HOUSE OF REPRESENTATIVES STANDING COMMITTEE ON PRIMARY INDUSTRIES AND REGIONAL SERVICES

Inquiry into Primary Producer Access to Gene Technology

CSIRO Submission

CSIRO spends about $50 M annually on gene technology research, predominantly in the areas of agriculture, aquaculture, forestry and natural resource management. The scale of our research investments reflects the view that the technology is of critical importance to Australia's future and must be underpinned by world class science. However, this should not be seen as an unfettered endorsement of gene technology per se; CSIRO's position on gene technology is set out in **Attachment 1**.

General Comments

CSIRO notes that the inquiry places particular emphasis on the capacity of small to medium primary producer enterprises to access the benefits of gene technology. It is equally important that these enterprises as well as the entire industry are capable of using the technology and managing the risks in a way that is economically, socially, environmentally and politically acceptable to all Australians.

Whilst the terms of reference appear to focus on production issues, the adoption of gene technology into Australian farming systems depends largely on off-farm considerations, such as the regulatory regime and consumer acceptance of food and fibre commodities produced by the use of gene technology. Given that Australia exports more than half of its agricultural production, the consumer issue is tied to the global marketing of agricultural commodities. Thus, if the current consumer sentiments seen in Europe, and in the UK in particular, are allowed to influence world trade of agricultural commodities, Australian producers may well be denied the benefits offered by the technology, at least in the immediate term.

CSIRO assumes that these issues are well known to the Inquiry but will make the point that without significant attention to the broader strategic issues and in particular urgent and decisive action on public awareness and regulation, the adoption of gene technologies into Australia will be delayed or, at worst, prevented. At the same time, there are strong indications that gene technology will be *the* technology of agribusiness in the future, and it is very much an issue of strategic positioning. The Standing Committee on Agriculture and Resource Management (SCARM), of which CSIRO is a member, has established a High Level Working Group on Gene Technology that is considering a broad set of these strategic policy issues on gene technology. CSIRO is aware that a report from the working group will be made available to the inquiry.

Furthermore, CSIRO notes that the terms of reference are phrased towards the use of new plant varieties; however, the same issues will apply to the production of novel or enhanced attributes in livestock. It is important to recognise that whilst the current emphasis on gene technology in Australia centres on plant products, there is a significant body of research being undertaken on livestock, in particular in breeding technology, mapping of useful traits and in the production of vaccines and other inputs using gene technology. Many discoveries made in human genetics will have direct applications in animal genetics and find their way into livestock production systems over time.

The future value and importance of genetically modified varieties

CSIRO recognises the significant importance that gene technology can play in crop, pasture and livestock improvements as well as offering the potential for significant environmental benefits. There are substantial production benefits to be obtained from gene technology; these are reflected in the commercial uptake of new plant varieties. It is remarkable that after a few years since their introduction, the area, worldwide, sown to transgenic crops in 1998 exceeded the total area of land cropped in Australia. Some further statistical information has been summarised by the International Service for the Acquisition of Agri-biotech Applications (refer http://www.isaaa.org/frbrief8.htm). Hence it is not cited here except noting that for 1996 and 1997, transgenic crops in the USA and Canada alone resulted in economic benefit to producers in excess of US$500 million.

Most genetically manipulated organisms (GMOs) in use to date are ones with agronomic advantages for crop plants (herbicide tolerance, pest and pathogen resistance). There are already domestic and international indications of environmental benefits from less pesticide use (as in the case of Bt cotton) and replacement of rather potent herbicides with more benign herbicides for herbicide tolerant crops; but there is also a need to manage the entire cropping systems better to maximise the value and sustainability of the technology.

However, the genetically modified crops in current commercial use are only the very beginning. There is substantial potential for quality enhancement of produce traits of produce, the 'Flavrsavr' tomato and silencing of browning genes in potatoes and other crops are only some examples of what has been achieved so far. Biocontrol of pests, weeds and diseases has been the subject of significant CSIRO research over the last 30 years with impressive results. Gene technology offers the potential to enhance the efficacy of biocontrol organisms as well as the potential to manipulate traits such as enhanced production of specific biocontrol compounds genetically. CSIRO also pursues genetic modification of microorganisms to bioremediate environmental hazards by enhanced degradation of organic contaminants in soils such as petrochemicals and pesticides. There are a number of other potential environmental benefits such as feral animal control (including fish such as European carp) as well as restoration of landscapes and endangered species.

Other current and expected examples include novel food products with enhanced flavour, nutritive value ("nutra-ceuticals") or other health attributes (eg. vaccines delivered in fruit and vegetables), production of industrial chemicals from modified starch, oils and fats as well as production of special (eg pharmaceutically significant) proteins in milk through transgenic animals. The commercial uptake of such technologies will be slow, but illustrates the further potential of gene technology in primary production.

The ability for producers to compete using traditionally available varieties

Given the investment in and rate of adoption of gene technology into current breeding programs as well as the persuasiveness of the benefits, it is unlikely that in the longer term traditionally available varieties will be competitive in terms of quality, quantity and price of the final produce compared with new genetically modified varieties. For instance, the

Australian aquaculture industry is competing in overseas niche markets against other countries developing transgenic technologies.

At present, it would appear that there may be market opportunities in supplying Japan and Europe with produce from a range of different industry sectors free of GMOs. If this is the case, noting that market signals are uncertain, the size and duration of these markets will depend on public rejection of GMO produce. This may subside once confidence in the regulatory systems in Europe is restored and a more rational approach to the technology develops.

There are niche markets for organic produce. In similar fashion, there may well be niche markets for agricultural products produced without the use of GMOs. Indeed, existing definitions of "organic produce" cover the role of GMOs in production, suggesting that the two niches could be tied together or considered as similar. This is unfortunate as it establishes a divide by which the marketing of GMO-free produce may be subsumed under the organic movement, leaving no differentiated market for non-GMO commodities produced by conventional agriculture. It would be important to establish credible and auditable certification systems for most if not all GMO-free produce to ensure truth in labelling. It would also be important for industry to ensure consumers are not confused between what is organic and what is GMO-free. (Recent changes in policy by UK retailers, towards rejection of GMO products, show what a problem this is.)

It should be noted, however, that over time it will become harder and harder for producers not to use GMO material at some point in the production chain. Many vaccines and other products are produced by gene technology, and as use of these become widespread, they will be difficult to avoid. For example, if it were a requirement that all poultry required immunisation against a particular virus and the most effective vaccine was a gene technology-derived vaccine, most poultry would then be produced by a GMO-influenced route. In fact, as GMO technology improves, it will result in a decreased use of agricultural chemicals relative to current production, and therefore might be expected to suit organic producers. The philosophical issues aside, it may well be economically feasible to produce cotton without any pesticide sprays by using Bt or any other gene technology as well as substituting fertilisers with manure; would this then constitute organic cotton given that application of Bt toxin is allowed in organic production?

If pest and pathogen-resistant lines of animals and plants are produced by genetic modification, and consequently, current control chemicals and drugs are withdrawn then there may be no technological alternative to GM-resistant lines.

The commercialisation and marketing of agricultural and livestock production varieties

This is a very complex area requiring a multitude of solutions. As part of a study in 1997 for the Supermarket to Asia Council, CSIRO summarised its experiences in a paper for the Council (refer **Attachment 2**); most of the issues raised are still relevant today. Furthermore, reference has already been made to ensure consumer confidence so that there is a market for GMO produce in the first place. However, one of the most critical issues at present concerns regulation to provide certainty to commercialise new inventions.

At present, the lack of a clear regulatory framework is an impediment to adoption of new crop and livestock varieties bred using gene technology. The breeding of a new cotton variety with an inserted Bt gene coding for a known pesticide ultimately came under the control of the National Registration Authority for Agricultural and Veterinary Chemicals (NRA). At the time it caused some degree of uncertainty and costs to meet newly developed NRA regulatory requirements but nevertheless provided a pathway by which the entire new cropping system could be introduced, monitored and managed in the field. However, similar arrangements are not in place at present for introducing new genes to confer resistance to plant diseases such as rust, nematodes, scald, etc or indeed when breeding herbicide tolerant crops.

In this area, regulatory certainty is a critical prerequisite and is being adequately and appropriately addressed by the current proposal for a new system to be managed by the Office of the Gene Technology Regulator as announced in the recent Commonwealth Budget. In particular, the Office will provide for the regulation of products not covered by existing systems, which would be predominantly agricultural and environmental applications. Given the proposed location of the Office in the Health portfolio, it would be important to ensure interests of the primary industries are well understood by the regulators and are incorporated into the new system.

Because of the pyramidal breeding structure of most extensive livestock industries, and the vertical integration of the intensive industries, commercialisation and marketing of genetic improvements, once these are covered by a satisfactory regulatory mechanism, should be relatively straightforward assuming that issues like animal welfare, ethics etc are appropriately dealt with. Producers of genetically enhanced livestock, whether at the research and development stage ie research providers including CSIRO, or at the commercial stage ie enterprises that can be expected to come into existence once regulation is clear, will licence the genetically enhanced animals to major breeders, who will spread them out to commercial producers and multipliers.

The cost to producers of new varieties

The cost of adopting new varieties will be market driven and should be seen in the context of the relevant production system, not just the direct costs of licensing or getting access to seed stock; especially where there may be savings or offsets on the input side.

Where technology is owned overseas, it may be very expensive to licence for Australian producers, especially where they are working with species, such as Merino sheep, that are perceived to be peripheral to the major world livestock breeds. Where the genetic enhancement is done in Australia, market forces will prevail, an argument for supporting R&D in the technology in Australia. The opportunity to exact unusually high profits will be extremely limited, given the competitive nature of all commodities.

However, where there are substantial economic benefits to producers from adopting gene technology through delivering competitively priced commodities, it would be expected by consumers that savings are passed on as cheaper produce, thus delivering tangible consumer benefits from the technology. This would further enhance the uptake and acceptance of gene technology in primary production.

Finally, it should be noted that individual producers at farm level are unable to carry out their own research and development due to the cost and complexity. Instead, cooperatives and larger producer companies fund on CSIRO and other research agencies to deliver new products and genetically modified organisms into their production systems.

Other impediments to the utilisation of new varieties by small producers

Reference has already been made to market forces, including the effect of consumer acceptance and the need for regulatory certainty. The outcome of the current food labelling debate is a case in point and the decision reached by ANZFA on labelling will impact significantly upstream on food producer industries.

As a consequence of the labelling decisions, market segregation of GMO and GMO-free produce may be necessary, at least in the immediate term. This raises the issue of who should pay the additional costs of introducing a segregation system, the GMO producers only, all producers or those producing GMO-free produce?

Livestock traceback systems have had a long history in Australia for disease and residue testing and have with considerable difficulty been used to segregate livestock from particular production systems, (eg those not treated with hormonal growth promotants destined for the European beef market); however, similar systems for bulk plant-based commodities such as sugar and grain cannot be introduced without significant capital expenditures, nor in some cases are they readily traceable and enforceable.

Another concern relates to dealing with large multinational corporations as owners and controllers of valuable intellectual property. Small agricultural producers can be limited by lack of expertise or knowledge of what is available, lack of experience with the technology and by lack of access to finance than by other factors. In the case of cotton, the producer-owned Cotton Seed Distributors went through a significant educational process, assisted by CSIRO, to position itself to take advantage of what gene technology offers for the cotton industry, both here and overseas.

Finally, there will be an issue about flow-on to the genetic improvement of minor crops and livestock. In the case of minor crops, we may have to develop our own technologies through licensing arrangements for those crops that may not attract attention by the multinationals. That could mean the majority of crops; hence it is important to maintain our own germplasm and research capacity and capability to insert critical genes into varieties of importance to Australian agriculture. The traditional structure of livestock improvement in Australia, that is purchase of improved sires or semen, will simply limit small producers by virtue of their financial capacity. It may be that there will be increased restrictions on sale of semen or sale of progeny, but in general, the structure of our livestock industry will preclude the introduction of elaborate, restrictive mechanisms.

Assistance to small producers to develop new varieties and the protection of the rights of independent breeders, in relations to GMOs

This is part of a larger question of the terms by which primary producers will have access to the technology, the management of intellectual property rights when commercialising new varieties as well as attracting the necessary capital to bring GMOs to market. In general, CSIRO has found that can often be necessary to enter into a strategic alliance with multinational corporations, either to get access to the desired gene or some enabling technology such as gene markers. The cost of commercial development is often significantly larger than just the research itself and small producers may not have sufficient capacity and financial resources to compete effectively.

The protection of CSIRO's rights in dealing with multinationals often becomes complicated and depends largely on the bargaining position we may have in any given situation. We often find the best solution is to enter into strategic alliances of various sorts (examples are at **Attachment 3**). CSIRO considers that the most effective and specific assistance to small producers and independent breeders would be educational in the form of sharing knowledge about how to position Australia and manage these relationships.

The appropriateness of current variety protection rights, administrative arrangements and legislation, in relation to genetically modified organisms

The Plant Industries Committee under SCARM is currently reviewing the appropriateness of the *Plant Breeder's Rights Act 1994* through a taskforce chaired by Dr John Blackstock, Victorian Department of Natural Resources and Environment. CSIRO has made a number of submissions to that inquiry. It would be important to retain, or perhaps even improve if warranted, the integrity of the current framework and not treat GMOs differently or suggest that special arrangements should be in place. Hence, CSIRO submits that it would be appropriate to await the outcome of that inquiry before considering if other administrative arrangements for GMO may be necessary.

In terms of legislation for GMOs, CSIRO strongly supports the creation of a statutory office or, preferably, a statutory authority to regulate gene technology and its application. We believe there is a strong case for implementing and monitoring post-release management plans as currently proposed as part of the regulatory model and we are conducting significant research on the management of resistance against Bt toxins in cotton.

Opportunities to educate the community of the benefits of gene technology

There is overwhelming evidence about the importance of community understanding and awareness of what is gene technology. The current information level, (which includes a significant level of misinformation) in the public domain does not match the need, and for some time there has been an urgent call on governments for action. CSIRO watches with interest the situation in Europe where the debate at times appears fairly fact free. The Commonwealth Government's recent initiative to establish Biotechnology Australia should address that need as a matter of priority and urgency. CSIRO has offered its assistance to deliver public awareness activities.

However, the issue is more about evaluating and managing risks and informing the community about how safety, both in terms of public and environmental health, is assured as well as education about the benefits. Furthermore, it is critical to involve all stakeholders and engage into an informed and public debate seeking to resolve issues rather than just creating conflict and polarisation. This must involve industry, governments, specific interest groups and the community at large.

Specifically, the current attention of the public debate appears to focus on human health issues. Whilst such vigorous debate is healthy for Australia, we should not overlook the need to ensure that environmental, social and ethical concerns are addressed to enable all sectors of the community to make informed choices wherever possible. Science can and should continue to offer insights and solutions, in particular in the environmental area, to ensure regulatory approvals are made on the basis on the best contemporary knowledge.

There are still many unanswered questions about ecological impacts of current GMO technologies, an example being the impact of Bt cotton trash on soil micro organisms. These questions need to be addressed to assuage possible community concerns. A case in point was the laboratory finding of mortality of Monarch butterfly larvae being fed pollen of Bt corn, reported in *Nature* in May. This lead to an outcry from environmentalist making a leap-of-faith extrapolation to ecosystem impacts alleging that the butterfly was in danger of extermination. This was not what the science showed, only that the toxin is expressed in the pollen and could potentially pose a problem if deposited onto the larvae's normal diet of milkweed leaves. The point is that Australia needs to have the capacity to answer these questions when they emerge and build this capacity into the normal risk assessment processes prior to release. Any change of technology includes taking risks, and it is important that the community has faith in the regulators who are responsible for evaluating such risks.

CSIRO's policy is to engage actively in public discussion of GMOs. CSIRO will continue to work with the community to the extent that resources permit. CSIRO was, for example, a sponsor and participant in the recent Consensus Conference on GMOs, and CSIRO offers training and educational activities in gene technology through our Education Program.

ATTACHMENT 1

CSIRO POSITION ON GENE TECHNOLOGY

CSIRO believes there is a window of great opportunity for Australia, its community and industries, based on research in gene technologies. It gives us the potential to improve our health, create a safer and more secure food supply, generate greater prosperity and attain a more sustainable environment. Our position on this issue is:

1. CSIRO is committed to playing a valuable, careful and ethical role in Australian and international efforts to develop beneficial new products and processes from gene technology.

2. CSIRO will help to provide a clean, safe food supply, novel materials and products and a sustainable environment for all Australians through the use of appropriate biotechnology including gene technologies.

3. CSIRO recognises and respects public interest and concern on issues surrounding genetically modified organisms. We will consult with the community, listen to and recognise its concerns, and help to inform Australians about gene technology.

4. CSIRO will help Australia and its industries to be world competitive in biotechnology and gene technology. We will commercialise our activities in the most effective way and promote the growth of local biotechnology companies as appropriate. We will continue to conduct world class research and train our scientists to the highest standards.

5. CSIRO complies with all guidelines laid down by Government for the conduct of gene technology research. CSIRO recognises the issue of gene technology regulation is under active policy consideration by Federal and State Governments, and will comply with all new laws, regulations and requirements they determine.

6. CSIRO will address risks as well as benefits in its own gene technology research. To minimise risks nationally, CSIRO supports a national capability for environmental risk assessment and will participate as appropriate in establishing this capability.

7. CSIRO supports the stimulation of innovation through the protection of intellectual property rights in original gene technologies.

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ATTACHMENT 2

CSIRO'S EXPERIENCE IN COMMERCIALIZING BIOTECHNOLOGY IN AGRIBUSINESS

(paper prepared in 1997 by Dr Chris Mallett, Deputy Chief Executive, for a working party on biotechnology under the Supermarket to Asia Council)

EXECUTIVE SUMMARY

Introduction

After our last meeting of the working party, I was asked to prepare a paper outlining our experience of commercializing biotechnology in agribusiness. The paper is attached, and, because of the complexity in this area, is thorough but large; I list below our major conclusions. Because of the nature of the paper, it either does not cover, or covers only in passing, the following issues:

- New applications such as functional foods (eg vitamin enhanced fruit) and bioremediation;
- Regulation and public safety implications;
- Consumer acceptance, especially important for animal gene biotechnology;
- The wider implications of a biotechnology-driven change in global agribusiness where the terms of trade are controlled more by multinational companies rather than local farmers as the culture changes from a production-based commodity culture to a global end-user demand-driven differentiation;
- The similarities in commercialization with other sectors with strong intellectual property protection such as pharmaceuticals, specialty chemicals and software.

Conclusions

- Under the Science and Industry Act, CSIRO works for the benefit of Australia;
- CSIRO's commercialization activities are governed by its *Commercial Practice Manual* which sets out guidelines on how that benefit should be achieved;
- Biotechnology activity is global, and requires very large sustained investment for success, and consequently has a number of large multinational players linking intellectual property from many sources;
- Within CSIRO, several strategies have been adopted to ensure successful market adoption, based on cooperating with relevant parties to incorporate Australian-owned IP into a complete, commercializable package, while returning benefit to Australia;

- **The conclusion from the case studies over the last decade is that there is no single route to success. Rather, each strategy is dependent on the intellectual property, the product, the crop, the market and the companies in that market, and should be incorporated at the outset into project planning.**

PREAMBLE

Australian agribusiness is dependent on export and international trade in plant and animal-based commodities and foods. Australia cannot afford to be marginalized from new biotechnologies and so relegated to a dependent player if it is to maintain its international competitiveness. Thus CSIRO has long been active in biotechnological research that will help indigenous industry enhance the quality, yield and profitability of their produce be they plants (cotton, soyabeans, maize, potatoes, tomatoes, peas) or animals (prawns, beef cattle, sheep).

This paper describes CSIRO's experience and approach to commercialization in the agribusiness and related industries of intellectual property generated through research in biotechnology. It explains why we invest in this research, how the global environment disciplines our commercialization, gives some case studies, and concludes with some comments on different market models.

SCIENCE AND INDUSTRY RESEARCH ACT (THE CSIRO ACT) 1949

CSIRO's raison d'etre and its operations are governed by the *Science and Industry Research Act of 1949* (amended in 1986) , particularly Section 9(1) which describes our primary functions as:

> *(a) to carry out scientific research for any of the following purposes:*
>
> > *(i) assisting Australian industry;*
> > *(ii) furthering the interests of the Australian community;*
> > *(iii) contributing to the achievement of Australian national objectives or the performance of national and international responsibilities of the Commonwealth;*
> > (iv) *plus any other purpose determined by the Minister*
>
> *(b) to encourage or facilitate the application or utilization of the results of such research.*

It is important to emphasize that CSIRO exists not to make profit for itself but to create wealth for the nation and that nowhere in the Act is there a requirement for CSIRO to earn money from its research, other than a Federal Government requirement of raising 30% of our revenue externally.

In conformance with the requirement to "*encourage or facilitate the application or utilisation of the results of such research*", we have to maximise the likelihood of technology uptake. Our experience to date (see below) is that success is determined largely by working with companies with the appropriate capabilities and track record, be they local ones, large or small, or multinational corporations.

INNOVATION AND COMMERCIALIZATION IN CSIRO

Since 1994, CSIRO's commercialisation activities have been governed by our *Commercial Practice Manual*, whose currency is overseen by our Commercial Committee chaired by a Deputy Chief Executive. There are policies that cover all aspects of the commercialization process, including staff training, contracts and contract management, intellectual property, costing and pricing, technology transfer, confidentiality and performance measures.

It is mandatory that all Divisions of CSIRO treat their intellectual property portfolio in accordance with CSIRO's *Commercial Practice Manual*. It is worth making the point that CSIRO's treatment of genetic technologies is no different from the way in which it attempts to commercialize its other intellectual property.

Innovation and the Context of Technology

> *In business, innovation is something that is new or improved done by an enterprise to create significantly added value either directly for the enterprise or indirectly for its customers (**Managing the innovating enterprise, Business Council of Australia, 1993)***

Thus, the generation of new knowledge *per se* will not necessarily lead to commercially successful products and processes, and innovation that relies on "technology push" is less reliable and less predictable than innovation that relies on "market pull" as very few innovations that are driven by technology are systemic.

The Need for Customer Partnerships in Successful Commercialization

One of our underpinning principles of successful commercialization, derived from our years of experience in all the industries where we are active, is that we work with the customer for our research at the outset and try to incorporate our R&D into their business strategy, rather than finalize the research in isolation and then try and find a buyer for it. Acceptance of this principle means that projects are often funded, at least in part, by the eventual customer, even at early strategic stages.

The reason we apply this principle in commercialization is the need to consider complementary assets of commercialization partners. The innovations arising from CSIRO are usually technical knowledge about how to do things better than the existing state-of-the-art. In order for something new to deliver value to the consumer, it must be sold or used in the market in conjunction with other systems or assets complementary to the technical knowledge. These complementarities include both product aspects (for instance, new genes need to be incorporated into seeds farmers can buy) and supply chain features (such as compatibility with customer's manufacturing, marketing and distribution facilities). Thus, within this context, CSIRO's *modus operandi* does not and should not extend to determining the marketing strategies for products containing CSIRO technology. Whilst most companies that deal with CSIRO are happy to share, for example, a business plan or a marketing strategy for a product that contains CSIRO technology, they are not prepared to share information on their whole portfolio relevant to that market segment.

Equally, they will never allow us to determine the price structure for the technology in various territories as this is essentially a business decision independent of technology.

However, in negotiating commercial arrangements with such companies, it is practical to ensure that owing to the input of Australian technology, the products or outcomes are available here at least as favourably, and preferably more favourably, than in other countries.

THE GLOBAL ENVIRONMENT

"*The ability to clone genes, to put them into plant cells and to regenerate plants from these cells has brought technology to a stage where all our major food groups are being genetically engineered for traits such as pest resistance and particular commercial qualities".*
"Major investment, particularly on behalf of chemical companies, is being made to develop and improve biotechnology applications for crop plants. Areas that are under development include genetically modified crops with in-built disease resistance and to the creation of plants that exhibit particular traits i.e. tomatoes with a high solids content. Engineered fresh tomatoes are on sale on the US and tomato paste from engineered tomatoes is on sale in the UK".

(Reference "Developing Long-term Strategies for Science and Technology in Australia, October, 1996".)

<u>The Development Cycle of the Industry</u>

From a commercial standpoint, the application of biotechnology is in its infancy. Genetically engineered products will go through evolutionary development based on new and enhanced technologies. The technology base is at the Model T Ford stage. There is a long way to go to producing a Ferrari.

Technology: The Catalyst for Revolutionary Change in Agriculture, Sano M. Shimoda, Bioscience Securities Inc., 1997.

Biotechnology, and in particular gene technologies, have made major contributions to plant science in the last decade and the advances are now beginning to reach into commercial agriculture. Transgenic crops are being grown in the United

States (1995, first crops) and Australia (1996, first crop). There will be a rapidly increasing number of commercial transgenics and they will be grown widely throughout the world. At present in some countries, for example in Europe, there is still public antagonism being voiced which has extended the discussion about the entry of transgenic crops into field production. However, these countries are already accepting the harvested commodities and processed food products derived from transgenic crops. This is true, too, of Japan.

We can expect that regulations and legislation will be in place such that transgenic produce will be a regular component of international trade. There may be a period when regulations pertaining to transgenics will be used as artificial trade barriers in some countries but this is likely to be transient.

The incursion of transgenic plants into commercial agricultural practice will be accepted because the technology offers, along with conventional plant breeding, higher quality products with greater efficiencies in production. Many of the quality traits that will be adjusted by gene technology will be of considerable significance for human health and will increase the market opportunities for plant-based agriculture. Expectations, too, are that there will be significant yield increases because the new technologies are enabling scientists to break through existing yield barriers and at the same time are providing the opportunities for sustainable agricultural practice. For example, the “insect-proof” cotton (Bt-cotton) now being grown in Australia offers, for the first time, a key component technology for extensive integrated pest management; its positive environmental features are already being appreciated by the public of Australia.

Crop yield increases, along with greater surety of supply, will be of consequence to the great demand for food production over the next several decades. World population growth is such that the present food supply will have to double by 2030. Gene technologies, with their simple delivery package where the genetic code for improved traits is built into the embryonic cells of the seed, will enable subsistence agriculture in developing countries to profit in time, as well as the extensive agriculture of developed countries.

The principal focus of this paper is on plant-based biotechnology; because of worldwide community concerns about biotechnology and animal welfare, exemplified by Dolly the cloned sheep, animal gene technology has been slow to develop. Once these concerns are allayed, and an appropriate regulatory regime is in place, this status could change. Those companies with the appropriate asset base, expertise to understand and use the technology, and capital to acquire it could rapidly disseminate gene technology, especially if vertical integration occurs.

The Role of Multinationals

Large multinational companies, previously based in the agrichemicals business, have increasingly oriented their business systems to gene technologies through internally restructuring to consolidate these high-risk – high-return activities into a single business unit. They have also made strategic mergers, particularly in the last 12-18 months; for example AgrEvo is a merger of Hoechst and Schering, and

Novartis is a merger of Ciba-Geigy and Sandoz. Probably the largest player at the moment is Monsanto. These multinationals are not only acquiring specialist gene technology companies that have been successful over the past decade, but also seed companies. They have changed their strategy from being technology purveyors to developing a vertically integrated system, where they can maximise their profits from gene technologies through the direct sale of seed to large-scale agriculture at a global level. It is possible that in the future their vertical changes will continue to cover major food processing companies or even extend to marketing fresh produce but as yet this has not happened to any significant degree.

There is a second run of quite powerful players, such as Zeneca, Rhone-Poulenc and Du Pont. Du Pont is likely to form a close operating alliance with Pioneer, one of the major seed companies of the world. Rhone-Poulenc is forming alliances with Groupe Limagrain, the fourth largest seed company, and another important alliance is Dow Elanco and Mycogen.

These relatively few players, through their intellectual property holdings and their vertical paths into agricultural production, are becoming increasingly important in international markets and they are beginning to influence the Australian scene. The initial focus of these companies has been the major crops - maize, cotton, soybean, canola - and in their second array, they are now setting up their business systems in potatoes, wheat, rice and barley.

Impact on Australia

The strength of the large multinational companies in plant gene technologies is beginning to affect Australian agriculture. Outside the USA, Australia is the first country to commit to large-scale commercial planting of transgenic crops and this trend is expected to accelerate rapidly. However, it is the intellectual property holdings of these companies that are beginning to limit the operation of the Australian research providers for Australian agriculture. Because these companies were early, large investors in plant gene technology research they were able, in many instances, to gain powerful intellectual property positions in some of the key enabling technologies. In other cases they have acquired those key enabling technologies from public research institutions or small companies through licensing and acquisition. The consequence, now becoming evident, is that in many cases, these large companies are not willing to grant licences for their enabling technologies. In some cases this is because of litigation concerns, particularly in crops that may be small on a world scale but still of considerable consequence to Australia, and in other cases because they are still in the process of building their global business system strategies. Apart from the delay, it is unlikely that Australia will be able to feature as a significant player in most of these crops unless we invest in research programs that target complementary or competitive traits.

Australian plant gene technology research is of high international standard and in some areas leads the field. Even though over the past few years the leading Australian laboratories have become aware of the need to protect the outcomes of their research and have been enhancing their expertise in the protection, registration and acquisition of intellectual property, there are two factors of overriding importance. Firstly, although we have excellent plant gene technology research, we are only 2% of the world scientific activity and there are a number of other laboratories around the world of equal excellence. We have good international research linkages and this is still a strength to Australia. Nevertheless, we have to be aware that there are a lot of discoveries being made elsewhere that are becoming protected by intellectual property tools with regard to their availability for commercial agriculture, even though we still have ready access at the research level.

The other factor of importance is that the public research institutions in Australia, although skilled in research and increasingly in the protection of the research results, are not resourced to the level needed for the management and protection of intellectual property on a world scale. In our own experience, in the Gene Shears company, the association of CSIRO with Johnson & Johnson, a major international pharmaceutical company, and to a lesser extent with Groupe Limagrain, a significant seed company, has been absolutely critical for the management of the intellectual property portfolio, without which Gene Shears would have no future.

The participation of a major, experienced company like Johnson & Johnson provides direct expertise and advice but also, by virtue of its size and global positioning, protects Gene Shears from some intellectual property attacks.

THE ISSUES AND CASE STUDIES

The major issue is, bearing in mind the current development cycle and market dominance of exclusively foreign-owned multinational companies, how best can Australia capitalize on its publicly funded biotechnology ?

Before answering this question from the CSIRO perspective, it is instructive to look at our experience in commercialising biotechnology, which has been mixed and can be categorised in the following ways:

1. No Customer - slow commercialization
2. No regulatory regime or consumer acceptance – no commercialization
3. Early days - uncertainty with little benefit to Australia
4. Scientific excellence and effective networks – substantial benefit to Australia

Examples of case studies relevant to each of the above categories are given below.

1. No Customer - Slow Commercialization

Case Study – CSIRO Prawn Project

Within four generations we've got 20-25% improved growth simply by selecting on external characteristics alone……CSIRO is trying to……free itself from vagaries of

public funding cuts. This research has already happened so the intellectual property is owned wholly by CSIRO.
Interview with Dr. Nigel Preston, CSIRO Division of Fisheries; "Superprawns Challenge Aussie Curse", Simon Grose, THE CANBERRA TIMES, Saturday January 11, 1997.

Although not a gene technology, our experience with improved prawn breeding is instructive. For many years the CSIRO Division of Marine Research has worked on the selective breeding of Kuruma prawns (*Pinaeus japonicus*) at the Brisbane Laboratories. This research was fully funded by CSIRO.

The collective know-how of the research team developed 20-25% improved growth by selecting on external characteristics alone i.e. by choosing the biggest prawns as parents.

The researchers became frustrated in their attempts to attract investors and for a period of time there was danger that the technology would be licensed to an overseas company, so threatening Australia's competitive edge in prawn farming. The CSIRO researchers were faced with all the ingredients of the old Australian paradigm:

- The need for a quality primary product
- The need for the best technology in the world
- Small companies who want the technology but don't have the resources or incentives to support the introduction of the technology for the market
- Large companies, conservative by nature, uninterested in taking risks in a new area
- Public funding sources whose conditions on grants are difficult to satisfy.

CSIRO attempted to exploit this technology through the establishment of a consortium; however, this route failed because the potential members could not come to a mutually acceptable agreed position. This case study is an example of CSIRO adopting a technology-push approach without first investigating the potential acceptance of the technology in the market place.

The Lesson: having a suitable customer (with finance and appropriate capabilities) working with the research team at the outset of a project greatly increases the likelihood of successful commercialization.

2. No Regulatory Regime or Consumer Acceptance – No Commercialization

Case Study – Bresagen/Bunge

This pig costs $12M and as yet we are not permitted to bring it to the market.
Reference: Interview with Dr. John Smeaton, published in DER SPIEGEL, May 12, 1997.

Despite posing no risk to human health, Bresagen has been unable to sell surplus transgenic animals for human consumption because of a lack of Government policies in this area.
Flight Regulations for Pigs: Dr. John Smeaton, paper presented at the LES ANZ Annual Conference – Perth, 1997

Bresagen produced a line of commercially viable pigs with enhanced growth hormone production with the advantage that the pigs grew faster for a given amount of food, putting on more muscle and less fat. Because there was no regulatory agency prepared to approve the use of these animals for human consumption and declare the technology safe, Bunge has slaughtered all the pigs and the germplasm is in existence as semen (and perhaps ova) stored in liquid nitrogen. It is highly likely that this technology will go overseas. It is not the inability of the Australian company that produced the pigs to commercialise them but the lack of a regulatory pathway that has caused the problem.

The Lesson: Without public and regulatory acceptance, the commercialization of excellent technology will fail.

3. Early Days and Uncertainty

Case Study – Calgene's FlavrSavr

In the early 1980's, recognizing the importance of tomatoes as a high-value, major volume crop, CSIRO began research on what vegetable markets had identified as the key challenge – why do ripe tomatoes soften when they ripen and so become difficult to transport. The work at North Ryde identified and partially sequenced the enzyme polygalacturanase (PG), which softens cell walls once the fruit is ripe.

At the time, in 1983, owing to the lack of a commercialization partner in an unstructured industry, and the call on resources required to go further, the work was stopped and the intellectual property sold for $20, 000 to the new start-up company, Calgene, in one of the earliest transactions of its kind in the world. After tens of millions of dollars expenditure on research (to "switch-off" PG) and regulatory clearance, Calgene brought the product successfully to the USA market. However, consumers soon found that the flavour difference between FlavrSavr and "ordinary" tomatoes was not significant and did not warrant the price premium associated with FlavrSavr. The growers found that their increased costs (associated with licensing fees) were not offset by better yield (yield was less than "ordinary" tomatoes) and better sale prices.

On the other hand, in a competing technology, Zeneca's genetically modified tomato (with high solids and therefore "bulkier") was found to be cost effective and is enjoying very good sales in the UK for processed products such as tomato paste, principally because of the marketing efforts of the major retailer selling it.

Later Tomato Work

There is, however, a strong follow-up to our early experience. 1992-93 studies on alcohol dehydrogenase levels in tomatoes as they matured led to the hypothesis that an increase in alcohol dehydrogenase activity early in the ripening period of a tomato may substantially improve the flavour in fresh tomatoes such that they could still be transported while firm and yet have flavour when they reach the consumer. This idea was discussed with Zeneca who were in the process of taking commercial tomato products to market. As a result a joint project was mounted between Zeneca, the Horticulture R&D Corporation and CSIRO to take this idea to proof of concept. The project is partly completed and so far has been successful. Contract conditions, as well as obtaining direct research funding from Zeneca, also call for Zeneca to maintain the cost of Intellectual Property protection for this idea, and in return they have the first right to negotiate the commercial outcome with CSIRO should the project be successful.

Transformation of tomatoes was carried out by a CSIRO employee in the Zeneca laboratories at Jealott's Hill in the UK. The material was then returned to Australia for further analysis, and thus far experiments have been successful with double blind taste-tests showing that the chosen tomatoes do have improved flavour. The current experiments plan to use English and Australian tomato lines to confirm this proof of concept. Zeneca has already taken transgenic tomato products to market successfully and has the resources available in terms of enabling technology and market experience to take this product to market if proof of concept proves successful.

The strategy in this project has been to form an alliance between CSIRO and an international company with proven capacity to get material directly to market.

The Lesson: In most cases, Australia alone does not have the resources or market access, or often the total required intellectual property, to take successful discoveries in biotechnology to the global markets these products can command and need to recoup investment in R&D.

4. Scientific Excellence and Effective Networks - Substantial Benefit to Australia

There is an opportunity for Australia now to gain effective entry into the global agribusiness systems, with protection and advantage to Australian agriculture. Although licensing is becoming less common, the companies are interested in acquisition of new intellectual property, which could be of advantage to them in our effective linkages of research into agricultural practice. The multinationals recognise that this country has some of the most effective plant gene technology research teams in the world and that these are likely to be of consequence in the development of their own business systems. They are willing, in most cases, to consider trades with some of their intellectual property.

Importantly, since the companies have gone into vertically integrated systems, Australian public researchers can sometimes extend their bargaining chips from intellectual property to germplasm. Where Australia has something of great value in either or both of these categories, there is an opportunity for it to be used as a catalyst for the generation of a strategic alliance between a major multinational, an Australian public research institution and, where possible, an Australian company or companies.

Conditions for Alliance Formation

We are likely to be able to forge these alliances because of our excellence and achievement in plant science research and our effective linkages of research into agricultural practice.

In forming these strategic alliances it will be very important to define the perimeters of the alliance carefully because an Australian public research institution needs to be able to form alliances with more than one of the multinationals for maximum benefit to Australia. This flexibility is indeed possible and the multinationals are quite comfortable with this policy provided the perimeters are drawn respecting crops and territories.

Case Study – Cotton

CSIRO's Division of Plant Industry has built up an international recognition for its excellence in cotton breeding. Since the release of its first varieties in 1984 when 100% of cotton seed planted in Australia was of the American Deltapine varieties, now CSIRO varieties are 94% of cotton seed planted and are out-performing the Deltapine varieties.

The cotton industry, through the Cotton R & D Corporation, gives strong support to the breeding programs and there is effective transfer and adoption of new varieties through the licensing arrangement between CSIRO and Cotton Seed Distributors, a non profit industry-based company set up to provide high quality planting seed to cotton farmers. All cotton farmers in Australia buy 100% of their planting seed each year.

In the licensing agreement with CSD, CSIRO retains full ownership of the germplasm, which is protected under Plant Breeders' Rights. CSD has been granted exclusive licence for our varieties for production and marketing of seed worldwide; it has the right to sub license only with our agreement. A royalty is paid back to CSIRO based on a percentage of the selling price and this royalty is shared on a proportional equity basis with the Cotton R&D Corporation. The relationship between CSD and CSIRO is excellent with very good communication and interaction; it is based on mutual trust built on high performance by both parties. CSD, in addition to the revenues provided to CSIRO through the sale of seed, make substantial investments in support of the long term CSIRO research supporting the cotton industry. The interaction with CSD is critical because the late-stage large-scale trialing of elite material would be beyond our capacity to carry out and to finance. CSD accepts these responsibilities and we work in close collaboration.

Transgenic Cotton

When it became apparent that the cotton industry in Australia would be in difficulties through the developing Heliothis-resistance to available chemical insecticides, CSIRO proposed, initially to CSD, that they should initiate molecular biology research in cotton. We established that the optimum strategy for the introduction of an effective Heliothis insecticide gene would be to form a relationship with Monsanto. The basis of this decision was that there was heavy and complex intellectual property protection, with a number of players. Monsanto appeared to have a strong position and certainly had the most effective science. CSIRO negotiated a research contract with Monsanto and made provision for a commercial relationship to be formed between Monsanto and CSD. The Monsanto-CSIRO interaction was made possible because of Monsanto's recognition of the high research capability of the CSIRO group. Both CSIRO and Monsanto worked together to gain regulatory approval for the first transgenic crop in Australia. When the approval was given, CSD, under commercial agreement with Monsanto, was able to sell, under NRA regulations, the transgenic seed for the 1996-planting season. They negotiated an intellectual property licence with Monsanto.

It was important that CSIRO restrict its relationships to the research phase and not be involved in any direct commercial negotiations on business.

The relationship between Monsanto and CSIRO has been effective but was not without its difficulties at times. CSIRO found Monsanto to be slow in providing information and there was certainly a learning phase for the two parties in establishing an effective working communication. Similarly the small Australian company, CSD, had to find an appropriate way of working with the large multinational at the commercial level.

An International Business

CSIRO initiated discussion of the possibilities of sale of Australian varietal seed in other countries and consultation with the industry, through the Australian Cotton Growers' Research Association, the representational body of the industry. The international sale of Australian cotton seed was something the whole industry considered very carefully. Initially, the industry felt that the availability of our cotton seed elsewhere in the world could disadvantage the Australian industry.

Our varieties are protected by Plant Breeders Rights but this in itself makes our seed available to be used by other breeders in the development of their own cultivars so there is no direct way of protecting our germplasm beyond a certain time period and beyond certain requirements of novelty. The industry recognised this and also recognised that our breeding program needed to provide a continual flow of increasingly improved varieties. They saw that if we were offering what were basically outmoded Australian varieties at the international level, we ought to be able to further benefit the Australian industry through the profits of international seed sales and yet in no way reduce our competitive position in the international market. It was agreed that this would not harm and in fact would be likely to benefit the Australian cotton industry, an attitude paralleled in the wine industry.

CSD carried out international trials in a number of countries and set up a new company, Cotton Seed International (CSI), with responsibilities for running an international business. CSIRO agreed to a sub licensing to CSI. Subsequently, CSI formed a joint venture (CSE) with LGI, itself a joint venture between, Groupe Limagrain and Rhone-Poulenc. CSE has begun a cotton seed selling business in

Turkey, Spain, Greece and Brazil. Once again CSIRO received royalties and maintains ownership of the original germplasm.

Transgenic Cotton in the International Market

> ***Competition from CSI brings an unheralded player to the table.*** *Adding to the competitive pressures on Delta and Pine Land in 1998 and beyond will be the addition of CSI to the competitive picture. CSI is the international subsidiary of CSD, the Australian cottonseed cooperative…..*<u>*Additionally, CSD has exclusive access to the biotechnology of CSIRO, the Australian equivalent of the USDA.*</u> *CSIRO has an extensive biotechnology research effort underway with projects to develop a wide range of value-added genetic traits*
> ***(Broker report by Godsey and Shimoda "Delta and Pine Land Company – Sell", Biosciences Securities, Inc, Orinda, California, February 1997, p11)***

International trials of the CSD-CSIRO Australian cotton varieties has shown our varieties to be of exceptional performance in a wide range of conditions in cotton growing areas around the world, including the major production areas in the United States. The high performance of the Australian varieties opened up the opportunity of marketing the CSIRO conventional and transgenic varieties in the United States. One disappointing aspect of the CSD-Monsanto commercial interaction was that Monsanto excluded CSD from international marketing of their transgenic cotton varieties.

The results of CSD trials in the United States attracted a great deal of interest from other seed companies, particularly those associated with multinational organisations. This provided an opportunity for CSD and CSIRO to consider forming an association with one of the multinational companies which could provide extensive advantages to Australian agribusiness.

The Lesson: Outstanding science that generates valuable intellectual property can, through licensing, provide Australia with a lever to access technology of great benefit to Australia on advantageous terms.

Case Study – Lepton Test Kit

Abbott Laboratories developed a diagnostic kit to identify between two species of moths (Heliothis *armigera* and *panltigera)* with the CSIRO Division of Entomology and a Queensland SME (Pan Bio). The product has been technically very successful. Abbott is sufficiently pleased that they have commissioned the same group to do similar thing for the very competitive American market.

The Lesson: that CSIRO and an Australian SME, with access to the resources of a multinational, can work together and take genetically-based technologies to the world.

<u>Case Study - Polyphenol Oxidase Technology</u>

In early studies of grape berry browning, polyphenol oxidase was identified by the CSIRO Division of Horticulture as the enzyme which was responsible for the browning and degrading of colour quality of dried grapes. The same enzyme was also identified as a critical enzyme in postharvest management, particularly during processing, for such crops as potato, banana, lettuce, pineapple, apple, pear and many vegetables which are subsequently partially or wholly processed. This finding was immediately patented.

Fruit and Vegetables

The work for other fruit and vegetable crops is thus an offshoot of the original project, and as a result CSIRO advertised for expressions of interest in commercialising this technology in fruit and vegetable crops. All applicants have to satisfy CSIRO on two points: 1. that they are able to make the technology available in Australia under no less favourable conditions of price and time to market than in other countries, and where practical involve Australian industry in the development; 2. that they have control of sufficient enabling technology to take the polyphenol oxidase technology to market in the crops for which they nominated. To date contracts have been signed with Zeneca for lettuce and bananas, and with a small Canadian biotechnology company, OBI, for apples and pears. Contracts are under consideration, or in the final stage of negotiation, for potatoes. This is an example in which the polyphenol oxidase technology is valuable and has been able to attract commercial partners with access to full enabling technology to ensure access to the worldwide market. Royalties are returned on sale of polyphenol oxidase technology products to Australia.

In addition CSIRO has obtained an additional research contract from Zeneca to further the technology.

Transgenic Grapevines for Australia

The strategy for transgenic grapevines is different and because of the long period of time required to get a transgenic grapevine product to the market. The first transgenic grapevines in Australia were obtained nine months ago, but these plants have no commercial value. The first plants containing modified polyphenol oxidase activity will be available for planting in the spring of 1998. Given the long growth period of grapevines, evaluation of fruit will not be complete until the Year 2004/2005 and if successful, material will have to be multiplied-up for distribution to the Australian grapevine industry. The strategy for transgenic grapevines has been to concentrate on the Australian application so producing a different plan to access enabling technologies than would be the case for international exploitation. This route will allow us to minimize the enabling technology we have to develop ourselves while optimizing the enabling technology that either will be out of patent at the time and available for commercial application or is not protected in Australia and thus can be used.

The Lesson: each application of gene technology needs careful planning to meet individual commercial outcomes

ALTERNATIVE STRATEGIES

We have indicated through the examples above that our differentiated, partnership approach has resulted, and will result, in appropriate return to Australian industry.

However, an alternative approach might be for the intellectual property of Australian research institutions to be consolidated to present a more powerful portfolio for bargaining and deal making. The formation of a centralised intellectual property company of this sort was not a success in the United Kingdom and the consolidation of discoveries is likely to be of importance only where they are in the same business system. These cases can be easily accommodated in the strategic alliances discussed above. For example, in one strategic alliance that we are currently forging, CSIRO Plant Industry was able to present intellectual property positions and discoveries from three CSIRO Divisions and from the Research School of Biological Sciences of the Australian National University.

In our view, however, there are some major disadvantages of such a consolidated approach

- the link between research and the customer end-user is broken, lengthening the time-to-market and the chance of success. A consolidated approach would only work if the intellectual property to be aggregated was unencumbered and so available for sale or licence

- it is very unlikely companies with crucial enabling technologies and complementary assets would work with, and thus fund, anyone but that group with the expertise.

- a level of bureaucracy would be introduced that would add little value to the commercialisation process.

CONCLUSION

With the overall goal of bringing benefit to Australia through leverage of our intellectual property, CSIRO is at various stages of discussion with SMEs and multinationals about specific technologies or strategic relationships. We believe we are in this position because we enjoy a reputation for scientific excellence and a strong intellectual property position and because we are able to deal flexibly with the differing commercial requirements for our customers. Furthermore, we have spent a great deal of time training our research scientists to understand the commercial requirements of our customers, and to ensure specialist commercial and legal skills are available when needed.

It is our opinion that the establishment of a stand-alone IP company would greatly reduce the flexibility required to exploit agricultural biotechnologies,

without adding any value other than cost and complexity, and so is a route less likely to be successful than that exemplified above.

ATTACHMENT 3

EXAMPLES FROM THE FIELD CROPS SECTOR OF STRATEGIC ALLIANCES

The CSIRO Field Crops Sector faces potential market failure on a large scale as a consequence of the blocking intellectual property positions of the multinationals. Australian industries need to be positioned with their own valuable IP, enabling them to negotiate positions of freedom-to-operate in their own right and/or on appropriate terms in joint ventures with the multinationals. Such alliances will give Australian agriculture access to the enabling technologies needed by our industries; eg:

- *CSIRO Cotton* varieties - The grower-owned licensee of the highly successful CSIRO bred cotton varieties in Australia, Cotton Seed Distributors Ltd, has taken a major step to break into the US cotton seed market by entering into a joint venture through its wholly owned subsidiary, Cotton Seed International, with AgrEvo, one of the world's biggest agrochemical and biotechnology companies. Initially seed will be exported from Australia with 1200 tonnes (25%of Australian sales) to be shipped in 1997 with the eventual aim of seed production in the US sourcing novel traits from CSIRO germplasm combined with AgrEvo technology for the international program. This relationship will provide the opportunity for CSIRO to develop new varieties with superior pest resistance, quantity and field performance for the Australian industry. It also makes possible a strategic alliance with AgrEvo to access other proprietary technologies which will bring a key benefit to the Australian agriculture industry.
- *AgrEvo/CSIRO Strategic Research Alliance* - A Strategic Research and Licence Agreement has been made with AgrEvo Germany and AgrEvo Australia in a five year research collaboration involving CSIRO, CSIRO Entomology and the Australian National University. The field of research covers genetically transformed seed and provides commercial opportunities for AgrEvo to exploit project technology internationally with special provision to protect the Australian industry. The Alliance provides CSIRO access to AgrEvo enabling and trait technology so as to provide CSIRO the opportunity to exploit other technology which would otherwise be restricted.
- *Graingene* –The 'core' of Graingene is a Joint Venture between three key parties in the Australian Grains Industry: AWB Limited, CSIRO and the Grains Research and Development Corporation (GRDC). Its purpose is to enhance Australia's investment and capability in new technologies and develop innovative Intellectual Property, to enable the Australian grains industry to prosper by capitalising on Australia's discoveries and by gaining access to essential IP owned by others. In addition, Graingene will draw in ‘associate’ research, breeding and commercialisation companies where they have expertise and Intellectual Property positions in specific projects.