co-innovation" (SCOI) model is proposed for the food industry. The model is similar to the Forward Commitment Procurement model, but the concepts of co-innovation and innovation networks have been added.

- 9) The SCOI model requires a central overseeing organisation similar to NFIS. However, it is proposed that the organisation becomes a joint venture between private and public partners. This organisation would:
- a. Provide a strategic framework for national food innovation, from a market-led, supply chain perspective.
 - b. Coordinate the activities required to introduce new technology in the marketplace
 - c. Coordinate government-led food innovation activities (e.g. grants and strategic directions for public R&D), from a supply and value chain perspective. This would avoid the lack of supply chain focus and would increase critical mass in the initiatives undertaken.
 - d. Enable the commercialisation stages in the innovation process, including assistance in seeking for venture / equity capital.
 - e. Provide timely competitive and technical intelligence to all stakeholders about the particular innovation areas targeted, bringing attention to current and emerging technologies and innovation trends in the targeted markets.
- 10) The SCOI model also requires the following types of consortia:
- a. A buyer consortium, formed by two or more supply chain partners that establish an alliance to contract/purchase the new process/ product/ service developed by a supplier consortium.
 - b. A supplier consortium, formed by two or more organisations that seek to deliver the innovation at the specifications (e.g. cost, time, performance) set by the legislative consortia.
 - c. A legislative consortium, which aims to increase the receptiveness of the market to new technologies/processes/products by introducing standards, regulations and laws that increase performance targets in certain areas.
- 11) In the SCOI model, a buyer consortium (which may or may not include a public sector organisation) commits to purchase a pre-defined quantity of a product\ technology\service, currently under development but not yet available as a commercial offering. NFISC and the buyer consortium agree in the performance sought for the innovation. The supplier consortium is formed and solutions are sought, based on past innovations or completely new concepts. Meanwhile, the legislative consortium develops standards, regulations and certification processes that enable fair competition and enhance the chances of the uptake of new solutions at the agreed performance specification. When the innovation has been developed, meeting all performance criteria, the buyer consortium purchases the product at a specified volume and cost, at levels that encourage other supplier consortium to enter the market. The private sector would react by freeing investment to search for innovations that respond to those specifications.
- 12) In the context of SCOI, I do not necessarily advocate for the government to become the early market buyer that executes the forward commitment options. This may be effective in some areas, such as food safety (related to public good). However, the Government may not be the ideal buyer innovations that lead to new products, new markets or new processes.
- 13) Instead, I propose that food supply chain players form alliances that commit to buy the new product / service/technology when this is developed. The drivers for such commitment could be based in (a) superior value proposition (including financial, environmental and social performance); (b) new regulations encouraging the uptake of the innovation; and (c) a demonstrated increase of competitiveness in the marketplace if the innovation is adopted.

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1 INTRODUCTION

During 2003/04, Australians spent more of their salaries in food and beverages than in any other household expenditure category, including housing. Although the manufacture of food, tobacco and beverages (FTB) contributes with almost 20% of the total value of manufacturing industries, the expenditure in research and development (R&D) of the FTB sector represents less than 8% of the total R&D investment in the manufacturing sector¹.

It is fair to say that R&D is not a synonym of innovation. Innovation is a process that goes beyond theoretical conception, through technical invention to commercial exploitation². Therefore, R&D is an element of innovation. This view is supported by the recent report “Public support for science and innovation”³, which defines innovation as:

“deliberative processes by firms, governments and others that add value to the economy or society by generating or recognising potentially beneficial knowledge and using such knowledge to improve products, services, processes or organisational forms. From the

¹ Australian Bureau of Statistics, 2007

² Dept. of Agriculture, Fisheries and Forestry Australia. 2001. Recipes for success: case studies illustrating successful innovations by food businesses. Commonwealth of Australia. 51 pp

³ Productivity Commission. 2006. Public Support for Science and Innovation, chapter 1: Introduction. Draft Research Report. Productivity Commission, Canberra. p. 7- Introduction.

*perspective of this study, these improvements may be specific to the entity, to the industry, country or world, and could be incremental or novel.*⁴

Historically, public R&D organisations have been an integral part of the Australian innovation system. However, it has become clear that these organisations alone are not capable of providing the full spectrum of activities required to commercialise inventions. One key distinction between R&D and innovation is that in the former, we don't necessarily know the outcomes. Therefore R&D endeavours are always a success, as they always increase knowledge. However, new knowledge may not deliver commercial outcomes, at least in the short term. To create an innovation, the desired outcome must be known before tackling the problem with R&D. Furthermore, innovation is fallible. As stated by DTI and DEFRA, "innovation can always be accurately targeted to a commercial outcome but unlike research it can fail"⁵.

What motivates scientists?

R&D organisations contribute substantially to innovation, by:

- a) Increasing the amount of useful knowledge.
- b) Training skilled graduates.
- c) Creating new scientific methodologies.
- d) Creating knowledge networks nationally and internationally.
- e) Increasing scientific and technological capacity.

And occasionally:

- f) Creating new companies, often in collaboration with business-savvy partners

Given that most Government innovation initiatives in the past have placed significant demands on universities and R&D organisations to commercialise their scientific production, it is worth exploring the reasons why young scientists choose to work in publicly-funded research. Ultimately, people, and not policies or institutions, are the innovators.

Jindal-Snape and Snape⁶ performed a study to understand the motivators in 18 scientists in a government research institute in the UK. The findings in this study were that curiosity, the need to do good science and the desire to make a difference, are the predominant motivators for scientists. None of these motivators related to financial issues (e.g. bringing external income) or management aspirations (e.g. becoming senior managers in the organization). Bigliardi *et al.* found that other motivators in engineering-oriented personnel include having the opportunities and facilities to have pleasant social interactions, such as interest-group meetings during breaks or off-duty hours⁷. The social dimension covers all contacts the employee has with other people, both inside the organization and in the environment of the organization - for example, customers, suppliers, colleagues and managers. Factors related to this dimension are communication, feedback, feelings of solidarity, acceptance, leisure time, status, leadership, power and the need to help others⁸.

⁴ DEST 2005c, p. 9

⁵ DTI & DEFRA, 2006. Bridging the gap between environmental necessity and economic opportunity. 1st report of the Environmental Innovations Advisory Group.

⁶ Jindal-Snape, D. and Snape, B.J. 2006. Motivation of scientists in a government research institute: Scientists' perceptions and the role of management. *Management Decision*. Vol. 44 No. 10, pp. 1325-1343.

⁷ Bigliardi, B., Petroni, A. and Dormio, A.I. 2005. Organizational socialization, career aspirations and turnover intentions among design engineers. *Leadership & Organizational Development Journal*. v26 i5/6. 424-441

⁸ Osteraker M., 1999, Measuring motivation in a learning organization, *Journal of Workplace Learning*, 11(2): 73-77.

These observations do not aim to stereotype researchers as persons with no commercial drive and always resistant to commercialise the results of R&D. Indeed, a US study⁹ found that academic researchers who have research grants and contracts work more extensively with industry than those without grants or contracts. Furthermore, the scientists who have industry contracts interact with industry to a greater degree than those who are exclusively funded by governments.

However, traditional academics and scientists do have concerns on the growing pressure on public R&D institutions and universities to produce immediate useful knowledge with close-to-market commercial benefits. This is often at the expense of longer term programs and the development of basic scientific research, which are key ingredients for groundbreaking science. Recent studies show that researchers that maintain a funding relationship with a private sponsor (or a Government grant that is set to respond to specific demands of the private sector) experience a decrease in their academic publications by 25%. Furthermore, academic talent is not necessarily a funding criterion for sponsors¹⁰. Therefore, concerns over a decrease in traditional scholarly activities as Government funding focuses on reaching commercial goals are funded.

This author knows of more than one public R&D researcher that has either left the organisation to join a university to continue their scientific endeavours “with more freedom”, or that has abandoned research to pursue a business career. Both types of researchers often leave in frustration, due to the complexities of following the double mandate of public R&D institutions: the public benefit driver vs the commercial driver.

From the previous discussion, we conclude that a nation that excels at innovating does not necessarily excel at creating new knowledge and groundbreaking science. The opposite statement is also true: a nation that excels at developing new scientific frontiers does not necessarily excel at innovating.

Do we want to see Australia as a nation of innovators or as a nation of Nobel laureates in the coming decades? Or do we want both? What is the *purpose* of the Australian Government?

Science in the innovation continuum

All research has a purpose. However, a commercialising purpose is very different from a knowledge-seeking purpose. If the new Government is seeking a balance between these, it should be aware that funding mechanisms to deliver in both areas will have to follow very different rationale. My view is that grants investing in knowledge-seeking endeavours should be discussed separately from the discussion of a national innovation system.

Past Government systems seemed to focus on the transformation of public R&D organisations into innovation “factories”. This may well be what it is required, but the roots of public R&D organisations are closer to knowledge-seeking endeavours than to innovation. Public R&D organisations and universities will require a clear mandate on the balance between funding for curiosity driven science and science targeted to bring commercial outcomes. A possibly more important issue is that the Government investigates what is the right funding split between the two.

Figure 1 shows a conceptualization of (a) what the innovation continuum encompasses; (b) how science can feed into innovation; (c) how the market can influence science; and (c) how scientific endeavours are successful even if they don't produce an immediate innovation. In the proposed concept, we assume that all ideas that progress into an innovation continuum, either supported by

⁹ Bozeman, B. And Gaughan, M.2007. Impacts of grants and contracts on academic researchers' interactions with industry. *Research Policy* 36:694-707.

¹⁰ Goldfarb, B. 2008. The effect of government contracting on academic research: Does the source of funding affect scientific output? *Research Policy*. 37: 41-58.

private of public funding, are worth exploring¹¹. New theories or knowledge (either born out of curiosity/creativity or market driven needs) lead to basic research, which in turn could lead to developing a close-to-market application, or not. A reason for the latter may be that present technology limits commercial application (e.g. Einstein’s theory of relativity was developed in 1905, but its application for the development of global positioning systems occurred 68 years later). Or perhaps the phase of applied research shows that the new product/service/technology will not be able to compete in price with current substitutes. Or perhaps the innovation infringes other’s patents. There are several reasons why innovations fail. But in this context, it is the implementation, rather than the new idea, what fails.

The model presented implies that, for every research that fails to deliver an innovation in a particular application field (e.g. electronics), there may be *n* different fields that may benefit from the same research (e.g. instrumentation). This multiplicative effect is further illustrated in Figure 1a. This effect explains why one of the ways to assess the impact of patented inventions is to quantify the citations of the original patent, either in the same area of application or in different areas.

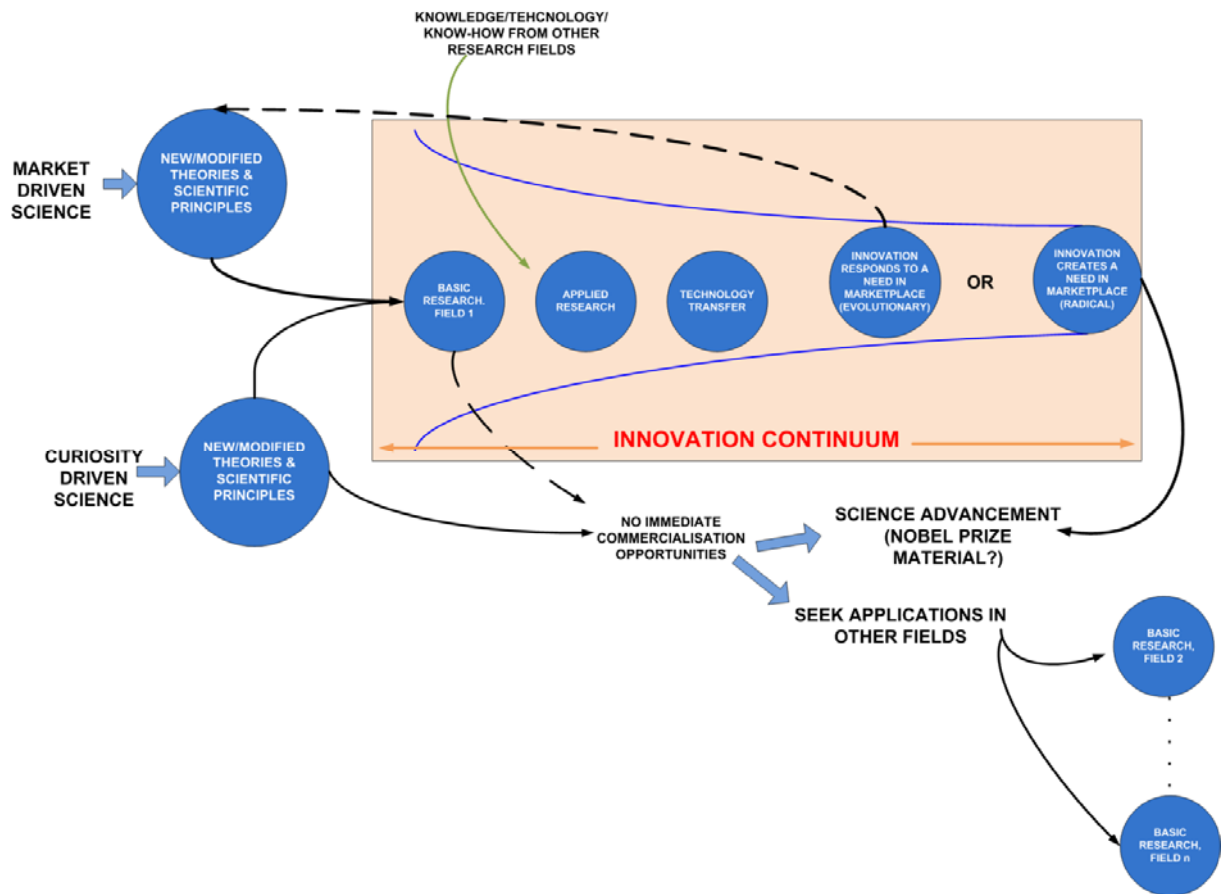


Figure 1. The innovation continuum and sources of innovation.

It is clear that some industries will benefit from a market push innovation model than from a technology push innovation model. In the following pages, I will focus on the food supply chains as an example of an area that would benefit from a market push approach. The application of concepts such as “innovation networks”, “consumer-led innovation” and “forward commitment procurement” in an innovation framework for the food industry is also discussed. Furthermore, I propose the introduction of an innovation model based on these concepts and the use of consortia

¹¹ The scientific community have quality assurance systems to ensure that this is the case (e.g. national and international peer reviews, strict use of the scientific methodologies, guidance by senior researchers and other mechanisms).

supplying innovations, buying innovations and creating the market conditions for successful uptake of food innovations.

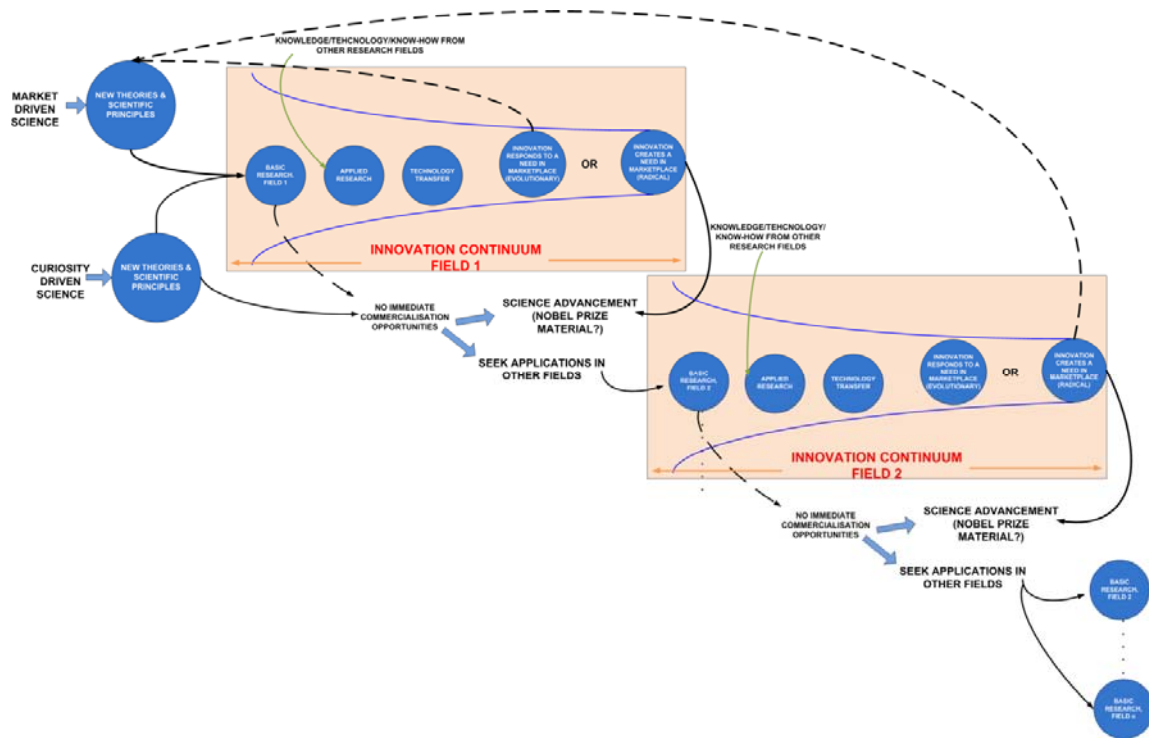


Figure 1a. The multiplicative effect of science and innovation.

2 THE AUSTRALIAN FOOD SUPPLY CHAIN

The aim of the food industry is to transform agricultural raw materials into safe, convenient, good tasting and nutritious products for consumers, in a profitable and sustainable manner. To reach the consumers, all the participants in a food chain need some sort of integration that allows the flow of product until reaching the final user. Therefore, the food supply chain is defined as a set of interdependent companies that work closely together to manage the flow of goods and services along the value-added chain of agricultural and food products, in order to realize superior customer value at the lowest possible costs¹².

Structure and Drivers

Food value addition is generated by activities linked to primary and secondary processing, packaging, distribution and retail, as illustrated in Figure 2.

The Australian food industry is strongly driven by the following trends:

- Horizontal issues¹³: Global trends in ageing and health awareness, consumer trust and consumer satisfaction (convenience), food safety and traceability, financial sustainability related to costs of production/packaging/transport, innovation as an engine for growth and sustainability in production systems.

¹² H. Folkerts and H. Koehorst. 1997. Challenges in international food supply chains: vertical co-ordination in the European agribusiness and food industries . Supply Chain Management: An International Journal. 2(1): 11-14

¹³ Issues in broad categories applicable to many or all food industries

- Vertical (specific) issues: each link in the chain has particular concerns and drivers. However, some of these have a cumulative effect (e.g. acceptance of GMOs affects both growers and manufacturers).

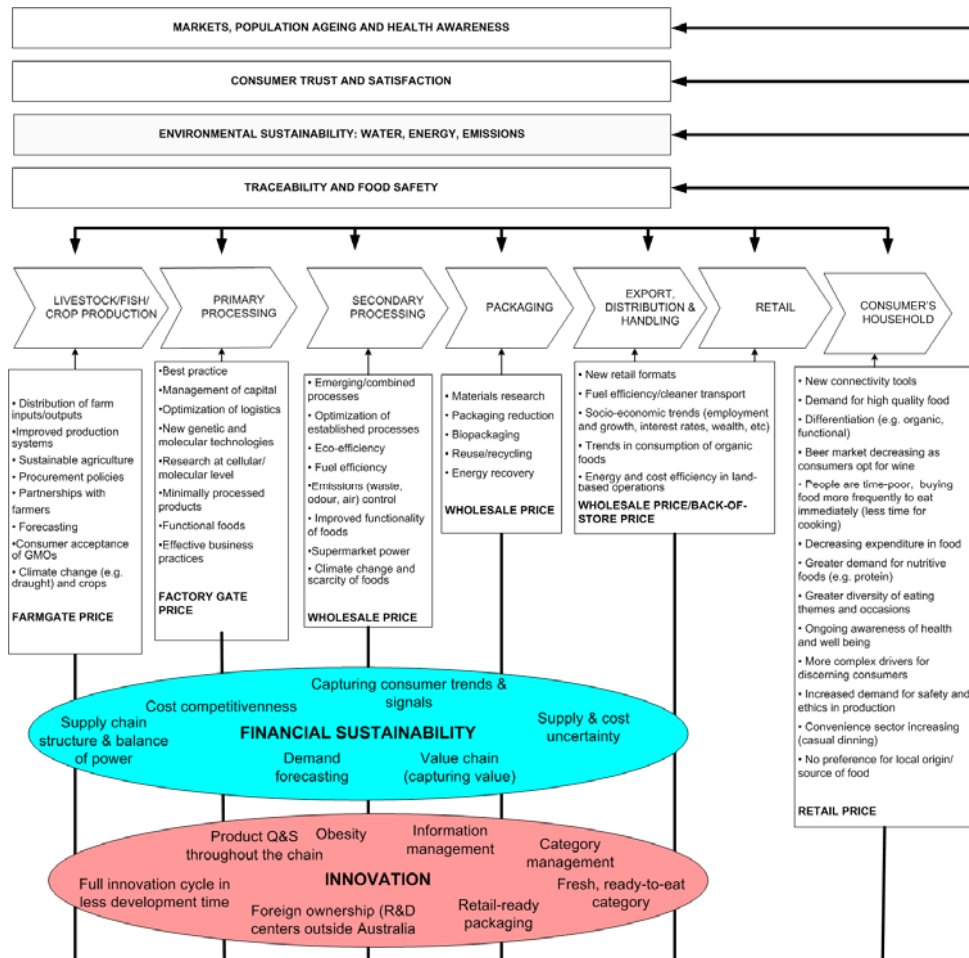


Figure 2. Interaction of horizontal and vertical issues in the food chain.

From a supply chain perspective, there are four major sub-chains that characterise the industry:

1. Primary production. In Australia, this sector encompasses a large number of relatively small firms, particularly upstream in the chain. In 2004, about 205,000 agricultural businesses (excluding services, forestry and commercial fishing) were accounted for by the Australian Bureau of Statistics (ABS). About 130,000 of these businesses were farm households or farming enterprises. A large proportion of the remaining businesses include harvesting, primary processors and small road transport units.
2. Food manufacturing. This is a diverse sub-chain, ranging from SMEs to major multinational companies. In 2004, about 9,000 food beverage and tobacco manufacturing businesses were accounted for by the ABS. The food manufacturing industry worldwide tends to be dominated by large, multinational firms and Australia is no exception, with the largest 50 food and beverage global corporations producing close to 75% of the domestic industry's revenue¹⁴. The implication for innovation is that most R&D activities take place outside Australia, in the global R&D headquarters of the companies.

¹⁴ Short, C. Chester and P. Berry. 2006. Australian food industry performance and competitiveness. ABARE research report

3. Food retailing. This sector includes supermarkets, grocery stores, non-petrol sales of convenience stores at petrol stations, take-away food, and others (e.g. fresh meat, poultry and fish; fruits and vegetables; liquor; bread and cakes, and specialised food retailers). About 65,000 food retail businesses were accounted for during the 2004 survey of the Australian Bureau of Statistics. Food represents about 40% of the total retail sales and 70% of food sales are registered in supermarkets and grocery store retailing.
4. Food exports. Australian farm exports were worth around \$23.8 billion in 2005-06, accounting for 15% of total merchandise exports¹⁵. Australia's profile as an exporter of rural-based products means that this sector's performance is affected by world commodity prices, exchange rates, trade barriers (e.g. tariffs and quotas), domestic support programs (e.g. production and export subsidies), and technical and regulatory barriers (e.g. product labelling and certification standards). Major export markets include Asia (Japan, Malaysia, Korea, Hong Kong, Taiwan), USA and New Zealand. Australia is a net exporter of food, with an export surplus of \$17 billion over food imports.

Sectors 1 to 4 can be identified in Figure 3, which illustrates the food value chain in Australia during 2005-06.

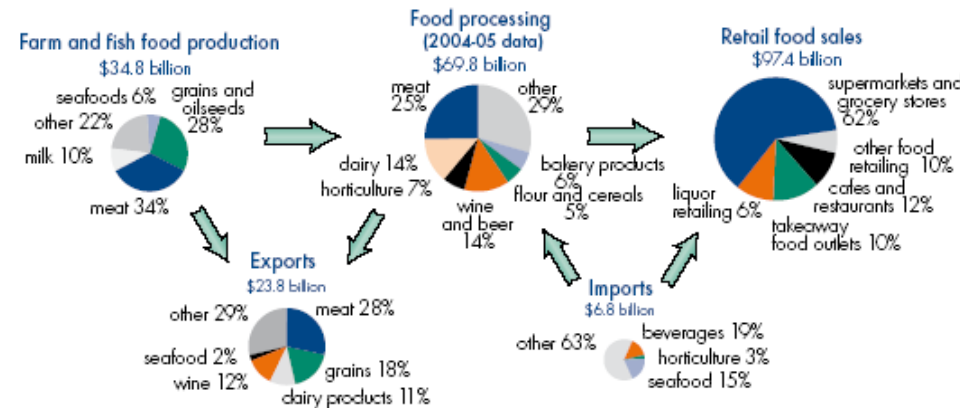


Figure 3. The food value chain in Australia (2005-06). Source: Australian Food Statistics 2006

In 2005-06, the value of primary production goods almost trebled by the time the food reached the shelves in supermarkets. The largest increment in value occurred between primary and secondary production.

Global competitiveness of the Australian food industry

A recent study by the European Commission compared the competitiveness of the European Union, Canada, Australia, New Zealand, US and Brazil. The economic indicators included real value added, export share growth and real labour productivity. Australia's performance was found to be the weakest of all countries analysed (Figure 4).

¹⁵ Agriculture and Food Policy Reference Group, 2006. Creating our future: agriculture and food policy for the next generation. Report to the Minister for Agriculture, Fisheries and Forestry.

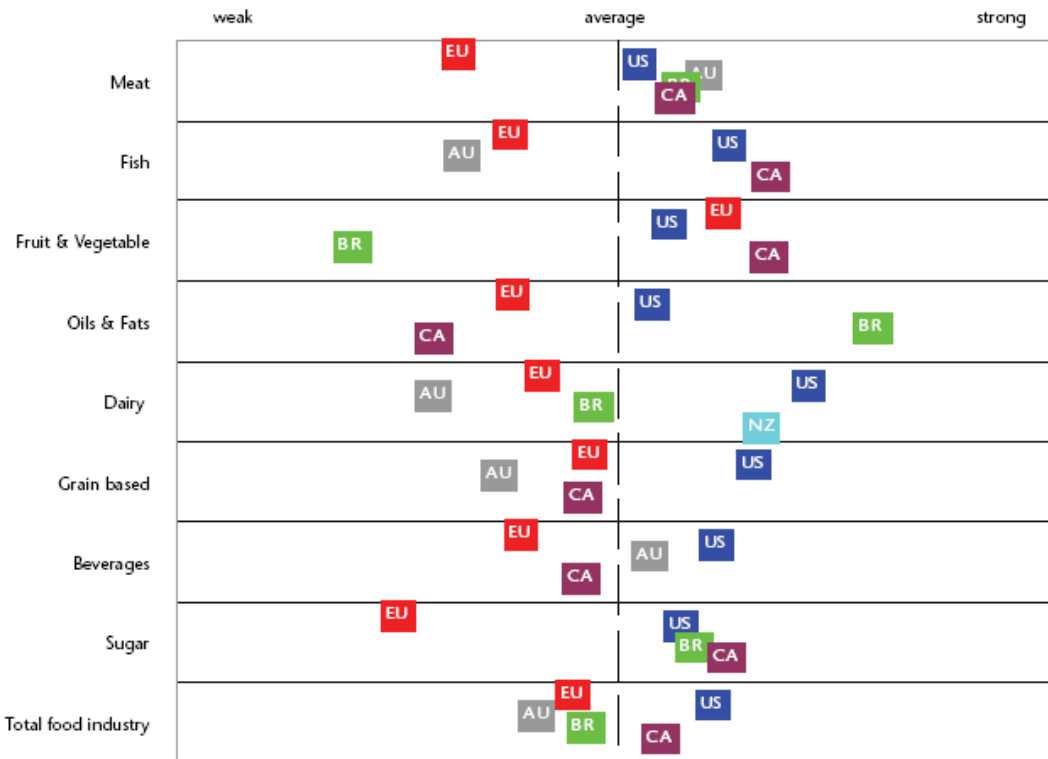


Figure 4. Global competitiveness of the Australian food industry.

3 GOVERNMENT-LED INNOVATION STRUCTURES FOR FOOD SUPPLY CHAINS

It is difficult to quantify the impact of the historic public expenditure in innovation-related strategies on the modern Australian food industry¹⁶. One reason is the concept of innovation itself, which encompasses a range of activities (e.g. new or improved products, business practices and processes). These activities are difficult to track and assess through the use of the same performance indicators. Other reasons are the complexity of the industry and its eventful history, which evolved from fierce competition in the 1980's to relentless consolidation and the supremacy of retailers as a market power in present times. Therefore, the effect of innovation structures and funding strategies in the past years is likely to be confounded with the effects of other events, such as the economic outlook, consumption trends and many others.

Nevertheless, food industry experts have reached consensus in two issues:

- (a) The Australian agri-food industry is in danger of losing markets that were taken for granted in the past (e.g. meat and grains)¹⁷, due to increased competition from countries such as New Zealand, South Africa and China.
- (b) Innovation has a key role in stopping the decline in the performance of the food industry sector in Australia.

The expert consensus is better illustrated by the following statements:

¹⁶ Arguably, the most detailed attempt to assess the impact of innovation in the food industry was the report by AEGIS (2001): The Processed Food Product System in Australia. University of Western Sydney. 131 p.

¹⁷ Australian Food Statistics, 2006

“Ultimately, for Australian companies to remain competitive in the international marketplace, they will need to boost their commitment to R&D, continue to develop alliances with global brands and supermarkets, and be innovative in their product development and process technologies.” Dr David McKinna, 2006.

“Posing challenges for some food manufacturers is the impact on category value and the viability of sustaining investments in branded products, including the level of innovation and R&D investment”. DAFF, Australia Food Statistics 2006.

“The challenge for Australian farmers will be to identify and embrace new market opportunities and to drive competitiveness through innovation in production and processing, enhanced efficiency, improved economies of scale, attracting greater returns through better understanding of markets and changing consumer needs, through achieving greater equity through the supply chain, and through differentiating and developing specialised products” National Farmers Federation, 2006.

“Product and process innovation will play a large part in the success that can be achieved. This will add convenience to a product solution rather than the traditional approach of supplying commodity lines in the form also available in retail stores”. Freshlogic, 2007.

“...food companies must continue to innovate and operate at high efficiency in order to achieve income growth”. Steve Spencer, Whitehall Associates, 2006.

“Innovation is the key to profitability in competitive world food markets”. NFIS, 2007.

Historic investment in food innovation

Using Fig. 2 as a frame of reference, research on pre-production and primary production have received much more funding than manufacturing and post-manufacturing research. This is illustrated by the 2004/05 statistics on national R&D expenditure. In 04/05, R&D investment in the primary production of foods was about \$1 billion dollars¹⁸, while R&D investment in food manufacturing was just below \$300 million. This focus reflects just the opposite of the value chain, where the last stages of the chain (e.g. manufacturing and retail) are the ones that triplicate the value of primary production. Furthermore, the low levels of R&D in the food manufacturing stage are at odds with the knowledge-intensive character of the industry¹⁹.

Most retail R&D is classified as manufacturing or services. There are no specific estimations of how much retail invests in R&D. Therefore, we assume that the food supply chain as a whole had an R&D public and private expenditure of about \$1.3 billion during 04/05.

Food manufacturing R&D expenditure increased from \$192m in 2000 to \$269m in 2005 (Figure 5). The sectors with increased funding are (in decreasing order of gains in the past 5 years): others – mainly sugar, confectionery, prepared animal and bird feed and seafood (+\$29 m), beverage and malts (+\$28m) and horticultural products (+\$16 m). R&D funding for the dairy industry has decreased in about \$2.5m per annum in the past 10 years.

¹⁸ This value is the aggregate of plant production & plant primary products plus animal prod. & animal primary products. ABS Research and Experimental Development Summary 2004/05.

¹⁹ Howard Partners. 2005. The emerging business of knowledge transfer. Report of a study commissioned by the Department of Education, Science and Training.

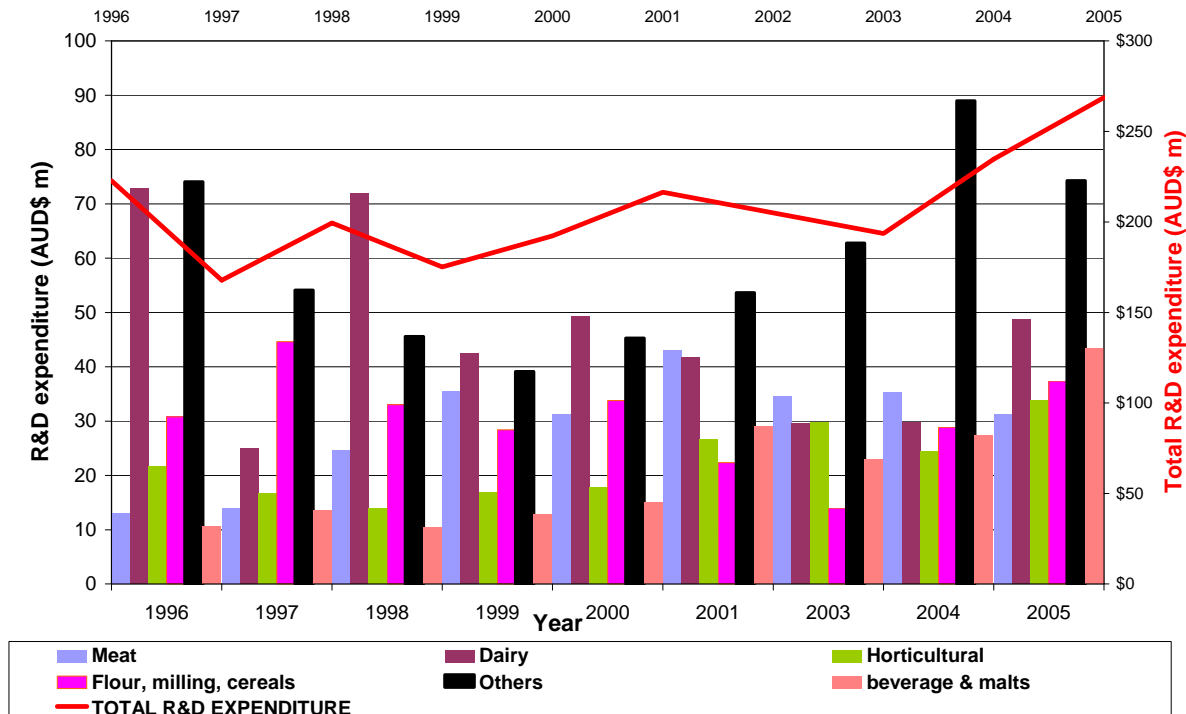


Figure 5. R&D funding for particular sectors in the food industry. Sources: Australian Food Statistics 2006; OECD 2004, Research and development expenditure in industry.

Interestingly, these statistics do not necessarily encompass R&D in logistics and supply chain management. These activities are central to the operation of the food chain, yet firms operating in these interstices are not counted as part of the food industry²⁰ and their innovation and R&D activities are accounted for in different industries. For example, R&D expenditure in retail logistics, transport and storage is accounted as “services”; packaging R&D may be accounted for in manufacturing of chemicals, rubber, plastics, fabricated metal products and others.

Initiatives supporting food-related innovation

Two major Government funding initiatives for R&D closely linked to market demands were:

- The Supermarket to Asia (STA) Strategy from 1996 to 2002, which had as a main objective the expansion of Australia’s agrifood exports to Asia. The Technical Market Access program was created through STA and it is still used by DAFF as a mechanism to enhance market access of Australian foods exports.
- The National Food Industry Strategy (NFIS) Ltd (2002-2007), an industry-led company, funded by the Australian Government to implement most aspects of the National Food Industry Council. The Food Industry Grants (FIG) were the most representative NFIS instruments for R&D funding.

The FIG Program had a budget of \$34.7 million over five years. The Program provided support to Australian based food businesses for projects involving technical and scientific R&D. Projects funded needed to present strong prospects for commercialisation.

Grants under the FIG Program were awarded on a competitive, merit-based assessment, with funding provided on a matching dollar-for-dollar funding basis for up to half of the eligible project costs. The majority of FIG proposals involved collaboration between Australian based food

²⁰ AEGIS, 2001. The processed food product system in Australia. UWS. 131 pp.

businesses and research organisations, including Food Science Australia and other CSIRO divisions, universities and a range of technical consultants²¹.

Data published by NFIS in regards to funded projects and grant applications from 2002 to 2004 (Figure 6) shows that a majority of these fall under ‘processing’, followed by ‘consumer value’ (22% and 14% per cent, respectively). The fruit and vegetable/horticulture products segment of the industry had the largest representation amongst FIG Program recipients (28%), followed by ingredients (22%).

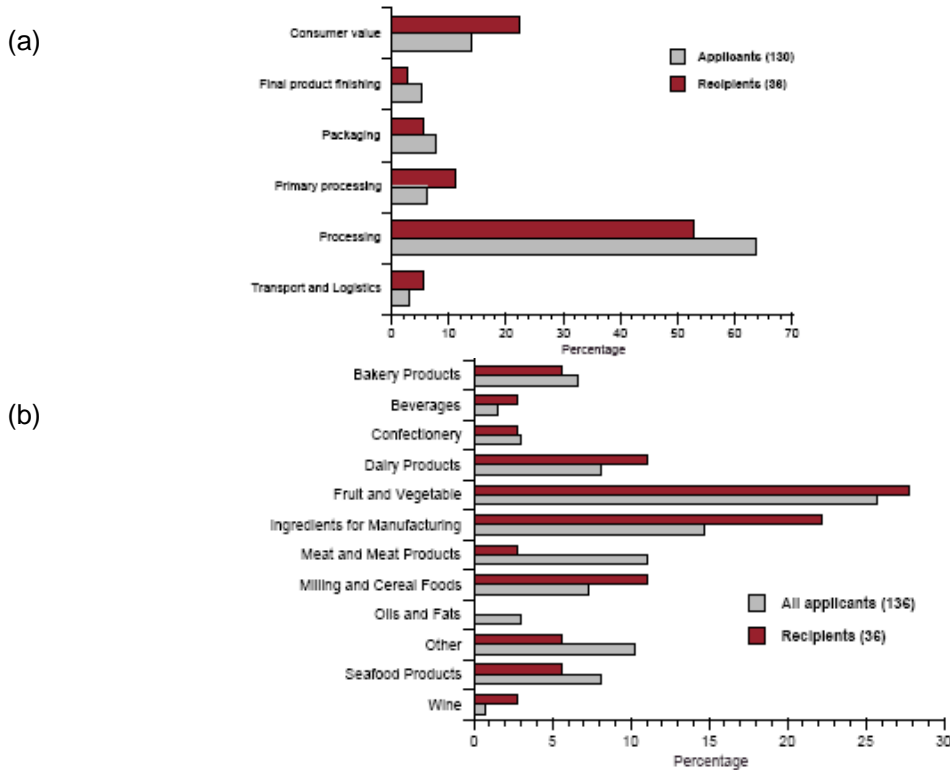


Figure 6. Innovation and product categories funded by the NFIS (a) by link in the chain; and (b) by product.

The FIG program was highly successful and well regarded by all the participants. One particular weakness was the relative low participation of SMEs with respect to the participation of larger firms using the FIG grants to undertake research. Given the large percentage of foreign owned/multinational firms, it is likely that FIG grants supported R&D activities that would otherwise be carried out outside Australia.

Figure 7 shows the past innovation funding and R&D providers²². To analyse the split of public R&D funding, this is commonly categorised on the basis of the stage of innovation supported (e.g. basic research, applied research, technology transfer). In Figure 4 I have opted to present the information in the context of food supply chains. The classification of CRCs in a food supply chain context relied on the information available in the CRCs websites (as per list in Appendix 2). Although the categorization in Figure 4 is open to debate, there are some general observations that can be drawn:

- In general, CRCs tend to support heavily the primary production sector.

²¹ The Allen Consulting Group. Food Innovation Grants Program Review-2004

²² As stated in the introduction, past innovation structures have centred in R&D funding. The correctness of this approach is open to debate.

- The intention of CRCs seems to overlap with some RDCs; for example, there is one CRC for dairy, one RDC (Dairy Australia) and schemes such as the Geoffrey Gardiner Foundation in Victoria that also support dairy. For grains, there are two CRCs dedicated to this category, plus one RDC. There are other open funding sources (e.g. RIRDC) that are used to support grains and dairy projects to some extent. One may wonder if this duplication is a result of: (a) poorly managed R&D funding resources; (b) the needs of more R&D investment in particular industries; or (c) the diversity of the dairy and grains industries. Whatever the reasons, the duplication of areas for investment could lead to poor efficiency at the cost of lost opportunities in other industries.
- CSIRO supports various projects across the food supply chain through cofunding. Through Food Science Australia (a joint venture of CSIRO and the Victorian Government), funds for R&D in food manufacturing industry are available in the form of collaborative research contracts. However, available cofunding is directed to strategic areas for CSIRO/FSA (e.g. little emphasis is placed on retail innovations).
- DPIs predominantly support the primary sector, mainly in pre-production and production issues. State-led initiatives have a strong role in the industries relevant to each territory.
- There is a scarcity of funding available to investigate the final stages of the food value chain. There is also a lack of funding sources devoted to create innovations in non-R&D related fields (e.g. business practices, supply chain management, competitive intelligence).
- NFIS had a strategic role in supporting business innovation, manufacturing, supply chain and value addition projects. Additionally, NFIS approached food innovation with a 'whole-of-the-chain' perspective. The termination of this initiative leaves a vacuum in R&D focused to food manufacturing and other areas of knowledge required to introduce food innovations in the marketplace (e.g. supply chain, consumer science and packaging).
- Other food innovation programs are fragmented and do not allow a 'whole-of-the-chain' perspective (e.g. the *Regional Food Producers Innovation and Productivity Program*). However, trends in the global food marketplace indicate that entire supply chains formed by alliances of two or more players (as opposed to lone companies) will be required to compete in the food market. This is also true in other industries

Another observation from Figure 4 is the high level of competition between public and private R&D providers for public funding. This brings the following disadvantages:

1. Wasted time and effort of R&D providers (public and private) in applying for a finite amount of public funding from RDCs and CRCs. R&D providers cannot always recoup the money spent in failed applications.
2. The competition process is not enhancing collaboration between universities and public R&D organisations. Neither is a process that improves communication between R&D providers and food supply chain players. Given the limited pool of funding, competing agencies prefer to apply as sole providers rather than sharing the funding with potential collaborators.
3. In many competitive calls for proposals from RDCs and CRCs, there is a lack of transparency as to how the proposals are evaluated. In addition to this, the timeframes between submitting an expression of interest and receiving the outcome of a full submission varies between 3 to 6 months. However, representatives of the food industry expect innovation projects to produce results in less than 1.5 years²³.
4. The competitive process does not support open innovation.

²³ NFIS, 2005.

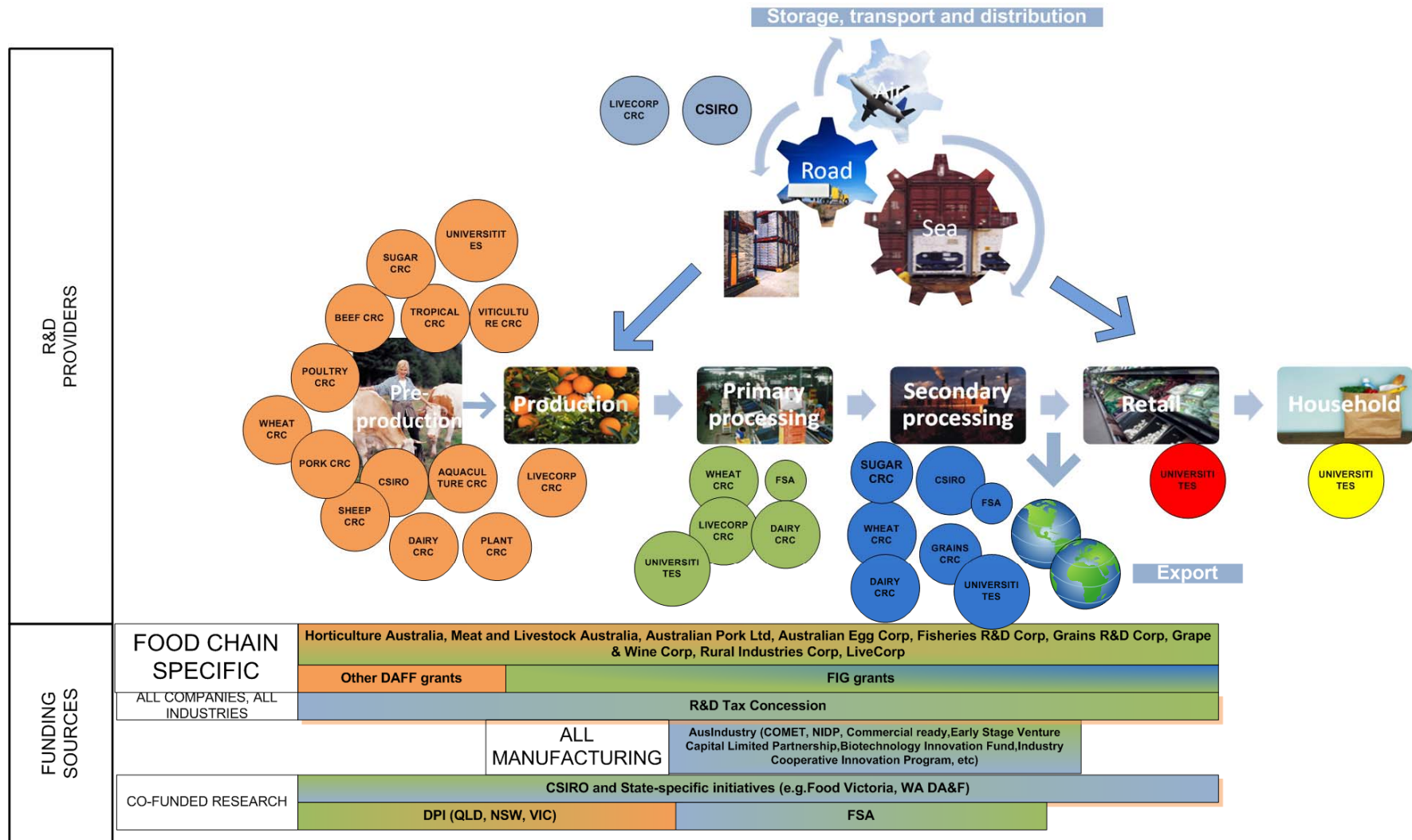


Figure 6. Funding and R&D provision structures for food innovation.

NFIS food innovation models during 2002-2007

Figure 8 presents the food innovation network model proposed by NFIS. The model is self-explanatory, indicating the role of NFIS as a hub coordinator of the activities between the network partners.

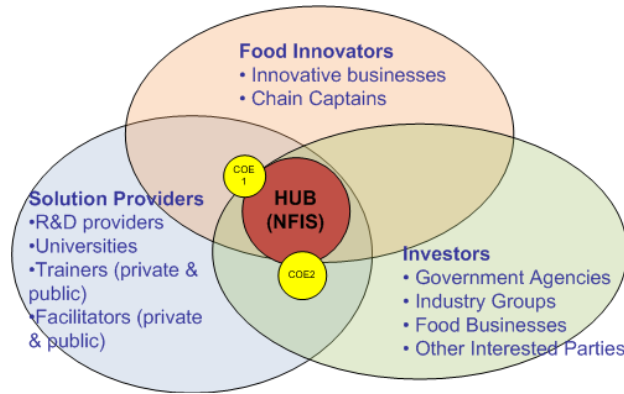


Figure 8. NFIS Food Innovation Network model.

Centres of Excellence (COEs)

The two existing COEs were created by the National Food Industry Strategy in 2003, to respond to the decreasing R&D funding in the food industry. In the areas that were the most important innovation trends in the early 2000's: functional foods and food safety. The Centres of Excellence operated as virtual hubs of innovation, as illustrated in Figure 9.

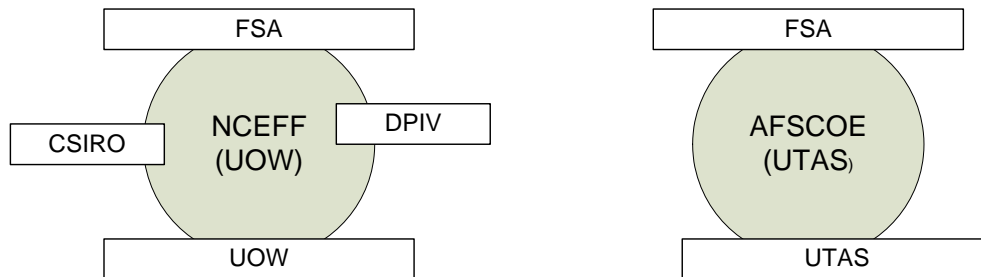


Figure 9. Centres of excellence created by NFIS in 2003. Notes: FSA= Food Science Australia, a joint venture of CSIRO and DPIV; UOW= University of Wollongong; UTAS= University of Tasmania.

Figure 10 shows the COEs model, where a virtual network of consortia partners agglomerate around one topic (i.e. functional foods, food safety) and provide a wealth of services to the industry. The review found that the COEs lacked formal mechanisms of engagement with industry: Why industry players should be involved? What is the cost of involvement? What is the motivation? The lack of engagement, the lack of a strong value proposition, weaknesses in governance and the duality of roles of the managers and scientists involved (e.g CSIRO-centre view, as opposed to NFIS-centred view) were highlighted in a critical review undertaken by NFIS in 2005²⁴.

Recently, AFSCOE (the most promising COE) has changed its affiliation to the Food Safety Centre, a self-sustained food safety information portal. The extent of funding from the host

²⁴ Ridge Partners on behalf of National Food Industry Strategy Limited (NFISL), 2005. Mid-term review of the National Food Industry Strategy. Final report.

organisations (i.e. FSA and UTAS) to support the Food Safety Centre is unknown. In regards to the NCEFF, it is not known if it is still active.

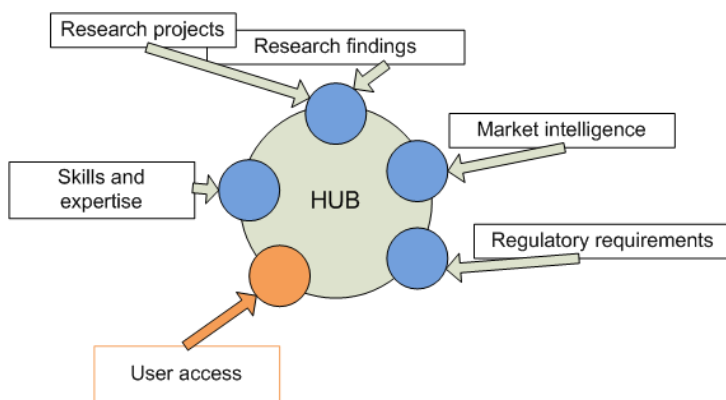


Figure 10. Hub model used for the NFIS funded Centres of Excellence.

4 CHALLENGES FOR PUBLIC ORGANISATIONS FOCUSING ON FOOD RESEARCH

In Appendix 1, Table A1 summarises the results of an analysis applied to understand the influence of social, technological, economic, ecological and political/legal factors on the strategic directions and competitiveness of public food R&D providers. In Figure A1 (Appendix 1), a “five forces” analysis was used to complete the external environment analysis, outlining the challenges of public R&D providers in competition with private providers.

The analyses revealed the following limitations for the development of food innovations by public R&D organisations:

1. Although the levels of R&D expenditure in the Australian food industry are increasing, R&D funding is decreasing in areas that are heavily staffed in public R&D organisations (e.g. meat, dairy, cereals).
2. *Supplier* issues are basically a human resource issue. In the current job market, finding and sourcing staff with the right mix of business and scientific skills required for public R&D is difficult. Particularly if those skills are in high demand in industries offering better employment conditions. An example of this situation is hiring scientists with expertise in industrial ecology or energy.
3. The role and influence of supermarkets (*buyers*) on the R&D agenda of manufacturers should be considered: The profitability of the retail sector is highly reliant on in-depth customer knowledge and reliable and efficient supply chains that can deliver the food products. Therefore, retail-led innovations focus on improving supply chain aspects. Additionally, the current environment for manufacturers (i.e. increasing production costs and decreasing sell prices) means that there are fewer margins available for innovation and capability development.
4. The commercialisation requirements for R&D providers can vary significantly. For example, RDCs have as a key priority the development of research that benefits the wider industry. This position does not encourage the use of intellectual property (IP) as a competitive advantage for a particular company²⁵. In the other hand, the industry

²⁵ DAFF has stated that the adoption of agrifood R&D outputs is largely achieved through an ‘open-source non-competitive extension approach’. However, DAFF also noted that food producers need to achieve a competitive advantage, ‘often through exclusive access to IP or the ability to exploit some particular knowledge’. (DAFF, 2005; Productivity Commission, 2006).

normally expects full ownership (or full entitlement of licences) of the IP developed with an R&D provider. Therefore, R&D providers need to have several strategies and business/IP models that accommodate these situations.

5. The levels of rivalry in the industry are high, as public food R&D organisations compete for decreasing industry and government funding with universities and private providers. Universities in particular are now competing in applied research grants, in addition to their traditional role of basic research providers.

5 POTENTIAL INNOVATION MODELS FOR THE FOOD INDUSTRY

I believe that open innovation models that:

- (a) bring together the necessary roles and players for innovation;
- (b) 'connect the dots' between the key innovation players; and
- (c) create the necessary market conditions for the commercialisation of innovative products

would be more successful than current approaches. There are three concepts that I would like to introduce at this point: co-innovation, consumer-led innovation and forward commitment procurement. I believe that these concepts are essential to develop a sound innovation framework for the food supply chain.

Collaborative Supplier-Manufacturer-Retailer Innovation

In the context of this paper, cooperation is defined as similar or complementary coordinated activities performed by different firms in a business relationship to produce superior outcomes, with expected reciprocity over time. In a cooperative framework, the relationship between partners is driven by the need of profitability and by strategies that are congruent within each company involved and within the relationship²⁶. Co-innovation is one of those strategies, where the success of a new product or service in the market means success for all the supply chain partners. Co-innovation seeks to extend the scale and scope of external partnerships and alliances to access and exploit new technologies, knowledge, and markets. Collaborative innovation requires early involvement of all chain players in the new product development (NPD) and the development of 'innovation networks', or clusters of collaborators working at every stage of the product cycle and at every link of the value chain.

The challenge of co-innovation is better understood if we take into account the balance of market power between food suppliers, manufacturers and retailers: in the Australian and UK environment, retailers (with emphasis on the supermarkets) are perceived as having more influence and control in the food chain. This influence received significant attention in the UK, which led to the introduction of a Supermarket Code of Practice, introduced in 2002. The Code explicitly mentions that all supply chain participants would benefit if they worked together to expand the market for their products and develop a profitable and sustainable business²⁷. In Australia, the ACCC is seeking to investigate the nature of the relationship between suppliers and retailers in a similar manner²⁸. Therefore, creating the required level of communication, trust, commitment and interdependence required for co-innovation calls for significant political and organisational efforts.

Appendix 3 shows examples of innovation spheres for manufacturers and retailers, showing some of the areas where co-innovation could be a successful approach.

²⁶ Shaw, S. A., and Gibbs, J. Retailer-supplier relationships and the evolution of marketing: two food industry case studies. *Int. J. Retail & Dist. Mgmt.* 23(7): 7-16

²⁷ Fearne, A. 2005. Justice in UK supermarket buyer-supplier relationships: an empirical analysis. *Int. J. Retail & Dist. Mgmt.* 23(7): 7-16.

²⁸ <http://www.accc.gov.au/content/index.phtml/itemId/809228>

Consumer-led innovation

Consumer-led product development arguably offers the best platform for co-innovative projects between suppliers, retailers and manufacturers. The aim of consumer-led product development is to create product differentiation, leading to higher consumer satisfaction, increased levels of consumption of specific products, or increased overall value of the given level of consumption²⁹. In a consumer-orientated approach, the development of new products, processes or services begins with consumer and market research to identify the specific characteristics required by consumers. The next step is the organisation of the cooperative framework and information exchange among all the actors in the production chain. An important aspect in this process is the translation of descriptive and qualitative terminology in which consumers express themselves into technological specifications for all the chain players participating in this form of co-innovation³⁰.

Consumer-led innovation also opens new doors of collaboration. Consider the highly perishable fruit and vegetables category, which have a shelf life of sometimes days only. The shelf life of the product dictates the speed the supply chain should operate at. Therefore, for these products, some retailers plan their resourcing more than once a day, because the potential wastage cost exceeds the savings through economies of scale in transportation and warehousing activities. In this case, the flow benefits of co-innovation can be captured simply with information sharing and forecasting collaboration. For less perishable items, say, canned food, a highly efficient supply chain depends on low inventory levels and high capacity utilization. In a co-innovative environment, sharing of information has more probabilities of success than in the case of a traditional, manufacturer-led innovation.

Figure 10 presents a co-innovation model proposed by Dr Andrew Fearne, the Director of the centre for Supply Chain Research at the Kent Business School, United Kingdom. Dr Fearne recently toured the Asia-Pacific region to explain his views on co-innovation and food supply chains.

Figure 11. Co-innovation framework (Source: A. Fearne, 2007. Co-innovation for sustainable competitive advantage. ABARE Outlook conference 2007).

²⁹ Grunert, K., and Valli, C. 2001. Designer-made meat and dairy products: consumer-led product development. *Livestock Production Science* 72 (2001) 83–98.

³⁰ Linnemann, A. R. Benner, M., Verkerk, R. and van Boekel, M.A.J.S. 2006. Consumer-driven food product development, *Trends in Food Science & Technology*, 17:184-190.

Fearne suggests that there are three drivers to undertake co-innovation:

- (a) It allows the development of new (value added) products/services for distinct customers and targeted consumer segments
- (b) Process improvement occurs for existing products/services beyond organisational boundaries
- (c) Innovation at the interfaces in the value chain are much more difficult for others to copy, thus increasing the competitive advantage

Since co-innovation quite often requires global innovation networks, there are further advantages, such as:

- (d) Supporting collaboration among geographically dispersed teams of suppliers, manufacturers and retailers
- (e) Speeding time-to-market and reducing costs for all the parties involved in the NPD process (due to resource pooling and reduction of learning curve)
- (f) Meeting customer expectations in a more close manner, due to the direct input of retailers into the main purchase drivers of products
- (g) Enforce consistency and quality of brands and innovations
- (h) Creating a compliance audit trail through sharing of quality documentation
- (i) Most importantly, creating a repository of protected know-how and intellectual property, only available to the chain participants.

How can organisations achieve the right environment for co-innovation? Several authors agree that the following are key aspects to achieve this:

- (1) Have a consumer focus and enforce collective responsibility
- (2) Promote value chain visibility and information flows (vertical and horizontal) across the chain
- (3) Promote the management of inter-personal and inter-organisational relationship
- (4) Align the required resources (physical, financial and organisational) with the final demand and process integration.

Forward commitment procurement model

Forward commitment procurement (FCP) is another type of demand side driven innovation, although this process is specifically led by the Government. It is defined as “a commitment to purchase, at a point in the future, a product or service that does not yet exist commercially, against a specification that current products do not meet, at a sufficient scale to enable the investment needed to tool up and manufacture products that meet the cost and performance targets in a specification”³¹.

In an FCP model, a public sector organisation commits to purchase a pre-defined quantity of a product\ technology, currently under development but not yet available as a commercial offering. The commitment is for a future date and is based on a specified product performance being achieved. When the product has been developed meeting this performance specification within the agreed timeframes and framework, the organisation purchases the product at a specified volume and cost, at levels that encourage supplier investment to ensure economies-of-scale. The private sector would react by freeing investment to search for innovations that respond to those specifications. Once the product/service has entered the market, normal market conditions will determine competition and price³².

³¹ <http://www.cambridgenetwork.co.uk/news/article/default.aspx?objid=16135>

³² <http://www.endsdirectory.com/index.cfm?action=articles.view&articleID=200704>

The FCP model has been highlighted as the most promising model to encourage environmental innovations, where the government itself acts as an early adopter. The procurement process is also supported by regulations that enhance the market conditions to create a demand for the innovations. A key aspect of FCP is the focus on needs and outcomes, rather than placing the focus on the product.

The European Commission investigated the FCP model for driving innovation in 2005³³. The major advantages that the EC has noted about FCP are:

- Firms are given the incentive to spend money on research in the knowledge that an informed customer is waiting for the resulting innovations and thus the risk of investing in R&D is reduced.
- Competition is shifted from a sole focus on price to the provision of solutions which offer the greatest advantage to users over the whole life use of the purchase.
- FCP opens up opportunities to improve the quality and productivity of public services offered to the citizens through the deployment of innovative goods and services.
- Technologies launched in this way may then move on to further deployment in private sector markets. Other policy objectives (e.g. sustainability, food safety) may also be achieved by procurement of innovative solutions.

Recently, the European Commission published a second document outlining the pre-commercial procurement process in the EU, reflecting their intention to use this approach for their strategic sourcing of innovation (Figure 11). Two European FCP models are shown in Figures 12 and 13.

The Australian Government is extremely knowledgeable about procurement strategies. However, there is a lack of guidance in regards to the use of procurement to drive innovation. Bridging this knowledge gap through enhancing public knowledge on the role of procurement to drive innovation is the first key step towards using FCP.

I raise the issue of the roles of CRCs and RDCs in regards to the role of “innovation procurers”: although RDCs align closely to what FCP is about, CRCs do not quite match this profile. CSIRO has a role as an R&D provider in basic areas of research, but it may well be that CSIRO can have a role as a procurer in seed/incubations stages. In any case, CSIRO could not sit in both (supplier and procurer). The role of public R&D organisations needs to be discussed in the light of any FCP initiatives in the future.

A crucial element of the FCP model is the identification of market needs and the translation of these into specifications for the tendering process. The needs may arise from policy changes, budget structures, operational/efficiency reasons or other sources. To illustrate the concept, we have used some of the challenges identified by DAFF³⁴ for the food industry to suggest some FCP statements of needs (Table 1).

³³ EC 2005. Public procurement for research and innovation. Developing procurement practices favourable to R&D and innovation.

³⁴ Australian Food Statistics 2006

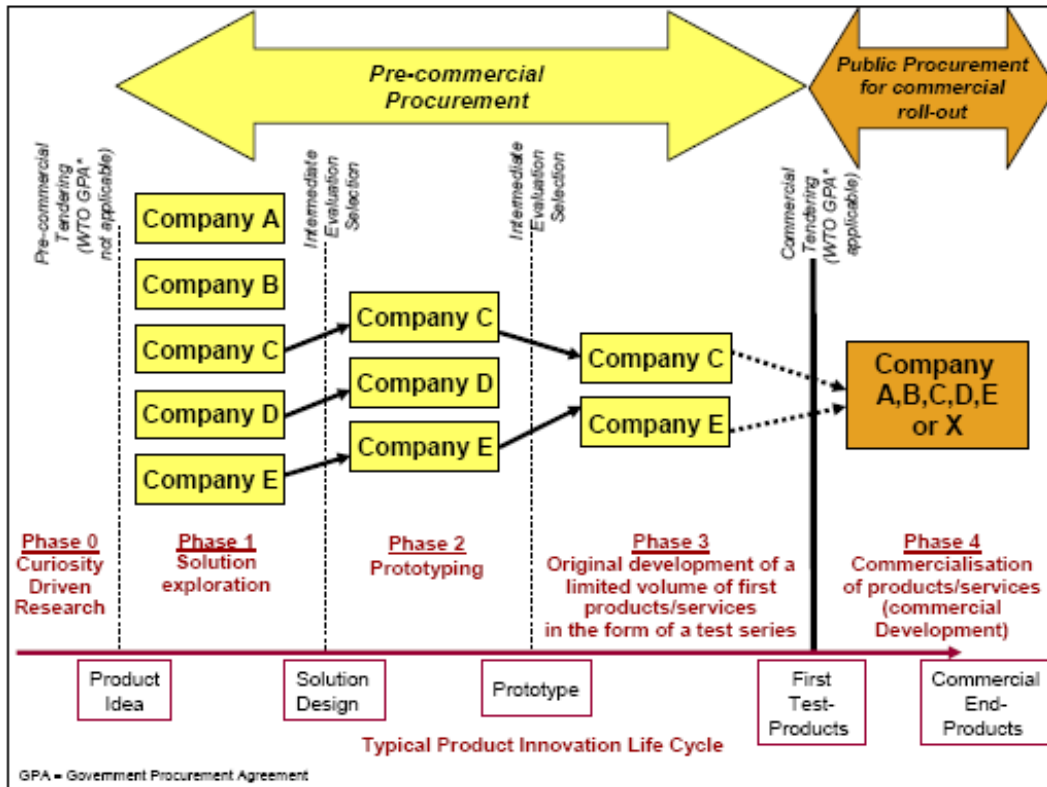


Figure 12. An European example illustrating a phased pre-commercial procurement process (Source: EC. 2007. Pre-commercial Procurement: Driving innovation to ensure sustainable high quality public services in Europe.

Table 1. Examples of innovation challenges in the food industry and their translation into market needs.

Product/process	Challenge	Potential need
Food value chains	Identifying improvement opportunities on food value chains	“Increase in 1% the margin profit of tomato growers, without increasing the product price at retail and without sacrificing other margins in the chain”
Fresh, ready-to-eat meals	Developing solutions to overcome the cost–time tradeoffs made by consumers, while also addressing quality and variety demands.	“Develop a range of chilled retail ready-to-eat salads that extend the product shelf-life to 10 days”
Logistics	Finding ways to add value in more than the supply of product	“Develop a logistics system that brings the shop to the consumer, rather than bringing the consumer to the shops”
Supply chain management	<ol style="list-style-type: none"> 1. Manage production in an environment of unreliable climate, including managing the supply and cost of water. 2. Added complexity in food marketing and distribution will require the use of demand signals and fostering relationship management to better understand customer trends and preferences. 	<ol style="list-style-type: none"> 1. “Develop horticultural varieties that require x% less water for growth and yet, maintain their desirable nutritional and quality attributes” 2. “Develop a forecasting tool for predicting the monthly demand of highly perishable, ready-to-eat sandwiches in petrol stations”.



Figure 13. FCP model for environmental innovations (Source: DTI & DEFRA, 2006. Bridging the gap between environmental necessity and economic opportunity. 1st report of the Environmental Innovations Advisory Group. P.15)

6 A NEW MODEL: SUSTAINABLE CO-INNOVATION

In this section, I use the three concepts discussed in the previous section to propose an innovation model for the food industry. I do not propose that this innovation model supersedes all innovation-related initiatives and it does not offer a solution to maintain curiosity driven R&D. However, the model proposed tackles the issue of innovation, or R&D with a purpose. I do believe that this model can replace the fragmented innovation attempts currently undertaken by CRCs and RDCs in the food supply chains.

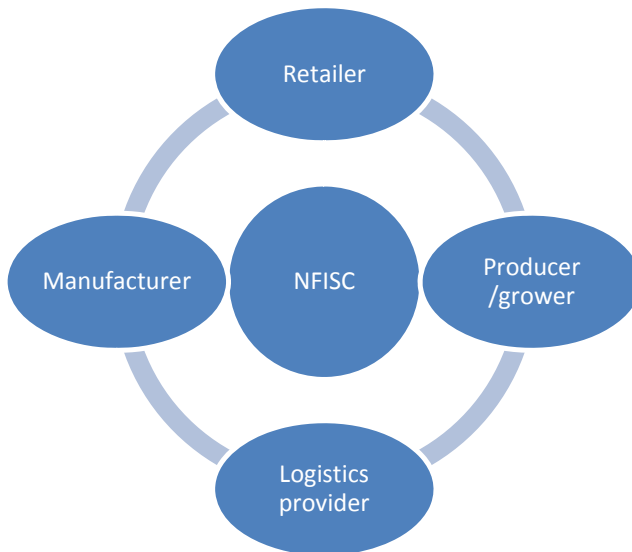
I will use the term “sustainable co-innovation” (SCOI) model to identify the proposed structure. The SCOI model follows closely the FCP model, adding the concepts of co-innovation and innovation networks.

The SCOI model requires a central overseeing organisation. This organisation (which we will identify in this proposal as “National Food Innovation Strategic Council” (NFISC), can be modelled after the successful NFIS and NFIC. However, we envisage that NFISC would amalgamate the two roles.

NFISC should receive funding from private and public partners (e.g. joint venture). NFISC would:

- (a) Provide a strategic framework for food innovation in Australia, from a market-led, supply chain perspective.
- (b) Coordinate the activities required to introduce new technology in the marketplace, following an FCP approach.
 - Engage with Government departments and food supply chain players to develop the buyers needs into specifications for tenders
 - Act as a technology broker, bringing venture/equity capital and innovator companies together
 - Coordinate legislative activities that provide adequate market conditions for adopting innovations in the wider industry.
 - Promote technology demonstrations and case studies to show the business case.
- (c) Coordinate government-led food innovation activities (e.g. grants and strategic directions for public R&D), from a supply and value chain perspective. This would avoid the lack of supply chain focus and would increase critical mass in the initiatives undertaken.
- (d) Provide timely competitive and technical intelligence to all stakeholders about the particular FCP projects targeted, bringing to the stakeholder's attention current and emerging technologies in the targeted technology markets.

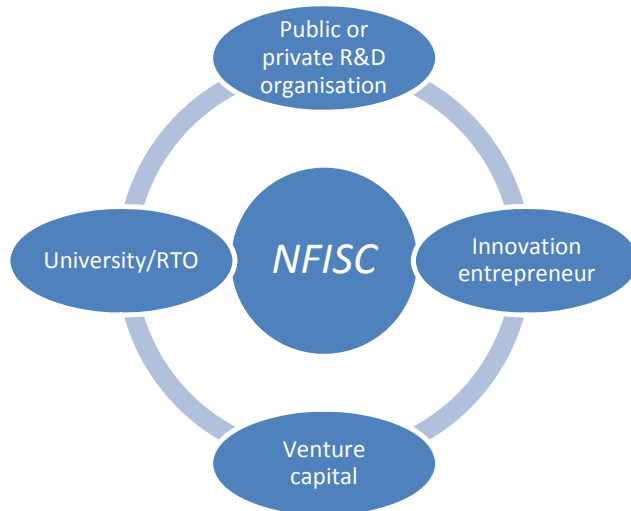
The NFISC role is crucial in the SCOI model, which is based on the development of three types of consortia:



The buyer consortia

A *buyer* consortium is formed by two or more supply chain partners that establish an alliance to contract/purchase the new process/ product/ service developed by a supplier consortium. Examples of alliances may be: (a) a retailer and a cooperative that have mutual benefit in purchasing a new retail-ready format for fresh produce that is also environmentally friendly; (b) a fast-food chain, a third party logistics provider and a food manufacturer that all mutually benefit with the use of new logistics systems that allow direct

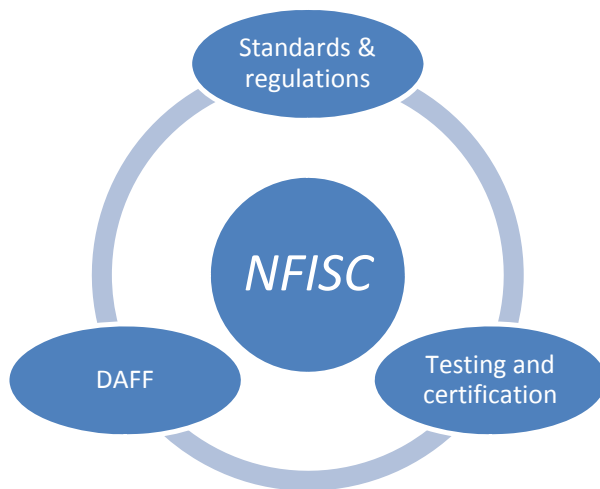
dispatch of home delivery orders from the manufacturer to the consumer. This type of consortia becomes effectively a supply chain innovation network.



The supplier consortia

A *supplier* consortium is formed by two or more organisations that seek to deliver the innovation at the specifications (e.g. cost, time, performance) set by the legislative consortia. Public and private R&D organisations supply solutions and showcase their R&D to innovation entrepreneurs looking to develop the new product/ technology, either as a start-up company or as a product in an established company. Universities and RTOs contribute with gap analyses of required skills and deliver training and education

programmes to address these gaps. Venture capital is sought to help innovation entrepreneurs to start the company, continue R&D in collaboration with the public/private R&D organisations and prepare case studies highlighting the business case. A crucial aspect of this consortium will be the willingness of public R&D organisation to transfer intellectual property rights to the innovation entrepreneur. We may well question why a public R&D organisation wants to own patents, given that the organisation itself is unlikely to commercialise inventions in many cases. Fair arrangements and payments should be negotiated to ensure that inventors and developers are rewarded.



The legislative consortia

A legislative consortium, which aims to increase the receptiveness of the market to new technologies/processes/products by introducing standards, regulations and laws that increase performance targets in certain areas. For example: we would expect increased innovation in water utilization if toughest regulations on water usage are introduced; innovation in food safety would be aided by increased regulations on the limits of food poisoning cases per State; innovation in refrigeration systems would be increased by limiting the energy rating of commercial and domestic appliances even further.

The SCOI model encompasses the steps and processes shown in Figure 14.

In the SCOI model, a buyer consortia (which may or may not include a public sector organisation) commits to purchase a pre-defined quantity of a product\ technology\service, currently under development but not yet available as a commercial offering. NFISC and the buyer consortia agree in the performance sought for the innovation. The supplier consortium is formed and solutions are sought, based on past innovations or completely new concepts. Meanwhile, the legislative consortium develops standards, regulations and certification processes that enable fair competition and enhance the chances of the uptake of new solutions at the agreed performance specification. When the innovation has been developed, meeting all performance criteria, the buyer consortium purchases the product at a specified volume and cost, at levels that encourage other supplier

consortium to enter the market. The private sector would react by freeing investment to search for innovations that respond to those specifications.

In the context of SCOI, I do not necessarily advocate for the government to become the early market buyer that executes the forward commitment options. This may be effective in some areas, such as food safety (related to public good). However, the Government may not be the ideal buyer innovations that lead to new products, new markets or new processes. Instead, I propose that food supply chain players form alliances that commit to buy the new product / service/technology when this is developed. The drivers for such commitment could be based in (a) superior value proposition (including financial, environmental and social performance); (b) new regulations encouraging the uptake of the innovation; and (c) a demonstrated increase of competitiveness in the marketplace if the innovation is adopted.

Selection criteria of publicly funded food innovations

Figure 15 is provided as a framework of analysis to enhance decision-making on the food innovation areas that would be able to compete in the marketplace. In the view of this author, the following general areas that should be assessed for R&D funding are:

Health areas

R&D examples:

- *Role of human nutrition, genetics and food trends in health trends (nutrigenomics)*
- *Functional foods*
- *Delivery technologies of health ingredients*
- *Evaluation of functionality for Australian native foods*
- *Portion control and obesity*

Food processes

R&D examples:

- *Non-thermal processes*
- *Micro-machine processing and production-descaling*
- *Biotechnology (e.g. development of high value bioproducts from food industry waste streams)*
- *Nanotechnology in food production and manufacture*

Food supply chains

R&D examples:

- *Information and Communication Technologies in modern food supply chains (e.g. track-and-trace systems)*
- *Food logistics and packaging systems adequate for specific chains (e.g retail-ready, convenience markets, ageing population)*
- *Quality keeping in perishable food chains*
- *Sustainability of food supply chains, with emphasis in water, energy and food waste (e.g. carbon-neutral supply chains)*
- *Improvements in food transportation and storage (cost, quality and energy)*
- *Pandemic scenario and contingency planning*
- *Tamper-resistant and sanitary packaging*

- *Automation in the food industry(including robotics/machine vision systems for production and quality grading)*
- *Biodegradable packaging*
- *Low cost alternatives for the transport of perishables*
- *Role of retail in market led innovations*

Food safety

R&D examples:

- *Detection of biological and chemical food contaminants*
- *Innovations to counter food bioterrorism threats*
- *Authenticity analyses*
- *Track-and-trace technologies for food safety*
- *Decontamination systems for the food industry*

PROCESS	WHO DRIVES THE PROCESS	INPUTS TO THE PROCESS	WHO IS CONSULTED	OUTCOMES
OUTCOME SETTING, SPECIFICATION AND AWARD CRITERIA		<ul style="list-style-type: none"> -Competitive and technical intelligence -Risk management procedures -Potential structures to manage contracts, IP and other business areas -Appropriate development time and human resources (this is critical) -Analysis and assessment of the innovation potential and cumulative effects 		<ul style="list-style-type: none"> -Development of precise, tight performance specifications and selection criteria -Promotion of networking and supply chain partner selection
POLICY SETTING		<ul style="list-style-type: none"> -Screening of current regulations to identify domains in which to integrate a performance based approach -Certification bodies and laboratories to develop testing methods and standards for the criteria established 	<ul style="list-style-type: none"> -Relevant associations, companies interested in developing the innovation as a product, companies interested in the uptake of the product 	<ul style="list-style-type: none"> -Improve legal certainty and consumer confidence -Adopt an initiative to promote application and Enforcement of specifications -Develop voluntary performance targets to enable the implementation of incentives and other policy measures to promote the innovation -Establishment of the legislative transition from voluntary to mandatory measures
SEED-TO-MARKET ENTRY STAGE		<ul style="list-style-type: none"> -Mobilization of private parties to place an expression of interest -Mobilization of R&D providers to link them with venture capital -Support access to R&D funding for those consortia selected for the next round -Transfer of knowledge and IP to innovation entrepreneur company 		<ul style="list-style-type: none"> -Development of pilot plant/prototypes -Development of case studies to show the business case -Anticipate the future qualifications and skills needs to uptake innovation -Deliver the innovation at a commercial-ready stage to the FC buyers
COMMERCIAL ROLL-OUT		<ul style="list-style-type: none"> -Revisited competitive and technical intelligence -Reviewed risk management procedures -Innovation developed as per specifications in tender -Approved certification and testing processes 		<ul style="list-style-type: none"> -Forward commitment options exercised

Figure 14. SCOI model

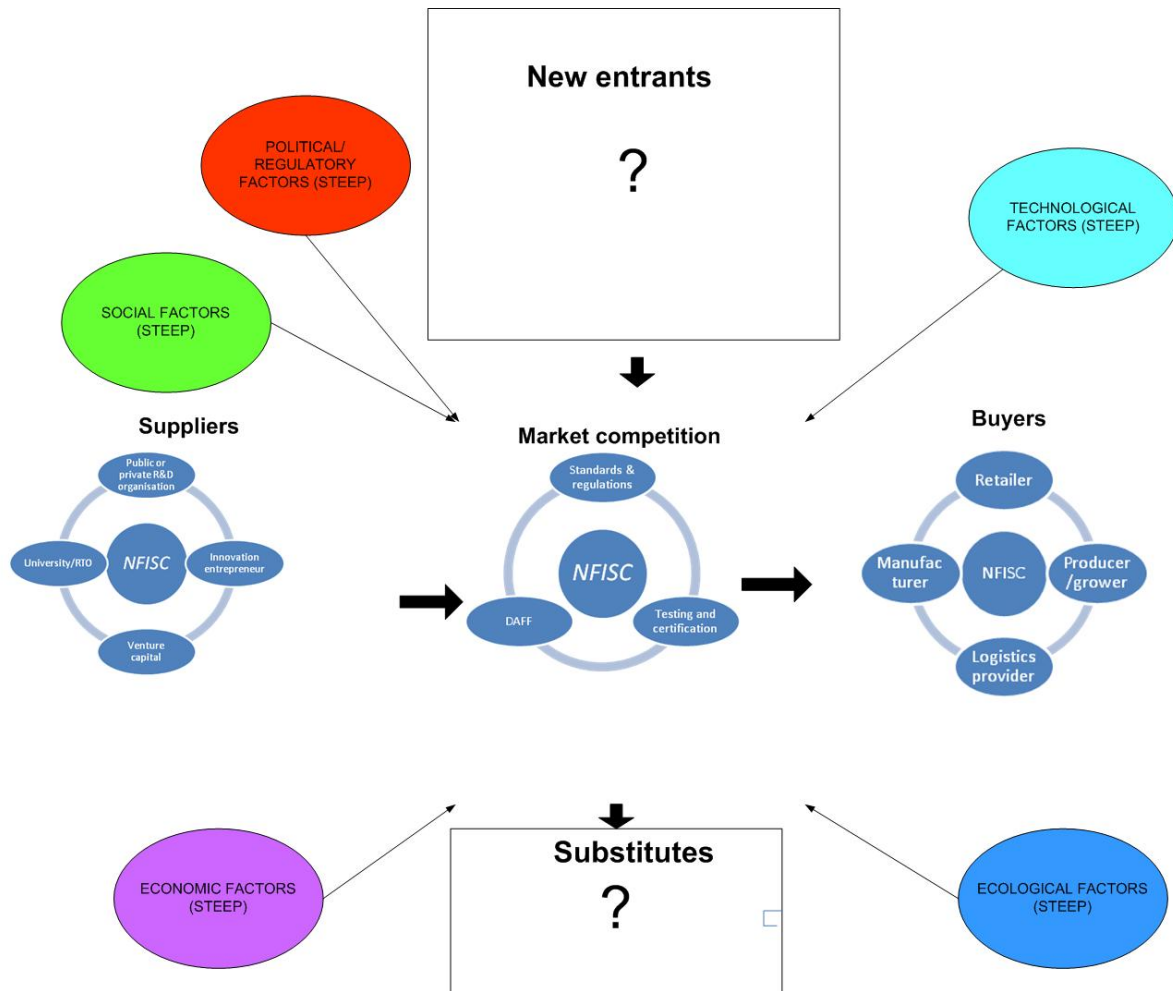


Figure 15. “Five forces” framework for the analysis of future innovation areas

Although I propose that the SCOI model replaces current funding sources to the food chain (including RDCs and CRCs), I also propose that funding should be available to establish “innovation networks” in key areas affecting the food supply chain environment (e.g. environmental impacts, economics of global supply chains, consumers and markets, social impacts). The innovation networks should be created in an ‘ad hoc’ basis and should serve a specific purpose.

For example:

- Brainstorming on particularly challenging issues affecting the Australian food industry (e.g. market barriers, cost effectiveness, labour) and possible innovative solutions.
- Sharing learnings and insights in discussion forums around particular industries (e.g. dairy, meat, horticulture), in a secure environment.
- Providing guidance to food supply chain players, in the form of workshops, seminars and competitive intelligence reports.

These networks should be dismantled as soon as their goal is accomplished. The lifecycle of these networks is likely to be shorter than current CRCs (e.g. months rather than years) and with input from a larger representation of supply chain players than CRCs structures currently allow.

TO SUMMARISE....

- 1) Innovation is a process that goes beyond theoretical conception, through technical invention to commercial exploitation. Therefore, R&D is an element of innovation.
- 2) One key distinction between R&D and innovation is that in the former, we don't necessarily know the outcomes. To create an innovation, the desired outcome must be known before tackling the problem with R&D.
- 3) All research has a purpose. However, a commercialising purpose is very different from a knowledge-seeking purpose. Funding mechanisms to deliver in both areas will have to follow very different rationale. My view is that grants investing in knowledge-seeking endeavours should be discussed separately from the discussion of a national innovation system.
- 4) It is clear that some industries will benefit from a market push innovation model than from a technology push innovation model. The food supply chain is an example of an area that would benefit from a market push approach.
- 5) There is a need for a concerted approach to innovation in the food industry, from agricultural production and rural based manufacturing to retail, thus adopting a value chain perspective. Such a concerted approach should recognise the highly dynamic nature of the food manufacturing industry, the benefits of market driven innovation and the usefulness of policy as an instrument to encourage innovation in the marketplace.
- 6) The current innovation system, which focuses on CRCs, RDCs, public R&D organisations and universities, has delivered a small number of innovations to the marketplace.
- 7) NFIS had a strategic role in supporting business innovation, manufacturing, supply chain and value addition projects. Additionally, NFIS approached food innovation with a 'whole-of-the-chain' perspective. The termination of this initiative leaves a vacuum in R&D focused to food manufacturing and other areas of knowledge required to introduce food innovations in the marketplace (e.g. supply chain, consumer science and packaging).
- 8) A new "sustainable co-innovation" (SCOI) model is proposed for the food industry. The model is similar to the Forward Commitment Procurement model, but the concepts of co-innovation and innovation networks have been added.
- 9) The SCOI model requires a central overseeing organisation similar to NFIS. However, it is proposed that the organisation becomes a joint venture between private and public partners. This organisation would:
 - a. Provide a strategic framework for food innovation in Australia, from a market-led, supply chain perspective.
 - b. Coordinate the activities required to introduce new technology in the marketplace
 - c. Coordinate government-led food innovation activities (e.g. grants and strategic directions for public R&D), from a supply and value chain perspective. This would avoid the lack of supply chain focus and would increase critical mass in the initiatives undertaken.
 - d. Provide timely competitive and technical intelligence to all stakeholders about the particular innovation areas targeted, bringing attention to current and emerging technologies and innovation trends in the targeted markets.

- 10) The SCOI model also requires the following types of consortia:
- a. A buyer consortium, formed by two or more supply chain partners that establish an alliance to contract/purchase the new process/ product/ service developed by a supplier consortium.
 - b. A supplier consortium, formed by two or more organisations that seek to deliver the innovation at the specifications (e.g. cost, time, performance) set by the legislative consortia.
 - c. A legislative consortium, which aims to increase the receptiveness of the market to new technologies/processes/products by introducing standards, regulations and laws that increase performance targets in certain areas.
- 11) In the SCOI model, a buyer consortium (which may or may not include a public sector organisation) commits to purchase a pre-defined quantity of a product\ technology\service, currently under development but not yet available as a commercial offering. NFISC and the buyer consortium agree in the performance sought for the innovation. The supplier consortium is formed and solutions are sought, based on past innovations or completely new concepts. Meanwhile, the legislative consortium develops standards, regulations and certification processes that enable fair competition and enhance the chances of the uptake of new solutions at the agreed performance specification. When the innovation has been developed, meeting all performance criteria, the buyer consortium purchases the product at a specified volume and cost, at levels that encourage other supplier consortium to enter the market. The private sector would react by freeing investment to search for innovations that respond to those specifications.
- 12) In the context of SCOI, I do not necessarily advocate for the government to become the early market buyer that executes the forward commitment options. This may be effective in some areas, such as food safety (related to public good). However, the Government may not be the ideal buyer innovations that lead to new products, new markets or new processes.
- 13) Instead, I propose that food supply chain players form alliances that commit to buy the new product / service/technology when this is developed. The drivers for such commitment could be based in (a) superior value proposition (including financial, environmental and social performance); (b) new regulations encouraging the uptake of the innovation; and (c) a demonstrated increase of competitiveness in the marketplace if the innovation is adopted.

APPENDIX 1
STEEP and Five Forces analyses for public R&D organisations (food-related)

The five forces analysis in Figure A1 needs to be examined in the light of the factors analysed in Table A1. The combination of Table A1 and Figure A1 allows both the identification of the main forces operating in the food R&D sector and the effect of these on the public R&D organisations.

TABLE A1. Social, technological, economic, ecological and political factors affecting public food R&D organisations

VARIABLE	TREND	IMPACT ON PUBLIC R&D PROVIDERS
Social	1. Global trends in ageing and health awareness.	1 & 2. Current R&D focuses on health and nutrition, functionality of ingredients, and environmental sustainability of the food industry. 3. Convenience as a major driver for new product development. 4. Food distribution and related activities seen as an activity outside the food manufacturing industry and thus, not part of the R&D science investment strategy. 5. Public R&D organisations are required to attract commercial income, but most have not developed a profit strategy that matches their social image and client’s expectations. 6. Scientific staff feel that there is an unresolved conflict between the mission of public R&D and the drive to earn external funding. This conflict extends to the dilemma of publishing vs patenting/commercialising technology
	2. Global trends in sustainability and ecology.	
	3. Consumer trust and consumer satisfaction (convenience).	
	4. Added complexity in food marketing and distribution will require supply chain relationship management and forecasting tools to better understand customer trends and preferences.	
	5. Public R&D providers are seen as having a moral and ethical responsibility to service the food industry and not as a profit-making organisation.	
	6. Government stakeholders expect that public R&D providers continue delivering R&D for the public good, but also demonstrating industry relevancy, by raising external funds.	
Technological	1. Innovation as a way forwards to grow and sustain production systems.	1. Public R&D has not clearly delivered “innovations” to the food industry. 2. Extension of perishables shelf-life at odds with “food miles” and freshness concepts. However, increasing shelf-life is vital for Australian exports. 3. New technologies that may not have a commercial future in Australia are embraced in R&D centres, to maintain a “high tech” R&D organisation profile 4. Recent initiatives by public R&D organisations include engagement with companies versed in commercialisation, IP and innovation management. Although helpful, it is not a complete solution for successful innovation.
	2. If a product moves away from being ‘fresh’, it loses potential revenue and quality advantages from local production.	
	3. Growth of new applications of nanotechnology and other emerging technologies (e.g. plasma, ultrasound and others) in food manufacturing.	
	4. The role of public R&D providers leads to support “open source” innovation, rather than closed innovation models preferred the by industry.	

Economic	<ol style="list-style-type: none"> 1. Supermarket power leads to lower margins for growers and manufacturers, thus leading to a decreased R&D budget. 2. Multinationals with in-house R&D dominate the food industry, but SMEs are often more innovative (i.e. higher tolerance to risk taking) 3. Escalating manufacturing and supply chain costs in Australia 4. Many multinational food companies are shifting their production to low-cost countries. 5. Pressure from competition with imported processed foods. 6. Australia's profile as an exporter of rural-based products continues. 7. Australia increased its food R&D expenditure from \$192m in 2000 to \$269m in 2005. 8. The sectors that increased R&D funding in 2000/05 were: sugar, confectionery, prepared animal and bird feed, seafood, beverage and malts and horticultural products. 9. R&D funding for the dairy industry has decreased in about \$2.5m per annum in the past 10 years. 10. During 2002/04, the horticulture segment had the largest representation amongst FIG Program recipients (28%), followed by ingredients (22%). 11. In Australia, logistics costs have been reported to be between 9.9% and 21.1%³⁵. 	<p>1a. Public R&D providers have not successfully engaged with supermarkets, partly due to a mismatch between R&D offered (e.g. new processes and products) and retailers needs (e.g. new forecasting tools, supply chain, category management).</p> <p>1b & 6. Public R&D organisations normally have a specialisation approach to problems, rather than a 'whole-of-the chain' perspective.</p> <p>2 & 7. See profit aspect in "Social– impact 5"</p> <p>2, 3, 4 & 5. Innovations such as cost reduction and efficiency in the food industry are not 'sexy' enough for R&D organisations, unless it is linked to new technologies. For example, the performance of CSIRO's divisions is assessed in terms of science impacts. Some R&D with efficiency drivers has negligible science impact but high industry impact.</p> <p>8, 9 & 10. Public R&D has strong capabilities in primary industries, but food R&D expenditure indicates that science capabilities need to be re-directed to confectionery, beverages, seafood, supply chain and other non-traditional areas.</p> <p>11. See food distribution aspect in "Social– impact 4" and 1b in this box. Supply chain management is not considered a research area in public R&D organisations.</p>
Ecological	<ol style="list-style-type: none"> 1. Managing production in an environment of unreliable climate, including managing the supply and cost of water, is a major challenge for Australia (DAFF, 2006). 2. The use of agricultural products (e.g. grains) for the creation of biodiesel is at odds with the use of grains for human and animal consumption. 3. R&D funding to CSIRO and DPI was increased to tackle sustainability/climate change issues. 	<p>1, 2. R&D organisations will need to acquire skills in the environmental area (through re-training or recruitment). A re-direction of funding also leads to decreased funding in R&D areas that are still important for the development of the food industry.</p>

³⁵ BTRE (October 2001) Logistics in Australia: A preliminary Analysis, Working Paper 49.

Political/ regulatory	<ol style="list-style-type: none"> 1. Disease-free livestock and plant industries remain critical to supply chain integrity. 2. Food safety and traceability regulations are increasing 3. Bioterrorism appears a new driver post-September 11, 2001. 4. New functional foods with health claims face regulatory hurdles, increasing the cost and time to commercialise new products/ingredients. 5. Pressure in R&D organisations to align better with the market development needs of suppliers and producers 	<p>1. Although there are public R&D organisations that focus into primary production issues, the perspective of a whole-of-the-chain food safety approach is lost.</p> <p>2 & 3. In CSIRO, there is a paucity of this type of work due to a rearrangement of budget funding priorities.</p> <p>4 & 5. Functional foods and ingredients are heavily funded, but basic market research and business plans are also necessary to prove that commercial exploitation is feasible. Public R&D tends to create new knowledge first and then explore possible paths for commercialisation. I suggest that innovation should start with a statement of a need, the business case and then R&D to seek for a solution.</p>
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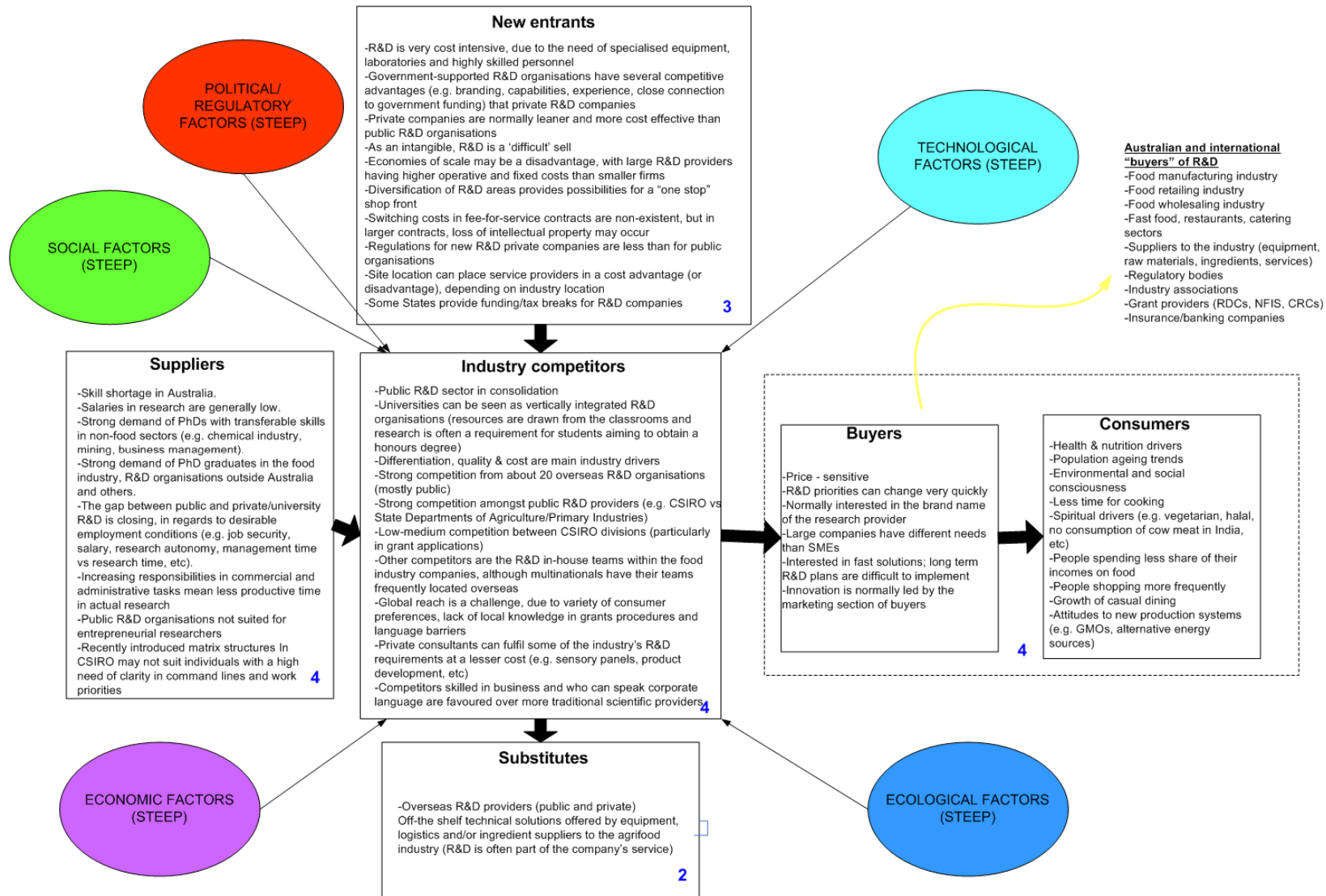


Figure A1. The Five Forces analysis for the public food R&D sector. The numbers in blue fonts indicate the strength of these influences (in a scale of 1 to 5; 1= weakest and 5= strongest)

APPENDIX 2.
List of CRCs supporting innovation in the food chain

- Agriculture and rural-based manufacturing
- Cotton Catchment Communities CRC
- Australian Sheep Industry CRC
- CRC for Beef Genetic Technologies
- CRC for Innovative Dairy Products
- Molecular Plant Breeding CRC
- CRC for Sustainable Aquaculture of Finfish
- CRC for Forestry
- CRC for National Plant Biosecurity
- CRC for Tropical Plant Protection
- CRC for Value Added Wheat
- CRC for Viticulture
- Australian Biosecurity CRC for Emerging Infectious Disease
- CRC for Australian Poultry Industries
- CRC for Innovative Grain Food Products
- CRC for Sugar Industry Innovation through Biotechnology
- CRC for an Internationally Competitive Pork Industry

APPENDIX 3. Innovation spheres of manufacturers and retailers

Most of the retail-led innovations in supermarkets have focused on improving supply chain aspects and ensuring that the shopping experience is enjoyable. This is hardly a surprise, as supermarkets are highly dependent on reliable and efficient supply chains that can deliver the products offered. Table 1 shows some of the global retail-led innovations in the past years.

TABLE 1. Retail-led innovations worldwide

Innovation	Outcome targeted
Air conditioning control	Comfort in supermarkets
Scanner systems	Efficient inventory
Bar codes	Traceability, supply chain management
Electronic cash register	Efficiency, shopping experience
Electronic data interchange	Paperless management of supply chain, reduced order lead time, fewer out-of-stock situations, lower inventory costs, reducing errors in ordering, shipping and receiving, reduction in labour costs, higher service levels
Category management	Vertical integration, matching of consumer's preferences by sellers offerings and growth of categories
Cross-docking	Cost efficiency in distribution
ECR	Efficiency gains in store assortment, promotion, new product introduction and replenishment, through constant flow of product and information between suppliers and retailers
CPFR	Coordination of supply-demand

Sources: Dappiran and Hogarth-Scott (2003);Keh (1998).

Innovations in the manufacturing side tend to gravitate towards new products, packaging and processes. Table 2 presents the most common types of manufacturing-led innovation initiatives.

TABLE 2. Types of manufacturer-led innovations

Innovation	Outcome targeted
New product development (NPD)	<ul style="list-style-type: none"> ▪ <i>'Me-too' products</i>: a product that replicates characteristics of existing successful products in the market, thus avoiding some NPD risks. The objective is to erode the market of a competitor ▪ <i>Line extensions</i>: variations of a well-known product (e.g. favours, colours, etc). The aim is to increase market share and improve product positioning with relatively little effort and development time, plus small changes in manufacturing processes, marketing strategy and storage and/or handling operations. ▪ <i>Repositioning of products</i>: changing the promotion strategy of current products in the market, to reposition these as products responding to current consumer's demands. The major efforts are, thus, in marketing. For example, repositioning of products as 'health' or functional products. The aim is to capitalize in niche markets. ▪ <i>New form/formulations for existing products</i>: these encompass products that have altered to another form (e.g. solved, dried, granulated, concentrated, spreadable, dried or frozen) or products that have been reformulated. For the former category, extensive R&D and development time may be required, plus changes in the supply chain operations. Formulation changes can have various impacts on the supply chain, according to the degree of variation in the product. The outcomes sought refer to: convenience, value addition, cost reduction, unreliable supply of some raw materials, or the availability of better/less costly ingredients. ▪ <i>Evolutionary innovative products</i>: substantial changes in an existing product, otherwise than described above. The changes must add

	<p>value/functionality in a significant manner to the original version. R&D times, costs and risks are generally larger than for other modifications. Marketing can also be costly.</p> <ul style="list-style-type: none"> ▪ <i>Radically innovative products:</i> a 'never seen before' product. These require extensive product development, have high R&D, marketing and capital (new equipment) costs and have the highest failure chance of all categories. Having said that, these products potentially offer greater rewards than others. The products can be potentially disruptive, but not all are.
New packaging development	Added functionality, better preservation of foods, variety in volumes/portions, more attractive designs for targeted consumer segments, labelling, convenience, retail-ready formats.
New processes	Cost reduction (e.g. less labour, energy efficient), OH&S compliance, reduction of environmental impact, requirement for manufacturing new product
New supply chains	Response to changes in client's (e.g. retail, foodservice, etc) business formats, supply chain initiatives, traceability (e.g. RFID).

Sources: Linnemann et al (2006);Keh (1998).

In Table 2, the items in blue fonts highlight the most common areas of collaboration between manufacturers and retailers. It is evident that innovation in transport and distribution has significant synergies between these two parties. Nevertheless, little collaborative approaches in this area take place currently.