Plant variety intellectual property rights in a changing and challenging environment

by

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Introduction

My mandate today is to look at the future operating environment for the Australian plant variety dependent industries and to examine the relevance of the Australian plant breeders' rights system in this, possibly, changed environment. I have done this by:

- considering the outcomes anticipated by the Australian Government when the PVR/PBR Acts were implemented,
- examining the factors that I perceive may impact on Australian and global plant breeding in the future and
- suggesting areas where the current PBR system may be improved.

Governments expectations from PVR

The purpose of the introduction of plant variety (subsequently breeder's) rights into Australia was "to provide a significant boost to Australian agricultural industries and to allow farmers and nurserymen to compete more effectively on world markets" (Kerin, 1986). It was also envisaged that PBR would improve export for seed and nursery plants. More specifically, the government anticipated the following outcomes:

- stimulus to plant breeding effort in Australia,
- improved access to overseas varieties,
- protecting the food supply for consumers,
- reproductive material may be used for research and breeding without infringing rights,
- farmers and home gardeners using a PVR/PBR variety will be able to retain seed or other propagating material for their own purposes and
- strong public plant breeding effort for our major crops

The second reading speech of the PBR Act asserts that the above intensions and limitations were still government policy (Faulkner, 1994).

I will be discussing the possible future trends for the Australian plant variety intellectual property system by:

- using congruity with the Government's intended outcomes as a measure of desirability where possible,
- developing a vision of the future operating environment for Australian plant variety dependent industries and
- considering aspects of the current Act that may require amendment.

Future Operating Environment

It is necessary to undertake some crystal ball gazing at this time to build up a picture of the probable future operating environment for plant variety based industries and plant breeding industries. The drivers that appear likely to impact on these industries include:

- international competitiveness of Australian variety based industries,
- unprecedented increase in private sector investment in plant breeding and enabling technologies,

- reduced public sector investment in plant breeding,
- international treaties,
- global warming and
- enforcement.

International Competitiveness

Industry viability and profitability is predicated on customer preference for the product of one company/country over a similar product from another company/country. This preference is determined to a significant extent on product quality and price. Australian industries have, in the past, found difficulty completing on price due to high production and transport costs. Many Australian plant variety based industries have competed quite successfully in the international market place on quality.

This was recognised by the Australian wheat over thirty years ago and, as a consequence, this industry has invested very heavily in out-competing competitors on wheat quality. This included countries such as the USA and Canada. The strategy was to understand what the customer requires, and then, through close interaction with breeding and R&D agencies ensure that the varieties bred have the elite inherent quality for the end produce. The importance of optimising all aspects of the value chain to ensure that the genetic quality is delivered to customers cannot be overemphasised

The singular importance of quality in achieving international competitiveness is now well understood by other players in the wheat industry. A senior official on the Canadian Wheat Board is quoted as saying that competition in the international food trade will be fought on genetics. The New Zealand kiwifruit industry has a very similar view and, as a consequence, has detailed product descriptions and invests in breeding to deliver on these. The role of varietal based quality in the international competitiveness of many agricultural industries appears to be well understood internationally. As a consequence, many Australian variety based industries will have to identify and deliver on new areas of excellence in consumer quality to be internationally competitive. This is in addition to maintaining internationally competitive for sensory attributes which include:

- colour: internal as well as external,
- flavour: sugar/acid ratio and the profile of volatiles,
- texture including mouth feel,
- shelf life which is a maintenance of sensory properties,
- smell and
- freedom from blemish

The international competitive advantage this type of quality attribute is now well understood internationally and Australia has to look for competitive superiority in other areas. These will include:

- internationally competitive production costs and
- other areas of customer satisfaction.

Australia has done much to make our productivity costs more internationally competitive through political and technical adjustments. These endeavours should not be diminished although it is difficult to see our production and transport costs

matching those for many developing economies. Plant breeding has a major role in delivering on minimising these costs through technical innovation. There is, in my view, substantial competitive advantage to be derived from innovation in alternative sources of customer quality. These will include:

- low or nil chemical residue,
- absence of any degree of spoilage due to carcinogens associated with such spoilage and
- high levels of endogenous chemical that maintain and or enhance health (IFT, 2005).

Plant breeding can play a major role in delivering varieties that are resistant to a wide range of pest and diseases such that chemical control of these pests and diseases is not required, or is minimised, to deliver high yields of unblemished product to customers. Australia has been good at this in the past but will have to be better to meet community expectations as there is still extensive use of chemical protectants in many industries.

The body of evidence to support the health ameliorating/maintaining properties (function properties) is now quite voluminous and compelling. The following claims are well documented and represent a few of the many claims for the health ameliorating properties of foods:

- reduced rate of coronary heart disease due to the consumption of fruit and vegetables (Dauchet *et al*., 2006),
- reduced rate of stroke due to the consumption of fruit and vegetables (Dauchet *et al*., 2005),
- apple consumption has been linked to reduced risk of lung cancer, asthma, type-2 diabetes, thrombotic strokes and ischaemic heat disease (Knekt *et al*., 2002),
- anthocyanins (the colour pigments found in many plants) are reported to reduce the risk of cancer (Kamei et al., 1995) and to be anti inflammatory (Meiers et al., 2001),
- role of plant stanol esters in reducing blood cholesterol levels is now acknowledged by the USA Federal Drug Administration (determinations 65 FR 5700 and 65 FR 5701 as quoted by IFT, 2005),
- FDA acknowledges the role of omega-3 fatty acids in lowering coronary heart disease (determination 56 FR 60672 as quoted by IFT, 2005) and
- Cranberries have been reported to be associated with reduced urinary tract infection (Foo *et al*., 2000a and 2000b)

There is now considerable evidence for substantial genetic variation within species for many of the above health ameliorating properties. Consequently, there are opportunities to maximise the health ameliorating properties of different species through plant breeding.

A significant expanding of the breeding objective for many Australian plant breeding programs would be required to deliver on the health outcomes outlined above. The required investment for these outcomes could not be absorbed in the budgets of current Australian plant breeding programs. There will also be significant investment required in enabling technology development to produce the selection tools,

germplasm and clearly defined breeding objectives if such a program is to be effective.

Although the public good from breeding healthier plant foods is undeniable, it is difficult to see expanded public investment in Australian plant breeding industry. The required increase in investment, I believe, will have to come from the private sector.

There would appear to be a compelling argument to examine the plant variety intellectual property system in Australia to determine the extent of adjustment that would be necessary to encourage the investment in the Australian plant breeding industry to deliver varieties with competitively high health ameliorating properties.

Private investment in plant breeding

One of the two signature scientific developments of the last half of the twentieth century has been the developments in biotechnology. These developments have enormous implications for many facets of society not the least of which is in the development of much improved plant breeding technologies and opportunities. A significant aspect of this development for plants has been the recognition of a very lucrative business opportunity predicated on the patentability of the new plant breeding technology.

A consequence of this recognition has been substantial merger and acquisition activity in the seed industry. Also, some companies have realigned their business strategies to emphasise plant genetics particularly transformation technology.

The extent of this activity is now well documented. Between 1996 and 2005 Monsanto made the following acquisitions (UNCTAD, 2006):

- 49% of Calgene Inc, (1996),
- Agracetus Transgenic Plant Division, (1996),
- Asgrow Agronomics (1997),
- Holdens Foundation Seeds (1997),
- Cargill's International Seed Division, (1998),
- Unilever's Plant Breeding International Cambridge, (1998),
- Dekalb Genetics, (1998),
- Limagrain Canada Seeds, (2001),
- Advanta Seed BV's canola seed operation, (2004)
- Channel Bio Corp, (2004),
- NC + Hybrids, Inc, (2005),
- Seminis, (2005) and
- Emergent Genetics (2005).

Acquisitions by other large seed companies include:

- DuPont acquired Pioneer Hi-Bred International, (1999),
- Syngenta AG: Golden Harvest and Garst Seeds, (2004),
- Bayer AG: Aventis Cropscience and Schering AG and
- Groupe Limagrain announced its intension to purchase Advanta's European crop business.

It was estimated that four companies (Monsanto, Syngenta AG, DuPont and Groupe Limagrain) have a combined market share of world seed sales of 30% (UNCTAD, 2005). Their share in 1998 was substantially larger in the USA for species where transgenic technology has been deployed in the development of GM varieties:

- Maize: 67%
- Soybean: 49%
- Cotton: 87%

These figures are a substantial under estimate of the market dominance of these companies as the area grown to GM varieties has increased significantly since 1998 in North America.

The implications for Australia of this concentration of economic power in a sector of such national importance, such as the food industry, is worthy of consideration in determining the future structure of Australia's plant variety intellectual property system. I have done this in what is a less than comprehensive way by looking at trends in North America where this concentration of economic power appears to be most pronounced.

USA plant variety protection systems

Plant variety intellectual property rights come in three forms in the USA (Seay, 1993; Mutschler and Lesser, 2003):

- Plant Patent Act of 1930 was initially for asexually propagated species except those propagated by tuber (ie potatoes),
- Plant Variety Protection Act of 1970 for sexually propagated species and
- Utility patents as a result of Supreme Court's 1980 decision in *Diamond* v. *Chakabarty* and the Board of Appeals and Interference's 1982 decision in *Ex parte Hibberd*.

Plant Variety Protection Certificates (PVPC) is the right issues under the Plant Variety Protection Act and is harmonised with UPOV 1991.

Canadian plant variety protection systems

Plant patents are not available in Canada. The Plant Breeders' Rights Act came into force in Canada in August 1990. Canada became UPOV harmonised in 1991.

Trends in applications for plant variety IP rights in the USA and Canada

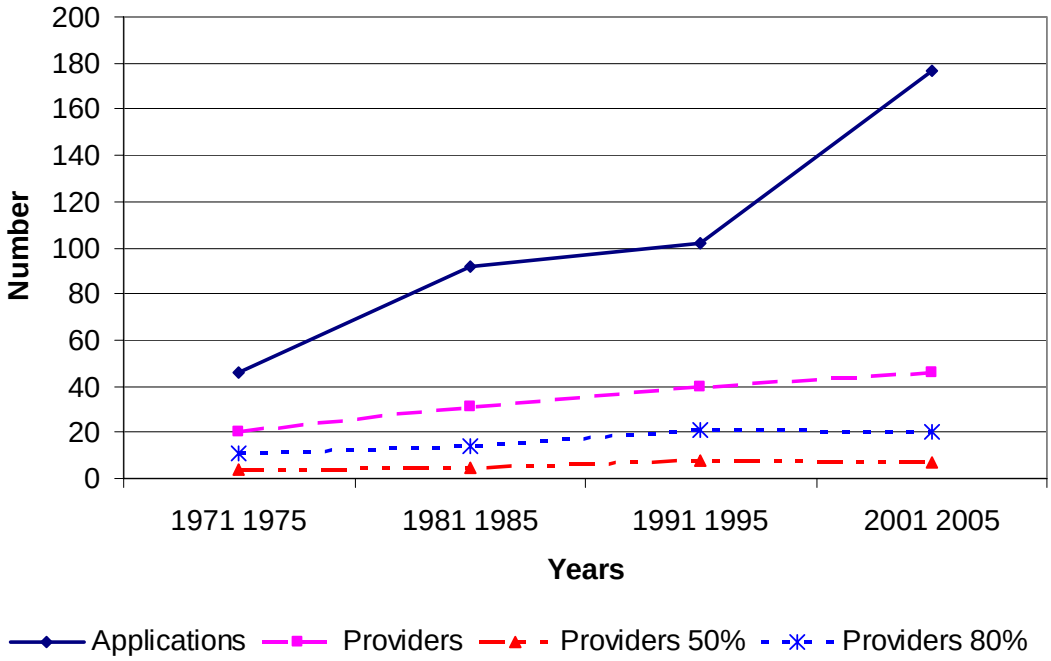
The trend over time in applications for plant variety protection certificates (PVPC), plant breeders' rights in Canada, plant variety patents and utility patents for plant varieties for several species or groups of species is postulated to be a reasonable measure of investment in breeding for the selected crop species.

Wheat applications

Wheat was considered first as transgenic varieties are not grown commercially at this time.

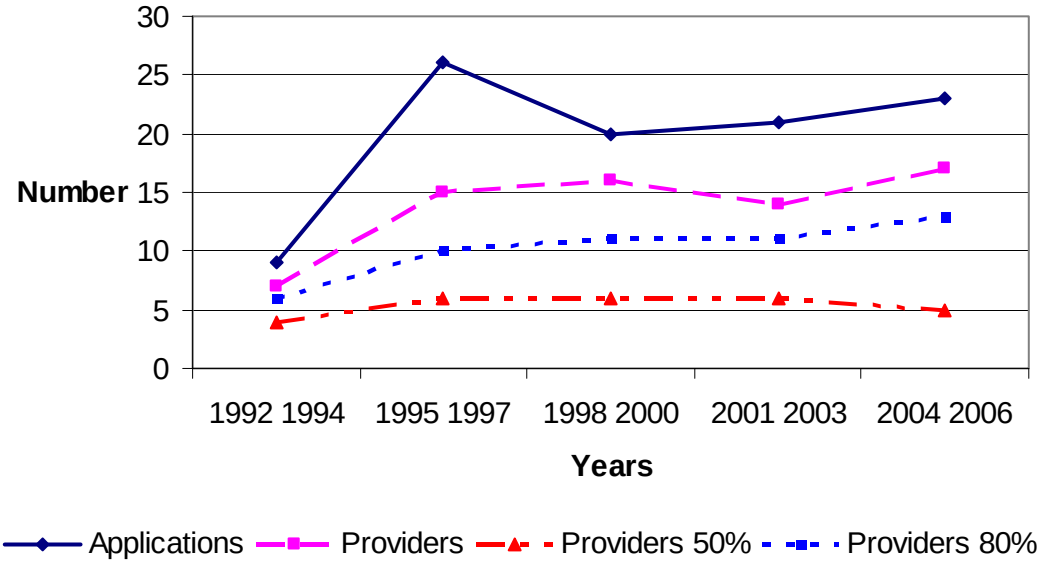
The increase in PVPC applications from 1971/75 to 2001/05 was over four fold and there was a doubling of entities making application (Fig. 1). This suggests that the establishment of a UPOV harmonised system in the USA for sexually propagated plants was very effective in increasing investment in wheat breeding. Also, there does not seem to have been any dominance by one or a few breeders as the trend for providers of 50% and 80% of applications showed an initial increase and then tended to plateau (Fig. 1).

Fig 1. USA PVPC wheat applications



The same trend was apparent, albeit in a smaller time frame, for Canada (Fig. 2). The implementation of a PBR system appears to have attracted more providers, increased the investment in wheat breeding and there does not appear to be domination by a few providers.

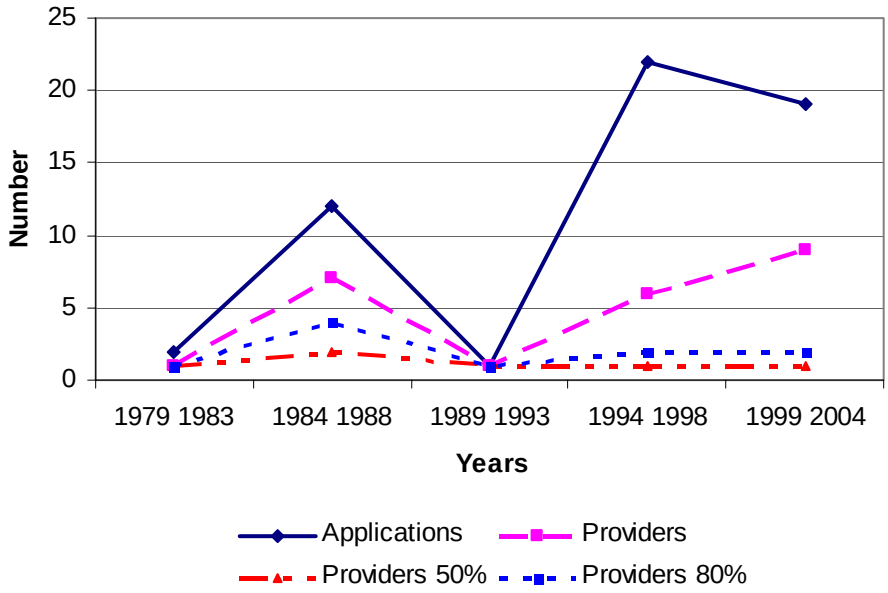
Fig 2. Canadian wheat PBR applications



Field pea PVPC applications

The trend in PVPC applications for field peas was examined to understand the pattern of investment in a representative 'small' field crop (Fig. 3). The trends, though more variable, were similar to wheat with a very substantial increase in applications and breeding entities over time without any dominance by one or a few breeding entities.

Fig 3. USA field pea PVPC applications



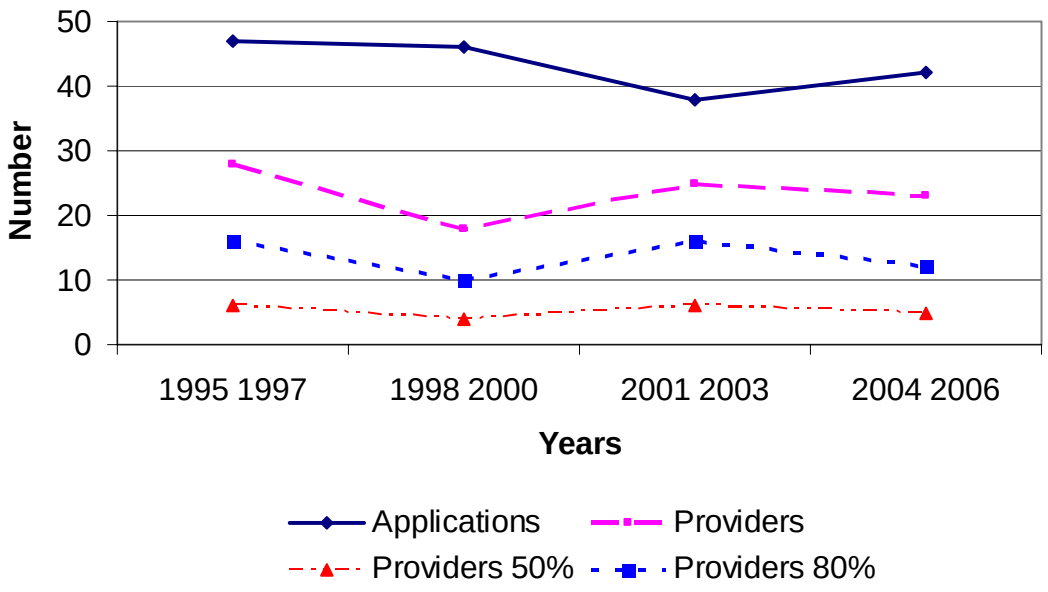
Potato PVPC applications

A very flat trend was noted for potato which was used as the representative tuber propagated crop (Fig. 4). In summery, there was no discernible trend in the number of:

- providers (breeder entities),
- applications,
- providers responsible for 50% of applications and
- providers responsible for 80% of applications.

It is assumed that the stimulus to potato breeding as a result of plant variety IP rights had occurred prior to the year in which the US PVPC database was populated with potato applications. The PVPC system was available for potato varieties from 1971 but the information in the on line database for potatoes commenced in 1995. This hypothesis requires further examination.

Fig. 4. Potato PVPC applications



Ornamentals PVPC applications

The trend in applications for ornamentals was determined by using the aggregate over thirteen different species due to the quite low number of applications for any one species. The species included were poppy (2), phlox (11), marigold (68), gazania (2), English daisy (3), dahlias (1), cosmos (1), primrose (3), snap dragon (4), stock (10), sweet pea (20), verbena (9) and wallflowers (6). The trend in application was quite different from that for the species considered previously.

Firstly, there were a relatively large number of applications in the first five years of available data. It is assumed that the providers of new ornamental varieties may have delayed the release of new varieties until the PVPC system was in place. Investment in breeding ornamentals appeared to rise until 1985/89 and/or 1990/94 with

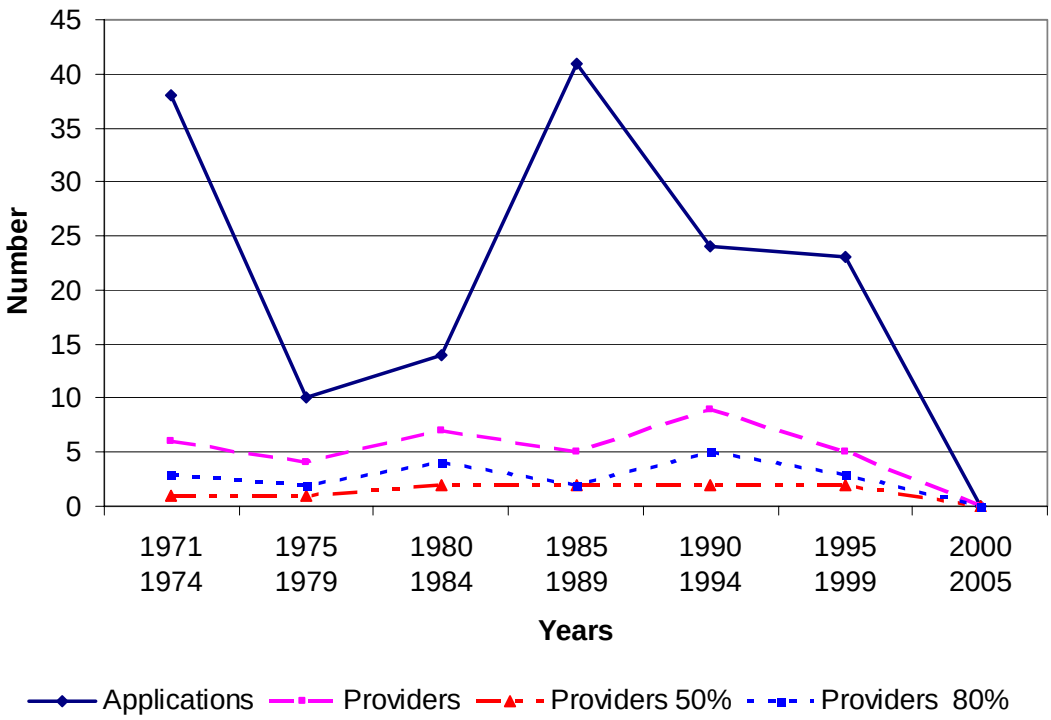
applications and provider entities and dropping to zero by 2000/05. The trends in the number of provider entities responsible for 50% and 80% of applications suggest that there wasn't a concentration of ownership by few provider entities (Fig. 5).

The reasons for rapid decline in the lodgement of applications over the last fifteen years may include:

- insufficient return on investment,
- variety IP protection is not cost effective for varieties with limited commercial life or
- preferring utility patents to PVP certificates.

The reason has not been determined at this time but it is evident that the UPOV harmonised plant variety IP protection system is not serving the needs of ornamental species breeders in the USA.

Fig 5. USA ornamentals PVPC applications



The trend in application for ornamentals in Canada, where there isn't a plant patent system, does not show any drop of in applications (Table 1). This suggests that breeders of ornamentals in the USA may be electing to use plant patents.

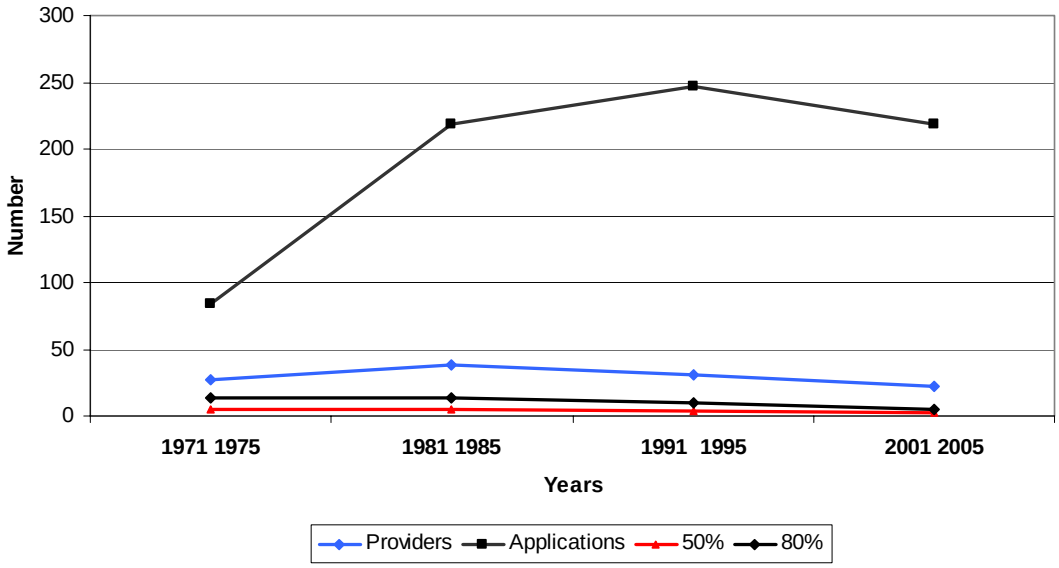
Table 1. Trends in applications for ornamentals in Canada

Year	2000	2001	2002	2003	2004	2005	2006
Number	283	241	307	410	451	562	387

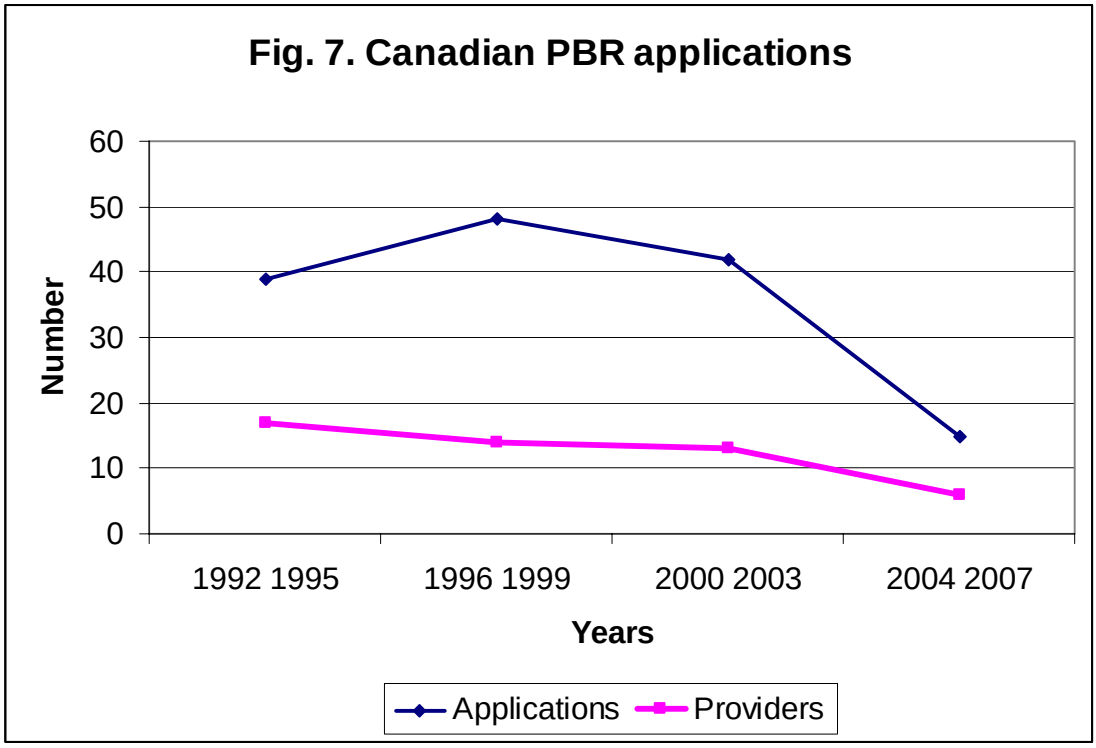
Soybean PVPC applications

Soybean PVPC applications were examined as this crop is one in which genetic modification has played a very large role in variety development in many countries particularly the USA and Canada since about 1996. The trend in applications suggests that the advent of plant variety IP protection in the USA for sexually propagated species had a very considerable impact on soybean breeding (Fig. 6). The number of applications more than doubled in the first ten years, then appeared to plateau before declining slightly in the last five years. The number of breeding entities increased by 30% in the first decade of the PVPC system and then declined to fewer than participated initially. The provider entities responsible for the majority of applications have declined for the life of the system. Fewer provider entities were involved in the last five years suggesting that there was a trend in concentration of ownership developing in soybean breeding in the USA. In fact, two providers, Pioneer Hi-Bred (DuPont subsidiary) and Monsanto, are responsible for 68% of applications in 2000/2005 while five providers were responsible for 81% of applications in the same period.

Fig 6. PVPC soybean applications



The introduction of the PBR system in Canada appears to have stimulated breeding activity in soybeans with substantial increases in applications and the number of entities submitting applications (Fig. 7). However, both these indicators of investment commenced dropping late in the 20th century and this trend has continued. Currently, there are fewer applications and providers than at the commencement of Canada's plant breeder's rights system. This trend appeared to commence soon after genetically modified soybeans were first cultivated in Canada in 1996 (James, 2004).



In 2006 there were 180 soybean varieties on the seed availability list for Ontario, Canada and all these had been introduced since 1991 (Table 2). Of these, 128 were roundup resistant (glyphosate tolerant) genetically modified (transgenesis was involved in its breeding) varieties. There was only one application for PBR for roundup resistant varieties. PBR applications had been made for twelve of the 51 non glyphosate tolerant varieties. A similar situation was found for Iowa, one of the major soybean producing states in the USA (Table 2).

Table 2. Varieties available for planting in 2006

Number	Iowa	Ontario
Total	130	180
Glyphosate tolerant	116	128
PBR/PVPC		
Total	16	13
Glyphosate tolerant	8	1
Seed providers	21	28

Monsanto's glyphosate tolerance technology appears to have been deployed for most, if not all, of the glyphosate tolerant varieties available in Canada and the USA in 2006. Growers who use varieties based on Monsanto's technology must sign a technology use agreement which, I believe, requires the growers to:

- pay a royalty for the use of the glyphosate tolerance technology and
- prevents them from using harvested seed for later production under any circumstance.

My request for as copy of this agreement has not been acknowledged but the Pioneer-Hi-Bred web site (for their Canadian operations) did provide the above information.

Consequently, the “farm saved seed” provisions of the Australian PBR Act are not available.

The research exemption mandated in a UPOV compliant system appears to be partly in place, as many providers appear to have glyphosate tolerant varieties available. Monsanto make their roundup resistance technology available free of change on the understanding that all growers of such varieties sign a technology use agreement with Monsanto.

The development of transgenic soybeans varieties appears to have delivered one of the major outcomes anticipated by the Australian Government from the introduction of the PVR Act. That is to foster increased investment in plant breeding.

Conclusions: Biotechnology

The following conclusions are based on a quite limited examination of the implications for biotechnology on plant breeding and plant variety intellectual property systems. A much more detailed examination that includes more crop species and more countries would be required before Australia could determine if PBR policy adjustments are necessary. This examination does emphasise that there is a need for Australia to have a close look at what is happening overseas to determine if this is the direction we wish to pursue.

For most species where transformation technology is not in the commercial arena, UPOV harmonised systems appear to be encouraging new providers to enter breeding, for an overall increase in investment and a diversity of breeding entities. This does not appear to be the case for ornamentals when utility patents are available. It would appear necessary to look more closely at this sector to determine if policy adjustments are required to promote the public good aspects of a UPOV harmonised system.

A UPOV harmonised system appears to have only minor value where transgenic technology has been commercialised in plant varieties such as soybeans in Canada and the USA. Consequently, PVPC/PBR applications are not a robust measure of either the providers of varieties or the overall level of investment in the breeding of a particular crop species. Also, one feature of the UPOV system, farmer saved seed, has been lost while another, the research exemption, has been only partly retained through the use of contacts. This is due to company policy not government policy which is, in my view, not a guarantee that the breeder/research exemption will always remain.

The implications of the large number of PVPC soybean applications by only two providers needs to be examined to determine the implications for Australia of what appears to be an undesirable level of concentration of ownership in soybean breeding in the USA.

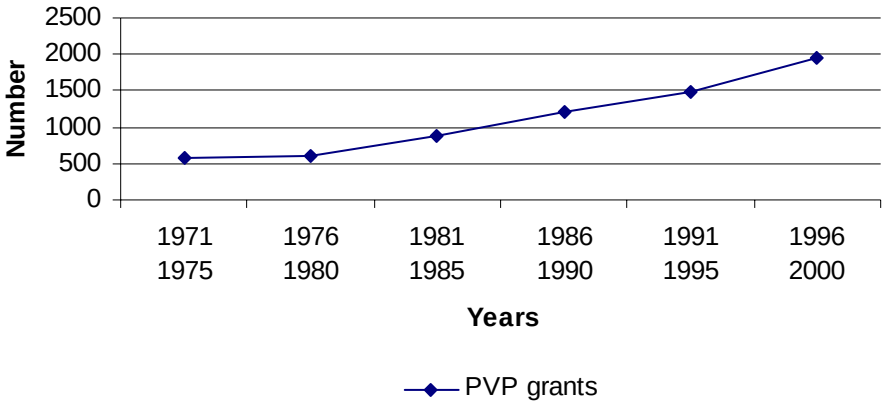
Plant Variety Patent Trends

The trends in plant variety patents in the USA have been drawn from published figures and not by direct interrogation of the USA patent database.

The use of plant patents in the USA has continued to increase very rapidly (Fig. 8, from Lesser and Mutschler, 2003). The figures used in this figure were taken from a publication and there will be some errors in the actual numbers but, I am confident, that the trend is correct.

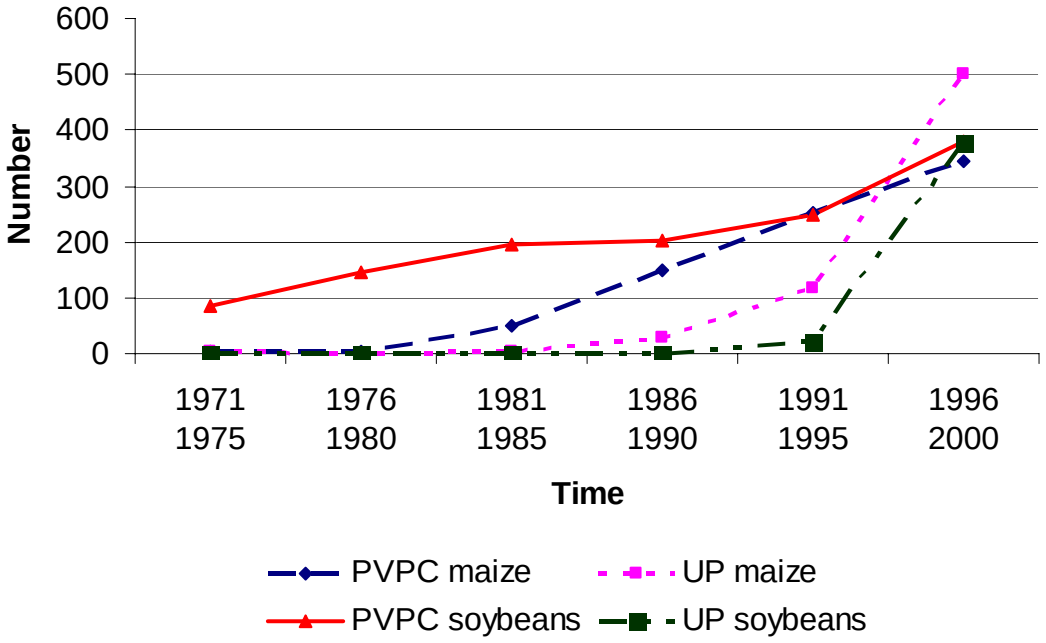
Over 600 utility patents applications were made for plant varieties between 1990 and 2000 in the USA (Chan, 2006; Fig 9). The apparent downturn after this time is due delays in including applications on the database and inference should not be drawn from figures after 2000. The very substantial increase between 1997 and 2000 suggests that plant breeders are increasingly using utility patents to protect their varieties. Chan (2006) indicates that 589 of these are for maize and soybeans. These are the two main species for which genetically modified varieties are available.

Fig 8. PVP grants



The use of utility patent and PVPC to protect plant variety intellectual property for maize and soybean suggests that, while PVPC for these species is still increasing, there appears to be a growing preference for utility patents (Fig 10, from Lesser and Mutschler, 2003). The upsurge in the usage of utility patents commenced just prior to the entry into USA agriculture of genetically modified maize and soybean varieties around 1996.

Figure 10. Trends in the use of utility patents and PVP cetificates for maize and soybean



Conclusions: Patents

The trend in the USA has been for greater use of utility patents for variety IP protection. The Australian government has recently elected not to extend the innovation patent (Australia's equivalent of the USA utility patent) to plant (and animal) subject matter on the advice of ACIP which suggested the following reasons for this action:

- there is no provision for farmers to retain sed for their personnel use,
- the research/breeders exemption would not apply and
- lack of examination would lead to uncertainties but

The first two concerns are relevant for patents as well.

There appears to be a compelling argument for Australia to examine more thoroughly the trend in preference for plant variety patents that appears to be a consequence of the commercialisation of GM (transgenic) varieties. If this trend is confirmed, there is a need to determine if this is in the best interest of the Australian community particularly when Australia has recently elected not to use innovation patents for plant varieties and patents have similar implications.

International Treaties

World Trade Organisation

There are a number of international treaties that impact on the Australian plant variety IP protection system. The obligations under the World Trade Organisation (WTO)

require Australia to conform to the treaty on Trade Related Aspects of Intellectual Property (TRIPS) which we more than conform to as our legislation is harmonised with the 1991 UPOV Convention. The UPOV Convention is the overriding driver of Australia's PBR system and the Australian Plant Breeder's Rights Office plays a major role in the administration and evolution of this system. It is anticipated that the UPOV Convention and UPOV have been adequately considered by other speakers.

The intent of the WTO is to promote free trade by the removal of artificial trade barriers. Nations who believe that other members are not providing this access have recourse through the judicial arm of the WTO. Recent cases, including the overruling of the EU embargo on food items derived from genetically modified crops, have demonstrated the determination of the international community to minimise artificial trade barriers.

Australia has set a high quarantine standard to minimise incursions of pests and diseases that would be economically damaging to our agricultural industries. There are considerable challenges in determining what pests and diseases will be damaging and the extent of the loss that may be incurred. Australia, with these uncertainties in mind, has tended to adopt the precautionary principle when determining import access to primary produce. The EU/GMO determination by the WTO suggests that this will no longer be an acceptable defence. There will probably be a greater agitation for access to the Australian market, such as is happening with New Zealand apples and bananas from the Philippines, which may result in a relaxation of our quarantine standards.

It is probable that, as a result of the WTO process, incursions of pest and diseases will become more frequent and some will become established. Breeding will be required to address these issues in possibly two ways:

- strategically by identifying high risk high impact possible incursions and commencing breeding before the causal organism arrives as the sugar industry did with smut or
- post entry.

Regardless of the breeding strategy involved, the Australian plant breeding industry will have added responsibilities.

Convention on Biodiversity

I believe that a big challenge for the international plant variety IP systems will come from the Convention on Biodiversity (CBD). In particular are our obligations to provide/gain access to genetic resources and how the benefit from these resources can be shared equitably. The latter is to provide the owners of genetic resources with equitable return.

The international community has agreed to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). This is an international law governing access and benefit sharing for germplasm of the world's major agricultural and horticultural crop species (Fowler, 2003). This agreement recently came into force and now the challenge is to develop robust protocols in put the good intensions of this treaty into effect.

Australia possesses a large and distinct portion of the world's biodiversity. Much of this is endemic to Australia and much has commercial potential in the forestry and ornamental industry. There are a number of species of actual or potential value for main stream human food (macadamias and midyim berries). The Australian plant breeding industry is exploiting the ornamental potential of Australia's flora as are breeders in a number of other countries.

I believe Australia has a compelling reason to pursue an equitable implementation of the access and benefit sharing provision of the CBD to protect our own interests in our native flora.

It is also in our interests to ensure that the endemic genetic resources of many of our neighbours in the Asia Pacific region are similarly protected. These nations have a wealth of plant genetic resources with considerable food and ornamental potential. The orderly exploitation (and conservation) of these resources has considerable economic development potential for these nations. It is certainly within our self interest to foster their economic development.

Australia's agricultural and horticultural industries, with the exception of macadamia nut production, are entirely based on germplasm from other countries. We are less dependent on overseas germplasm in our forest industry. The ITPGRFA provides an instrument that will underpin Australia's access to the germplasm we require in breeding to support just about all of our agriculture and horticultural industries. The implementation of this treaty in a manner that serves Australia's interests requires that:

- equitable benefit sharing arrangements are in place and
- the provisions of the agreement have to be extended to cover all species of interest to Australia.

The Australian Federal Government and the governments of Queensland and the Northern Territory have legislation covering access and benefit sharing of genetic resources in their jurisdictions. Other state governments are in the process of implementing similar instruments. However, the protocol for compliance with these provisions, particularly disclosure of the use of genetic resources, is still unresolved.

One suggestion for disclosure is that this should be an obligation built into the patent system. It appears reasonable to conclude that there may be similar energy at international fora to have disclosure of the use of genetic resources included in the PBR application process. There are many ramifications of such a step and the Australia plant breeding industry has a vested interest to ensure that it is not unreasonably disadvantaged by such a move.

Conclusions: International Treaties

The international community has made considerable progress in the development of international law governing assess and benefit sharing arrangements for the world's plant germplasm. Australia has a vested interest in ensuring that robust and equitable

arrangements are in place to ensure orderly access and benefit sharing of these resources. Our interests are predicated on:

- our dependence on overseas species for the vast majority of our agricultural and horticultural industries,
- Australian endemic plant genetic resources of considerable commercial value,
- plant genetic resources endemic to our near neighbours and
- possible impact of the implementation of the international treaty on our plant variety intellectual property system.

Climate Change

Climate change will impact on many aspects of day to day living for the world community. The impact on food availability will be a major impact. It has been estimated in 2002 that the annual loss in productivity due to the change in climate since 1981 was 40 million tonnes ($US5 billion) for wheat, maize and barley alone (Labell and Field, 2007). This was based on a global temperature increase of about 0.4^0C which is less than the change anticipated in the near future.

Climate change will also change the availability of water for irrigation and may also influence the importance of the endemic pests and diseases of our agriculturally important species.

Another aspect of climate change is that it seems reasonable to assume that carbon trading will be introduced internationally. One unknown will be the extent of the carbon tax placed on production and transport of agricultural commodities. This may be particularly severe for perishables such as fruit and vegetables.

The nature of the impact of climate change, as it affects plant variety based industries, appears certain to include:

- substantial changes in the outcomes of plant breeding programs to accommodate the different growing environments and stresses that can be anticipated and
- changes in Australia's portfolio of commercial crop species.

Clearly, substantial increases in investment in Australia's plant breeding industry will be required for the public and private good of Australia. This increase in investment may not be forthcoming in the present economic climate and it will probably require government intervention to ensure that the public good interests of Australia are met. This may be through direct investment, which would appear to be unlikely, or through modifications to the "careful balance" in Australia's plant variety intellectual property system.

Availability of plant breeding professionals

My professional career has included a long involvement with a number of Australia's Universities and interaction with professional from a large number of universities both within and outside Australia. A common theme from these interactions is the lack of attractiveness for students of biological science, except biotechnology, in general and agricultural science in particular. I am confident in my mind that the enormous

different in salary expectation between a plant breeder with a PhD and an accountant/lawyer with a pass degree is a significant contributing factor in this equation. This dichotomy in wealth generation expectations may be based on the reliance of Australian plant breeding on public sector investment.

One possible way to redress the wealth generating imbalances that exist would be to attract substantially greater private sector investment into the Australian plant breeding industry. It is probable that supply and demand would underpin higher salaries for plant breeders as they are in short supply. The corollary to this is that plant breeding has to be a more attractive private sector investment target. Australia needs to examine the investment attractiveness of Australian plant breeding to determine if adjustments to the plant variety intellectual property system can be made to enhance the profitability of plant breeding.

Possible modification of the current Act

Enforcement

There are two aspects of enforcement:

- enforcement of the right granted and
- enforcement of the intent of the Act.

Enforcement of rights

The first is the subject of the ongoing ACIP inquiry. The level of interest in this inquiry and the financial extent of some of the issues being raised are both very high particularly when the size of the Australian plant breeding and plant variety dependent industries is considered.

I will not be considering the nature of the issues raised further because of:

- time restrictions,
- extent of industry awareness through the ACIP's Issue Paper and
- additional consultations that will take place.

My preliminary impression is that, if solutions to the issues raised can be found that are acceptable to the Australian Government, there may well be an increased private sector investment in the Australian plant breeding industry. I cannot judge if this increase will be sufficient to deliver the varietal products necessary to address the concerns that have been raised above.

Enforcement of the intent of the Act

Enforcement of the intent of the BPR Act is not included in the minute provided to ACIP by the minister but is, not withstanding, an important issue. Consequently, it will not be considered in the current ACIP enquiry.

The second reading speech for the PVR Act explicitly noted that the Governments intension in introducing this bill included:

- 'use of plant material in further breeding and research programs' and

- ‘strong public plant breeding for our economically important crops’ (Kerin, 1986).

I am strongly of the view that the plant variety IP system should not place any restrictions on the availability for breeding and research of protected varieties. This is a fundamental public good measure that contributes to maximising the genetic gain that can be made to the varieties required for the international competitiveness of Australia’s variety based industries.

I am aware that, at least, some rights holders or licensees, are using contract to restrict access by breeders to varieties for which Australia has granted PBR. Also, the use of patents will also restrict the availability of IP protected varieties for breeding.

I strongly believe that Australia needs to look at options for minimising these constraints to genetic advance.

Public Investment in Plant Breeding

While I am unaware of any quantification, my observations, and my experience, suggest that Australian governments are tending to reduce their investments in plant breeding. There appears to be a belief that plant varieties are a private good and, as a consequence, market forces should determine the level of investment for a particular species. It is difficult to argue against this premise except that it is clearly contrary to the intent of the PVR/PBR Acts (Kerin, 1986, p40).

The relevance of the Government’s desire in 1986 to maintain or increase public investment in plant breeding particularly in the major crops needs to be re-examined in light of:

- perceived change to state and federal government priorities,
- perceived scarcity of outstanding plant breeding professionals and
- Australia’s requirement for varieties that are nationally and internationally competitive in a rapidly changing operating environment for plant variety based industries.

Equitable Benefit Sharing

A successful variety, particularly, in a major crop species requires that the variety has the following attributes:

- yield well in a range of production situations,
- relatively easy to grow,
- resistance/tolerance to a range of biotic and abiotic stresses and
- nationally and/or internationally competitive consumer quality.

This generally requires a very large investment and a considerable period of time to achieve.

It is possible through relatively inexpensive and less time consuming breeding systems to incorporate a single attribute into the original variety. The derived variety may gain a large portion of the market that would normally have gone to the variety

from which it was derived. This would permit the breeder of the derived variety to capture an inordinate share of the value of the original variety. The derived variety may not be available for exploitation by other breeders if the invested attribute is derived from patented technology.

This type of event would deter breeders from making the investments necessary to produce the original variety due to the reduced return on investment.

There is a need to look at our PBR system to develop strategies to share the value from plant breeding investment in a more equitable manner.

Implications for the Australian PBR System

Investment needs

The arguments for Australia having an internationally competitive plant breeding industry are, in my view, more compelling now than they were when the PVR bill was passed in 1986. This is predicated on:

- need to have new attributes, particularly for health amelioration, in our agricultural and horticultural products to be nationally and internationally competitive,
- requirements for varieties whose performance is maximised in the, probably, very different production environments of the future,
- possibly the different agricultural commodities that will underpin our exports in the future and
- requirement to address the concern of incursions of pests and diseases.

I strongly believe that the investment in Australia's plant breeding industry needs to be strengthened to meet these needs. Public investment is unlikely as governments see plant varieties as a private good and the responsibility of the private sector. Public sector investment through government agencies is probably undesirable as remuneration is not competitive with the private sector.

Increased private sector investment is the preferred model for the Australian plant breeding industry but adjustments need to be made to increase the profitability of such investments. The role of the plant variety intellectual property system is pivotal to encouraging private sector investment.

I am confident that improved enforcement of plant breeder's rights in Australia will drive private sector investment but I do not know if this will be sufficient.

The argument for the small investment in low value industries is that we tend to only consider the Australian industry as the outlet for the varietal products of these programs. One option that could be explored to enhance the commercial attractiveness of investment in smaller value crops would be to develop off shore markets for the varietal outcomes of these investments. This would be particularly true for many tropical species which may be successfully commercialised in our near neighbours in the Asian and Pacific region. One impediment to realising an appropriate return on the overseas commercialisation of Australian bred plant varieties in these countries is the

lack of an effective plant variety intellectual property protection system in many of our close neighbours (Table 2). It is noted that an obligation of WTO membership is to have an effective plant variety intellectual property system. Clearly, many of our close neighbours have not achieved this.

A corollary of this is that Australia should foster the development of robust plant variety intellectual property systems among our near neighbours.

Table 2. Membership of the WTO and UPOV of many of Australia's near neighbours

Country	WTO Member	UPOV Member
Brunei Darussalam	Yes	No
Cambodia	Yes	No
Federated States of Micronesia		No
Fiji	Yes	No
Indonesia	Yes	No
Kiribati		No
Laos	Yes	No
Papua New Guinea	Yes	No
Philippines	Yes	No
Samoa	Yes	No
Solomon Islands		No
Thailand	Yes	No
Tonga	Yes	No
Vanuatu		No

Conclusion

Excellence in plant breeding is fundamental to the national and international competitiveness of many of our plant variety based industries. This is a time of great change for many of these industries. Change brings opportunities if the implications of change are well understood and adjustments are made.

Adjustment to Australian plant breeding is unlikely to come from public sector investment. However, adjustment to the PBR system may deliver the desired policy outcomes.

This would best be achieved by a much more comprehensive analysis of the issues raised here, robust consultations with interested parties and developing the policy settings necessary to enhance investment in a competitive breeding industry that enhances the national and international competitiveness of Australia's plant variety dependent industries.

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